BACHELOR OF SCIENCE (HONOURS)

BACHELOR OF SCIENCE (HONOURS)

SCHOOL OF PHYSICS

SCHOOL OF MATHEMATICAL SCIENCES

SCHOOL OF BIOLOGICAL SCIENCES

SCHOOL OF CHEMICAL SCIENCES

2022/2023

www.usm.my

Transforming Higher Education for a Sustainable Tomorrow

2022/2023

Bachelor of Science

Academic Session 2022/2023

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

CONTENTS
SECTION A
ACADEMIC INFORMATION

SECTION B
DEGREE PROGRAMME INFORMATION

UNIVERSITI SAINS MALAYSIA

ACADEMIC CALENDAR - ACADEMIC SESSION 2022/2023

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

Main Campus : Registration for New Student (07 - 09 October 2022) / **Orientation Week (10 - 14 October 2022)
Engineering Campus : Registration for New Student (08 October 2022) / **Orientation Week (08 - 14 October 2022)
Health Campus : Registration for New Student (09 October 2022) /Orientation Week (09 - 13 October 2022)**

SEM	WEEK	ACTIVITY	DATE	REMARKS
ONE	1	Teaching & Learning (T&L 7 Weeks)	Monday, 17.10.2022 - Sunday, 23.10.2022	
	2		Monday, 24.10.2022 - Sunday, 30.10.2022	24.10.2022, Monday - Deepavali**
	3		Monday, 31.10.2022 - Sunday, 06.11.2022	
	4		Monday, 07.11.2022 - Sunday, 13.11.2022	11, 12 & 13.11.2022, Friday, Saturday & Sunday - Sultan of Kelantan's Birthday (Kelantan)
	5		Monday, 14.11.2022 - Sunday, 20.11.2022	
	6		Monday, 21.11.2022 - Sunday, 27.11.2022	
	7		Monday, 28.11.2022 - Sunday, 04.12.2022	
	8	Mid Semester Break (1 Week)	Monday, 05.12.2022 - Sunday, 11.12.2022	
	9	Teaching & Learning (T&L 7 Weeks)	Monday, 12.11.2022 - Sunday, 18.12.2022	
	10		Monday, 19.12.2022 - Sunday, 25.12.2022	25.12.2022, Sunday - Christmas
	11		Monday, 26.12.2022 - Sunday, 01.01.2023	26.12.2022, Monday - Christmas 01 & 02.01.2023, Sunday & Monday - New Year of 2023
	12		Monday, 02.01.2023 - Sunday, 08.01.2023	
	13		Monday, 09.01.2023 - Sunday, 15.01.2023	
	14		Monday, 16.01.2023 - Sunday, 22.01.2023	22.01.2023, Sunday - Chinese New Year
	15		Monday, 23.01.2023 - Sunday, 29.01.2023	23 & 24.01.2023, Monday & Tuesday - Chinese New Year
	16	Revision Week (1 Week)	Monday, 30.01.2023 - Sunday, 05.02.2023	04.02.2023, Saturday - Thaipusam**
	17	Examination (3 Weeks)	Monday, 06.02.2023 - Sunday, 12.02.2023	
	18		Monday, 13.02.2023 - Sunday, 19.02.2023	
	19		Monday, 20.02.2023 - Sunday, 26.02.2023	
	20	Mid Semester Break / Industrial Training (4 Weeks)	Monday, 27.02.2023 - Sunday, 05.03.2023	
	21		Monday, 06.03.2023 - Sunday, 12.03.2023	
	22		Monday, 13.03.2023 - Sunday, 19.03.2023	
	23		Monday, 20.03.2023 - Sunday, 26.03.2023	23.03.2023, Thursday - Ramadhan
TWO	24/1	Teaching & Learning (T&L 7 Weeks)	Monday, 27.03.2023 - Sunday, 02.04.2023	
	25/2		Monday, 03.04.2023 - Sunday, 09.04.2023	08.04.2023, Saturday - Nuzul Al-Quran
	26/3		Monday, 10.04.2023 - Sunday, 16.04.2023	
	27/4		Monday, 17.04.2023 - Sunday, 23.04.2023	22 & 23.04.2023, Saturday & Sunday - Eid-ul fitr**
	28/5		Monday, 24.04.2023 - Sunday, 30.04.2023	24.04.2023, Monday - Eid-ul fitr**
	29/6		Monday, 01.05.2023 - Sunday, 07.05.2023	01.05.2023, Monday - Labour Day 04.05.2023, Thursday - Wesak Day
	30/7		Monday, 08.05.2023 - Sunday, 14.05.2023	
	31/8	Mid Semester Break (1 Week)	Monday, 15.05.2023 - Sunday, 21.05.2023	
	32/9	Teaching & Learning (T&L 7 Weeks)	Monday, 22.05.2023 - Sunday, 28.05.2023	
	33/10		Monday, 29.05.2023 - Sunday, 04.06.2023	30 & 31.05.2023, Tuesday & Wednesday - Pesta Kaamatan (Sabah) 01 & 02.06.2023, Wednesday & Thursday - Hari Gawai (Sarawak)
	34/11		Monday, 05.06.2023 - Sunday, 11.06.2023	05.06.2023, Monday - Agong's Birthday
	35/12		Monday, 12.06.2023 - Sunday, 18.06.2023	
	36/13		Monday, 19.06.2023 - Sunday, 25.06.2023	
	37/14		Monday, 26.06.2023 - Sunday, 02.07.2023	28 & 29.06.2023, Wednesday & Thursday - Eid-ul adha**
	38/15		Monday, 03.07.2023 - Sunday, 09.07.2023	07.07.2023, Friday - Penang Heritage 08.07.2023, Saturday - Penang Governer's Birthday
	39/16	Revision Week (1 Week)	Monday, 10.07.2023 - Sunday, 16.07.2023	
	40/17	***Examination (2 Weeks)	Monday, 17.07.2023 - Sunday, 23.07.2023	19.07.2023, Wednesday - Awal Muharram
	41/18	Examination (3 Weeks)	Monday, 24.07.2023 - Sunday, 30.07.2023	
	42/19		Monday, 31.07.2023 - Sunday, 06.08.2023	
*KSCP / LONG SEMESTER BREAK	43/20	Long Semester Break / Industrial Training (10/11 Weeks)	Monday, 07.08.2023 - Sunday, 13.08.2023	
	44/21		Monday, 14.08.2023 - Sunday, 20.08.2023	
	45/22		Monday, 21.08.2023 - Sunday, 27.08.2023	
	46/23		Monday, 28.08.2023 - Sunday, 03.09.2023	31.08.2023, Wednesday - National Day
	47/24	*T&L	Monday, 04.09.2023 - Sunday, 10.09.2023	
	48/25		Monday, 11.09.2023 - Sunday, 17.09.2023	16.09.2023, Friday - Malaysia Day
	49/26	Examination	Monday, 18.09.2023 - Sunday, 24.09.2023	
	50/27		Monday, 25.09.2023 - Sunday, 01.10.2023	27.09.2023, Wednesday - Prophet Muhammad's Birthday
	51/28		Monday, 02.10.2023 - Sunday, 08.10.2023	
	52/29		Monday, 09.10.2023 - Sunday, 15.10.2023	

**This Academic Calendar is subject to change

1.0 BACHELOR OF SCIENCE

1.1 General Information

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

In line with the government's aspiration and emphasis to expand heavy industries and the transfer of technology, strong training in all fields of applied science and industrial technology is needed. Due to increasing demand, a Bachelor of Pure Science programme is offered by the Pure Sciences Schools 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 Programme Structure

Students from the School of Physics, Biological Sciences, Chemical Sciences, and Mathematical Sciences can choose a Major-Minor or Major-Elective specialisation programmes. Both specialisation programmes require specific minimum credit units for graduation, to be accumulated in the duration of 6-14 semesters. Courses are divided into several parts as follows:

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

1.3 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 categorised into four levels, viz levels 100, 200, 300, and 400 suitable to the requirements for a four-year study programme.

The undergraduate courses offered according to the course structures of each programme are Basic Courses, Core Courses, Elective Courses, Minor Courses, Laboratory Courses, University Courses and Option Courses.

<u>Core Courses</u>

Core course is a compulsory course package which aims at giving a deeper understanding of an area of specialisation/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 programme 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-curriculum 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.

1.4 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

1.5 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

1.6 Graduation Requirements

Students must fulfil the following requirements to graduate:

[a] Fulfil all the credit requirements of the course and required units for each component [Core, Elective/Minor, Option and University Courses].
[b] Obtain a CGPA of 2.00 and above for Core Components.
[c] Obtain a CGPA of 2.00 and above for the programme.
[d] Achieve a minimum grade C or a grade point of 2.00 for Bahasa Malaysia, English Language, Philosophy and Current Issues (HFF225/2) and Appreciation of Ethics and Civilization (HFE224/2) course.
[e] 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 Activity

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 process based on the stipulated duration of study.

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-Registration

E-Registration is a platform for online course registration. The registration is done directly through the Campus Online portal**.** Course registration exercise for both semesters begins after the release of Official examination results of every semester.

The online registration for Long Vacation Semester (KSCP) begins officially after the release of the 2nd semester examination result.

The date of the E-Registration will be announced to the students via email during the revision week of every semester and details of the activity will be displayed in USM's official website.

All courses are allowed to be registered through E-Registration, except for co-curriculum courses. The registration of co-curriculum courses is managed by 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.

Students are required to pre-register their co-curriculum courses before the actual E-Registration activity. They are allowed to follow the respective course once the pre-registration is approved. The list of the co-curriculum courses taken will be included in their course registration data.

Access to *E-Daftar* System

a. *E-Daftar* System can be accessed through the Campus Online 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 Activity at the School

Registration activities conducted at the Schools/Centres are applicable to students who are academically active and under Probation (P1/P2) status. Students who encounter difficulties in registering their courses during the E-Registration period are allowed to register the courses at their respective School/Centre during the official period of course registration.

The official period for registration begins on the first day of the new semester until 3rd week. Registration during 4th - 6th week of the official academic calendar is considered as late registration. Hence, a penalty of RM50.00 per registration will be imposed unless justifications for the late registration are provided by the students. The Examination and Graduation Unit, Academic Management Section (Registrar Department) will manage students' late registration.

2.1.3 Course Registration General Information

1. Several information that can be referred by the students pertaining to the registration activity:

   a. The website of the respective School, for the updated information of the courses offered or course registration procedure.

b. List the courses to be registered and number of units (unit value) for each course (refer to Students Handbook for Study Programme).

Academic Status	PNG	Minimum Units	Maximum Units
Active	2.00 & Above	9	25
P1	1.99 & Below	9	12
P2		9	10

c. Students with arrears are not allowed to register any courses. You may only register courses after paying off your arrears.

2. 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

3. Academic Advisor's advice and approval are necessary.

4. Students are not allowed to register or re-sit any course with grade 'C' and above.

5. Medical, Dentistry and Pharmacy students are not allowed to register or re-sit any course with grade 'B-' and above.

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

1. The information of the 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 Schools/Centres.

5. Teaching and Learning Timetable for all Schools/Centres/Units from the three campuses.

6. List of preregistered 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	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 5400/5430	
	: 04-599 5402/5407	
Health Campus Programme Chairperson	: 09-767 1262	

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 5242/5248)

Deputy Director of the Centre for Co-Curricular Programme, Engineering Campus (04-599 5097/6308)

Deputy Director of the Centre for Co-Curricular Programme, Health Campus (09-767 2371/6625)

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 an '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 Campus Online 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' courses 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 only allowed during the first and up to the third week with approval from the Dean. Application to add a course after the third week will not be considered, except for special cases approved by the University. A RM50.00 fine will be imposed on students if reasons given for late registration are not accepted by the University or School.

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. Students who intend to drop any course are required to fill in the dropping of course form. The form needs to be signed by the lecturer of the course involved and the Dean/Deputy Dean (Academic, Career International Affairs) of the School. The form has to be submitted to the general office of the School/Centre which offers that particular course.

2. Students who wish to drop language courses must obtain the signature and stamp of the Dean/Deputy Dean (Academic, Career and International Affairs) 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/Coordinator of the 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 the *Courses during the Long Vacation* (KSCP) period.

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/ of Students' Personal and Academic Records

Students may check their personal and academic information through the Campus Online portal.
Students are advised to regularly check the information displayed on this website.

1. Student may update their correspondence address, telephone number and personal email through the Campus Online portal.

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

3. The office of the Student Data and Records Unit must be notified of any application for correction of academic data such as information on major, minor, MUET result and the course code (besides data on the examination results).

2.1.12 Academic Advisor

Each School will appoint an Academic Advisor for every 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 particular course would be given a chance to improve their grades by repeating the course during the KSCP (see below) or 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 *(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 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 Penalty for not attending the examination

Students who do not attend the examination for any of the courses they have registered must provide their reasons in writing to the Principal Assistant Registrar, Examination and Graduation Unit, Academic Management Division within 48 hours (for full-time students) and 48 hours (for Distance Learning Education programme students) after the examination being held. The reasons provided will be considered by the Examination Board of the School/Centre and endorsed by the University Examination Board as below:

1. For reasons accepted by the University Examination Board, students will be granted a DK grade (with permission). DK grade will be granted to the students if they submit Medical Certificates (from hospital/government clinic or panel clinic/USM clinic) or submit any reason that can be accepted by the University Examination Board. DK grade will be exempted from the GPA/CGPA calculations of the student.

2. Candidates who fail to sit for the examination without any reason will be granted an F* grade.

2.3.7 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 the courses, has not attended the examination without valid reasons), as well as medical reasons can be disqualified from pursuing his/her studies.

2.3.8 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 semester results document namely 'SEMGRED' through the Campus Online portal (campusonline.usm.my) on the same day/date of the results announcement.

2.3.9 Re-checking of Examination Result

Students can apply for the re-checking of their examination result for the course/s taken during the semester. The application form can be obtained from USM official website or at the Academic Management Division, Registry Department of each campus. The appeal form must be submitted along with a copy of the official receipt / e-payment statement amounting to RM25.00 for each examination paper. The appeal period is two (2) weeks after the official result is announced.

The re-checking process is only to ensure that all answers in the scripts have been marked and consistently graded and the calculation of marks awarded are correct. The answer script of the course will not be re-evaluated.

The school will confirm any changes in the students' examination results. If there are any changes in the grades or marks, students may request a refund of RM25.00. The Examination and Graduation Unit will make amendments to the results of the course and students can check their updated status in the respective Campus Online portals.

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 may only be granted for courses taken at diploma level including courses under the General Studies

Component (MPU) such as Philosophy and Current Issues and Appreciation of Ethics and Civilisations.

However, unit exemptions are not permitted for Language courses under the U1 Group of the General Studies Component (MPU).

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 the 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-level study, the student must have work experience for at least one year. The students are 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>USM Supervised IPTS (Private Institutions of Higher Learning) /External Diploma Graduates</u>:

a. Students from USM supervised IPTS/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 (at least 80% of the course must be the same) to the courses offered in USM.

[2] Students taking courses at the 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 Examination and Graduation Section or the respective Schools.

The form must be approved by the Dean of the School prior to submission to the Examination and Graduation Section 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

USM full-time Bachelor Degree level students who would like to attend specific Bachelor Degree level courses at other IPTAs.

USM full-time diploma level students who would like to attend specific diploma level courses 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 (at least 80% of the content is 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. Credits transferred are the same as the course units offered in USM. The 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 condition (i) or (ii), and take into account the programme requirement.

3. General Conditions

a. The total maximum units transferred should not exceed one-third of the total number of units for the programme.

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

c. 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.

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

e. 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.

f. 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.

g. 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.

h. 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 in academic is important because it is the main pillar in ensuring that manners and ethics with regards to higher education integrity are preserved.

Universiti Sains Malaysia encourages its students to respect and ensure that any matter relating to academic integrity are 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 of lack of integrity in academics:

1. Cheating

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

   a. Copying answers from others during tests or exams.

   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 such as hand-written notes or any smart electronic device during test or exam.

   d. Asking or allowing another student to take a test or exam on behalf and vice-versa.

   e. Sharing answers in assignments or projects.

   f. Purposely tampering with the marks/grade given in any course work, and then re-submit it for remarking/regrading.

   g. Give the command, to force, persuade, deceive or threaten others to conduct research, writing, programming or any task for a student's personal gain.

   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.

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 to educate and prevent plagiarism and can be used as the guideline if the University's staff and students violate 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 study, serve 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.

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 on every report and offence 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 represents the student's own effort nor the truth concerning a particular investigation or study and thus violates 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.

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.

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. Late to lecture, tutorial, class or other forms of teaching modes relating to their courses.
   b. Sending or submitting late any assignment relating to their courses.

   c. Hire someone else to do the assignment or thesis.

   d. Carrying out business by providing service to write assignment or thesis of the students.

   e. Any other violations that USM deemed 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 a student or students would encounter any incident that denotes academic dishonesty, the student(s) need 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 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 disciplinary procedures

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 the 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 Ringgit Malaysia Two Hundred (RM200.00);

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;

e. expulsion from the University.

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.

4. 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 yeardegree 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 & 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 disciplinary 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/Thesis 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:

<table>
<tr><th colspan="3" rowspan="2">UNIVERSITY COURSE REQUIREMENTS</th><th colspan="2">CREDIT TOTAL</th></tr>
<tr><th>Local Students</th><th>International Students</th></tr>
<tr><td colspan="3">General Studies (MPU)</td><td></td><td></td></tr>
<tr><td>U1</td><td colspan="2"><u>Local Students</u>
▪ HFF225 (Philosophy and Current Issues) (2 credits)
▪ HFE224 (Appreciation of Ethics and Civilisations) (2 credits)
▪ LKM400 (Bahasa Malaysia IV) (2 credits)
<u>International Students of Science and Technology</u>
▪ HFF225 (Philosophy and Current Issues) (2 credits)
▪ LKM100 (Bahasa Malaysia I) (2 credits)</td><td>6</td><td rowspan="2">4</td></tr>
<tr><td></td><td><u>International Students of Arts</u>
(program with Malay Language as the medium of instruction)
▪ HFF225 (Philosophy and Current Issues) (2 credits)
▪ LKM100 (Bahasa Malaysia I) (Z)
▪ LKM200 (Bahasa Malaysia 2) (U) (2 credits)</td><td><u>International Students of Arts</u>
(program with English Language as the medium of instruction)
▪ HFF225 (Philosophy and Current Issues) (2 credits)
▪ LKM100 (Bahasa Malaysia I) (U) (2 credits)</td></tr>
<tr><td>U2 (Local students)
AND
U3 (International students)</td><td colspan="2"><u>Local Students</u>
▪ WUS101 (Core Entrepreneurship) (2 credits)
▪ English Language Courses (4 credits)
<u>International Students</u>
▪ SEA205E (Malaysian Studies) (4 credits)
▪ English Language Courses (4 credits)</td><td>6</td><td>8</td></tr>
<tr><td>U4</td><td colspan="2">Co-curricular courses*</td><td>2</td><td>2</td></tr>
<tr><td>Options</td><td colspan="2">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</td><td>1-8</td><td>1-8</td></tr>
<tr><td></td><td colspan="2">CREDIT TOTAL</td><td>15-22</td><td>15-22</td></tr>
</table>

* 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-curricular courses that consist of three (3) credits. Further information can be obtained from the Academic Office, School of Dental Sciences.

3.2 General Studies Components (MPU) (14 credits)

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) HFF225 (Philosophy and Current Issues) (2 credits)

The course synopsis is as follows:

This course covers the relation between philosophy and the National Education Philosophy and Rukun Negara. Philosophy is used as a tool to refine the culture of thought in life through the art and methods of thinking as well as through our understanding of the concept of the human person. Key topics in philosophy, namely epistemology, metaphysics, and ethics, are discussed in the context of current issues. Emphasis is given to philosophy as the basis for intercultural dialogue and fostering common values. At the end of this course, students will be able to see the disciplines of knowledge as a comprehensive and integrated body of knowledge.

(ii) HFE224 (Appreciation of Ethics and Civilisations) (2 credits)

The course synopsis is as follows:

This course prepares students to appreciate the ethics and civilisation that existed in the multiple ethnic society in Malaysia to strengthen their critical and analytical thinking in handling a more

challenging life. The content of this course focuses on appreciating ethics and civilisation according to the Malaysian mould. Students will be exposed to the dynamics of the concept of ethics and civilisation that gave strength to the formation of a Malaysian nation based on the timeline of its historical evolution from the precolonial to the postcolonial era. Understanding the formation of the ethical and civilisation is discussed to increase their civil ethical appreciation towards strengthening the concept of national and Malaysian nation. Civilisation in the Malaysian mould needs to be analysed and debated in academic activity with reference to the Federal Constitution as the base for integration and a vehicle for ethics and civilisation. The development of national unity is too much influenced by globalisation and the development of information technology and complex communication. Therefore, the appreciation of ethics and civilisation has given rise to socially responsible behaviour and moved at the level of individual, community, society and nation. Therefore, the change that is happening in the society and direct economic development has brought new challenges to the strengthening of ethics and civilisation in Malaysia. Finally, High Impact Educational Practices is carried out during teaching and learning to learn the course in-depth.

(iii) 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	Credit	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 Languages, 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 following courses. In order to graduate, the minimum passing grade required is Grade C.

(i) HFF225 (Philosophy and Current Issues) (2 credits)

The course synopsis is as follows:

This course covers the relation between philosophy and the National Education Philosophy and Rukun Negara. Philosophy is used as a tool to refine the culture of thought in life through the art and methods of thinking as well as through our understanding of the concept of the human person. Key topics in philosophy, namely epistemology, metaphysics, and ethics, are discussed in the context of current issues. Emphasis is given to philosophy as the basis for intercultural dialogue and fostering common values. At the end of this course, students will be able to see the disciplines of knowledge as a comprehensive and integrated body of knowledge.

(ii) Malay Language Course (2 credits)

All international students are required to take and pass the Malay Language course. In order to graduate, the minimum passing grade required is Grade C. Malay Language course requirements by academic programme are as follows:

a) International students pursuing a Bachelor's Degree in Arts (*program with Malay Language as the medium of instruction)* are required to take the following courses:

Code	Type	Credit
LKM100	Z	2
LKM200	U	2

b) International students pursuing a Bachelor's Degree in Arts (*program with English Language as the medium of instruction*) are required to take the following course:

Code	Type	Credit
LKM100	U	2

c) International students pursuing Bachelor's Degrees in Science and Technology are required to take the following course:

Code	Type	Credit
LKM100	U	2

B. U2 or U3 Group

Local Students

WUS101 (Core Entrepreneurship) (2 credits)

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 on 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.

International Students

SEA205E (Malaysian Studies) (4 credits)

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 discusses Malaysia from the perspectives of history, politics, social, culture and economics. It looks at the relations between the country's history and its politics, the formation of a plural society that has since become its important characteristics, as well as issues related to development in Malaysia. Students will also be exposed to contemporary issues in Malaysia such as the marginalized groups, popular culture, issues related to health and wellbeing, as well as looking at Malaysia from the global context.

Local and International Students

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

(i) 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.

No.	MUET qualification/ Pre-requisite course	Grade	English Language Course	Course Type
1.	MUET **or**;	Bands 2, 2.5, 3 / 3.5	LMT100 (2 credits)	Pre-requisite/ Type Z
	Discretion of the Dean of PPBLT			
2.	MUET **or**;	Bands 4 / 4.5	LSP300 (2 credits)	Compulsory/ Type U
	LMT100 **or**;	A - C		
	Discretion of the Dean of PPBLT			
3.	MUET **or**;	Band 5	LSP 401/402/403/404 (2 credits)	Compulsory/ Type U
	LSP300 **or**;	A - C		
	Discretion of the Dean of PPBLT			
4.	MUET **or**;	Bands 5+ / 6	LHP 451/452/453/454/455/ 456/457/458/459 * all LHP courses are 2 credits except for LHP457 which is 4 credits	Compulsory/Option / Type U
	LSP401/402/403/404 **or**;	A - C		
	Discretion of the Dean of PPBLT			

(ii) 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.

No.	TOEFL (Internet Based Test)	IELTS	English Language Course	Course Type
1.	35 - 59	5.0 – 5.5	LMT100 (2 credits)	Pre-requisite / Type Z
2.	60 – 93	6.0 – 6.5	LSP 300 (2 credits)	Compulsory/ Type U
3.	94 - 109	7.0 – 7.5	LSP 401/402/403/404 (2 credits)	Compulsory/ Type U
4.	110 - 120	8.0 – 9.0	LHP Series * all LHP courses are 2 credits except for LHP457 which is 4 credits	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 credits in English Language courses, students have to pass with a minimum grade 'C'.

- Students with Bands 5+ / 6 in MUET must accumulate the 4 credits 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 credits but students 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 Bands 2/2.5/3/3.5 in MUET **may** re-sit MUET to improve their score to Band 4 OR take the LMT100 course and pass with a minimum grade C before they can register for the LSP300 course.

(iii) <u>English Language Course</u>

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 (Arts) 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

C. U4 Group

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)	St John Ambulance	Red Crescent Emergency Aid Team
WPA103/2	WJA102/2	WBM102/2
WPA203/2	WJA202/2	WBM202/2
WPA303/2	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	WSC124/1 - Sepak Takraw

WSC106/1 - Golf	WSC 125/1- Futsal
WSC110/1 - Archery	WSC 126/1 - Netball
WSC111/1 - Table Tennis	WSC127/1 - Event Management 1
WSC112/1 - Swimming	WSC227/1 - Event Management 2
WSC113/1 - Aerobics	WSC128/1 - Petanque
WSC114/1 - Squash	WSC130/1 - Orienteering
WSC116/1 - Tennis	WSC131/1 - Woodball
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	WMU112/2 – Artificial Intelligence Literacy
WMU122/2 - Data Science Literacy	

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 Options (1 – 8 credits)

A. Co-curricular course

Students who have enrolled in 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 (Sustainability: Issues, Challenges & Prospects) (2 credits)

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 (Thinking Techniques) (2 credits)

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 their 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) SHE101 (Ethnic Relations) (2 credits)

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.

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

(v) 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/Kredit	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)*

(vi) 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:

Arabic	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 Buildings 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 emerges 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 the following three undergraduate academic programs:

- Physics
- Geophysics
- Medical Physics

The main objective of the School of Physics is to produce Physics and Applied Physics graduates who are high achievers, skilful 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 the development of human capital, knowledge, and technology for a sustainable nation

ADMINISTRATIVE STAFF

DEAN

Professor Dr. Abdul Razak Ibrahim

DEPUTY DEANS

Assoc. Prof. Dr. Iskandar Shahrim Mustafa
[*Academic, Career & International*]

Assoc. Prof. Dr. Azhar Abdul Rahman
[*Research, Innovation and Industry-Community Engagement*]

PROGRAMME CHAIRMAN

Assoc. Prof. Dr. Quah Ching Kheng
[*Applied Physics & Engineering Physics*]

Assoc. Prof. Dr. Ahmad Fairuz Omar
[*Physics*]

Dr. Ramzun Maizan Ramli
[*Medical Physics*]

Dr. Andy Anderson Anak Bery
[*Geophysics*]

ADMINISTRATIVE

Mr. Hajjaj Juharullah Jaafar
[*Principal Science Officer*]

Madam Nor Farah Shaik Omar
[*Senior Assistant Registrar*]

Ms. Edzuwyn Fathin Hj Mahyuddin
[*Assistant Registrar*]

Administrative (Academics)	Telephone Extension	E-mail
DEAN		
Prof. Dr. Abdul Razak Ibrahim	3200/3814/5306	arazaki@usm.my
DEPUTY DEANS		
Academic, Career & International		
Assoc. Prof. Dr. Iskandar Shahrim Mustafa	3650/6129	iskandarshah@usm.my
Research, Innovation & Industry-Community Engagement		
Assoc. Prof. Dr. Azhar Abdul Rahman	5125/3655	hslim@usm.my
PROGRAMME CHAIRMAN		
Physics (Pure Physics Track, Electronics and Semiconductor Track, Optics and Photonic Track)		
Assoc. Prof. Dr. Ahmad Fairuz Omar	4111/5102	iskandarshah@usm.my
Applied Physics & Engineering Physics		
Assoc. Prof. Dr. Quah Ching Kheng	6128/3438	ckquah@usm.my
Medical Physics		
Dr. Ramzun Maizan Ramli	5301/5104	ramzun@usm.my
Geophysics		
Dr. Andy Anderson Anak Bery	5106/5310	andersonbery@usm.my
ADMINISTRATIVE OFFICERS		
Senior Science Officer		
Mr. Hajjaj Juharullah Jaafar	3666/2130	hajjaj@usm.my
Senior Assistant Registrar		
Mrs. Nor Farah Shaik Omar	3204	nor_farah@usm.my
Assistant Registrar		
Miss Edzuwyn Fathin Hj Mahyuddin	3025	edzuwyn@usm.my

ACADEMIC STAFF

Professors	Telephone Extension	E-mail
Abdul Razak Ibrahim, Dr.	3200/3814/5306	arazaki@usm.my
Azlan Abdul Aziz, Dr.	2930/2929/5305	lan@usm.my
Md. Roslan Hashim, Dr.	3677/2901	roslan@usm.my
Associate Professors		
Ahmad Fairuz Omar, Dr.	4111/5102	fairuz_omar@usm.my
Azhar Abdul Rahman, Dr.	5125/3655	arazhar@usm.my
Iskandar Shahrim Mustafa, Dr.	3650/6129	iskandarshah@usm.my
Lim Hwee San, Dr.	3663	hslim@usm.my
Lim Siew Choo, Dr.	5322	sclim@usm.my
Nordiana Mohd Muztaza, Dr.	5313	mmnordiana@usm.my
Quah Ching Kheng, Dr.	6128/3438	ckquah@usm.my
Shahrom Mahmud, Dr.	3643	shahromx@usm.my
Wong Chow Jeng, Dr.	5308	wongcj@usm.my
Yam Fong Kwong, Dr.	4178	yamfk@usm.my
Yoon Tiem Leong, Dr.	5314	tlyoon@usm.my
Senior Lecturers		
Andy Anderson Anak Bery, Dr.	5106/5310	andersonbery@usm.my
Beh Khi Poay, Dr.	3673	behkhipoay@usm.my
Dian Alwani Zainuri, Dr.	5323	dianalwani@usm.my
Idahwati Sarudin, Dr.	5316	idahwati@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
Mohammed Ali Dheyab, Dr.	3041	mdali@usm.my
Mohd Fareezuan Abdul Aziz, Dr.	2474	fareezuanaziz@usm.my
Mohd Mahadi Halim, Dr.	5315	mmhalim@usm.my
Mohd Marzaini Mohd Rashid, Dr.	3659	marzaini@usm.my
Mohd Zamir Pakhuruddin, Ts. Dr.	2770/5318	zamir@usm.my
Muhammad Rabie Omar, Dr.	3654	rabieomar@usm.my
Naser Mahmoud Ahmed, Dr.	5302	naser@usm.my
Nik Noor Ashikin Nik Ab Razak, Dr.	3674	nnashikin@usm.my
Norhaslinda Mohamed Tahrin, Dr.	5330	haslinda@usm.my
Norlaili Ahmad Kabir, Dr.	5317	norlailikabir@usm.my
Nur Azwin Ismail, Dr.	3676	nurazwin@usm.my

School of Physics

Nurhafizah Md Disa, Dr.	5304	mdnurhafizah@usm.my
Nursakinah Suardi, Dr.	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.	5301/5104	ramzun@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
Sya'rawi Muhammad Husni Mohd Sharoni, Dr.	5319	
Teoh Ying Jia, Dr.	5309	tyj@usm.my
Wan Maryam Wan Ahmad Kamil, Ts. Dr.	5328	wanmaryam@usm.my
Wan Mohamad Husni Wan Mokhtar, Dr.	2176	wanhusni@usm.my
Wong Khai Ming, Dr.	3678	kmwong@usm.my
Yasir Bashir, Dr.	5321	yasir.bashir@usm.my
Yasmin Md Radzi, Dr.	3667	yasminradzi@usm.my

NON-ACADEMIC STAFF

Research Officers

Siti Khadijah Mohd Bakhori, Dr.	5307/3661	skmb@usm.my
Mohd. Mustaqim Rosli, Mr.	5324/3690	mustaqim@usm.my
Yushamdan Yusof, Mr.	5306/3599	yushamdan@usm.my

Science Officers

Hajjaj Juharullah Jaafar, Mr.	3599/2130	hajjaj@usm.my
Nor Izzati Hashim, Ms.	5003/6326	norizzati@usm.my
Nur Awanis Sirat, Ms.	2471/6325	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. Among the key roles of ICAP are 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 graduates.

Industry and Community Advisory Panel	**Position/ Organization**	**Contact**
Pure Physics Mr. Tan Chun Aun	Specialist Engineer *Vitrox Corporation Bhd.*	47, Lorong Prestij 4, Taman Prestij III, 11000 Balik Pulau, Pulau Pinang Email: chunaun@gmail.com H/P: 012-6510683
Geophysics Mr. Khairool Anwar Laksamana	Senior Geophysicist *Petroleum Sarawak Berhad (Petros)*	Icom Square, CT660, Level 6, Block C, 93450, 93450 Kuching, Sarawak Email: khairool.laksamana@petroleumsarawak.com H/P: 019-8798897
Geophysics Mr. Faizan Akasyah Ghazali	Staff Exploration Capability *Petroliam Nasional Berhad (PETRONAS)*	B-14-05 Twin Residence, Jalan Pipit, Bukit Tandang, 47170 Puchong, Selangor Email: akasyah.ghazali@outlook.com H/P: 013-4668429
Geophysics Mr. Devendran Arumugam	Geotechnical Manager *MMC GAMUDA KVMRT (T) SDN BHD.*	Level 3A-3, Corporate Building (Block E) Pusat Komersial Southgate No.2, Jalan Chan Sow Lin, Off, Jalan Dua, 55200 Kuala Lumpur Email: Devendran@kvmrt-ug.com.my Tel: 03-23858000
Optics and Photonics Dr. David Lacey	R & D Director *Osram Opto Semiconductors*	2, Denai Bayu 22, Seri Tanjung Pinang 10470 Tanjung Tokong, Pulau Pinang Email: davidlacey@osram-os.com Tel: 04 – 890 4406 (O); H/P: 012-4307003
Optics and Photonics Mr. John Ong	General Manager *Genetron Company*	11 Sunbird Avenue, 487335 Singapore Email: johnong@genetron.com.my H/P: 019-3885491
Electronics and Semiconductor Dr. 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 H/P: 012-4377288
Medical Physics Mr. Rahmatfadli Marzuki	Deputy Head of Physics *National Cancer Institute, Malaysia*	No. 4, Jalan P7, Presint 7, 62250 W.P. Putrajaya Email: rffadli@yahoo.com Tel: 03-88925555
Medical Physics Encik Razali Harun	Principal Consultant/Director *REM Consultants Sdn. Bhd.*	No. 43-2, Jalan Cecawi 6/33, Seksyen 6 Kota Damansara, 47810 Petaling Jaya, Selangor Email: razalihk7@gmail.com Tel: 03-61423311

PROGRAMME STRUCTURE FOR THE DEGREE OF BACHELOR OF SCIENCE WITH HONOURS – PHYSICS

Major-Elective or Major-Minor Physics Programme

A student must attain a minimum of 2.0 CGPA ('C' average) for the whole programme and the 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 a 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**

PROGRAMME EDUCATION OBJECTIVES (PEOs)

The objectives of the programme are:

1. to develop skilled human resource in various aspects of Physics field;
2. to produce graduates with knowledge and skills in Physics aligned with the industrial needs, in particular, electronics, semiconductor, optics, and photonic industries; as well as a research organisation and higher education institutions to fulfil the market demands and needs;
3. to provide human capital equipped with logical and critical considerations in the decision making and capable to gain, develop and administer sources of knowledge; and
4. to produce graduates who appreciate cultural diversity and able to contribute and lead effectively.

PROGRAMME LEARNING OUTCOMES (PLOs)

Upon completion of this programme, the students will be able to:

1. Master the fundamental and advance Physics principles;
2. Carry out experiments, analyse and construe data;
3. Make vital decisions using logical reasoning and critical thinking;
4. Attain communication skills and teamwork;
5. Value culture and cultural diversity, and work in a team;
6. Perform the tasks professionally with values and ethics;
7. Learn independently through the ability to locate, assess, and exploit resources;

8. Build up and administer knowledge to comprehend specific business;
9. Contribute and lead efficiently as a team member to achieve maximum yield;
10. Use Computational Physics and other related software to solve Physics problems; and
11. Perform numerical method analysis to solve Physics problems.

CORE COURSES

Common Core

ZCA 101/4	Mechanics
ZCA 102/4	Electricity and Magnetism 1
ZCT 103/3	Vibrations, Waves and Optics
ZCT 104/3	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
ZCT 293/2	Physics Practical III
ZCT 307/3	Solid State Physics I
ZCT 398/8	Physics Project (two semesters)

Pure Physics Track specialisation

ZCT 214/3	Thermodynamics
ZCT 219/4	Mathematical Methods
ZCT 294/2	Physics Practical IV
ZCT 304/3	Electricity and Magnetism II
ZCT 314/3	Statistical Mechanics
ZCT 317/3	Solid State Physics II

Electronics & Semiconductor Track specialisation

ZAT 281/4	Introduction to Microprocessors
ZAT 283/3	Instrumentation
ZAT 386/4	Physics of Semiconductor Devices
ZAT 487/4	Semiconductor Fabrication Processor
ZAT 489/3	Low Dimensional Semiconductor Structure

Optics & Photonic Track specialisation

ZKT 224/3	Electronic and Photonic Materials
ZKT 244/4	Workshop Training and Product Design
ZKT 245/3	Optical Fiber and Photonic Devices
ZKT 296/2	Photonics Laboratory
ZKT 327/3	Solid State Lighting
ZAT 489/3	Low Dimensional Semiconductor Structure

Total: 72 units (21 or 22 compulsory courses, according to track)

*The course content of ZCA 110/4 overlaps with Mathematics course MAA 101/4 Calculus for Science Students 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 4 units may be selected from other Science or Applied Science programmes, not from the School of Physics.

ZCE 111/4	Computational Approach in Physics Learning
ZCE 208/3	Classical Mechanics
ZCE 275/4	Introduction to Astronomy
ZCE 277/4	Structure of the Universe
ZAE 282/3	Materials Science
ZCE 305/3	Atomic and Nuclear Physics
ZCE 321/3	The Engineer in Society
ZME 336/4	Medical Laser
ZCE 341/4	Energy Studies
ZGT 374/4	Remote Sensing
ZCE 376/4	Astronomy Principles and Practices
ZCE 378/4	Introduction to Radio Astronomy
ZMT 431/4	Radiation Biophysics
ZME 432/4	Medical Laser
ZME 438/4	Physics of Medical Imaging
ZCE 451/3	X-Ray Analysis
ZAE 484/4	Laser Technology and Its Application
ZAE 485/4	Applied Spectroscopy
ZAE 488/4	Non-Destructive Testing
ZCE 499/12	Industrial Training

Suggested Progress Schedule for Course Registration of Bachelor of Science with Honours Degree Programme – Physics (*Pure Physics Track*)

	YEAR 1				YEAR 2				YEAR 3				YEAR 4				
	SEM 1		SEM 2		SEM 1		SEM 2		SEM 1		SEM 2		SEM 1		SEM 2		
COMPONENTS	**Code**	**Cr**	**Code**	**Cr**	**Code**	**Cr**	**Code**	**Cr**	**Code**	**Cr**	**Code**	**Cr**	**Code**	**Cr**	**Code**	**Cr**	**Cr**
Core courses (T)	ZCA 101	4	ZCA 102	4	ZCT 206	3	ZCT 205	3	ZCT 307	3	ZCT 304	3					72
	ZCT 103	3	ZCT 104	3	ZCT 210	4	ZCT 219	4	ZCT 314	3	ZCT 317	3					
	ZCA 110	4	ZCT 106	3	ZCT 214	3	ZCT 294	2	ZCT 398	4	ZCT 398	4					
	ZCT 191	2	ZCT 112	3	ZCT 215	3											
			ZCT 192	2	ZCT 293	2											
Elective (E) or Minor (M) courses									#	4	#	4	#	4	ZCE 499 or @	12	30
									#	3			#	3			
University courses (U)	*WUS 101*	2	U*	2	*HFF 225*	2	*HFE 224*	2	U*	2	U*	4	U*	4			18
Total Credit Hours		15		17		17		11		19		18		11		12	**120**

Note:

U* : for details, see Chapter 3 of the BPRP

: Choose any from Part VII List of Elective Courses, and Minor courses if relevant

@ : Choose any 400 level courses from Part VII List of Elective Course

Suggested Progress Schedule for Course Registration of Bachelor of Science with Honours Degree Programme – Physics (*Electronics & Semiconductor Track*)

	YEAR 1				YEAR 2				YEAR 3				YEAR 4				
	SEM 1		SEM 2		SEM 1		SEM 2		SEM 1		SEM 2		SEM 1		SEM 2		
COMPONENTS	**Code**	**Cr**	**Code**	**Cr**	**Code**	**Cr**	**Code**	**Cr**	**Code**	**Cr**	**Code**	**Cr**	**Code**	**Cr**	**Code**	**Cr**	**Cr**
Core courses (T)	ZCA 101	4	ZCA 102	4	ZCT 206	3	ZCT 205	3	ZCT 307	3	ZAT 386	4	ZAT 487	4			72
	ZCT 103	3	ZCT 104	3	ZCT 210	4	ZAT 281	4	ZCT 398	4	ZCT 398	4	ZAT 489	3			
	ZCA 110	4	ZCT 106	3	ZCT 215	3	ZAT 283	3									
	ZCT 191	2	ZCT 112	3	ZCT 293	2											
			ZCT 192	2													
Elective (E) or Minor (M) courses									#	4	#	4	#	4	ZCE 499 or @	12	30
									#	3	#	3					
University courses (U)	*WUS 101*	2	U*	2	*HFF 225*	2	*HFE 224*	2	U*	2	U*	4	U*	4			18
Total Credit Hours		15		17		14		12		16		19		15		12	**120**

Note:

U* : for details, see Chapter 3 of the BPRP

: Choose any from Part VII List of Elective Courses, and Minor courses if relevant

@ : Choose any 400 level courses from Part VII List of Elective Courses

Suggested Progress Schedule for Course Registration of Bachelor of Science with Honours Degree Programme – Physics (*Optics & Photonic Track*)

	YEAR 1				YEAR 2				YEAR 3				YEAR 4				
	SEM 1		SEM 2		SEM 1		SEM 2		SEM 1		SEM 2		SEM 1		SEM 2		
COMPONENTS	**Code**	**Cr**	**Code**	**Cr**	**Code**	**Cr**	**Code**	**Cr**	**Code**	**Cr**	**Code**	**Cr**	**Code**	**Cr**	**Code**	**Cr**	**Cr**
Core courses (T)	ZCA 101	4	ZCA 102	4	ZCT 206	3	ZCT 205	3	ZCT 398	4	ZCT 398	4	ZAT 489	3			72
	ZCT 103	3	ZCT 104	3	ZCT 210	4	ZKT 224	3	ZCT 307	3							
	ZCA 110	4	ZCT 106	3	ZCT 215	3	ZKT 244	4	ZKT 327	3							
	ZCT 191	2	ZCT 112	3	ZCT 293	2	ZKT 245	3									
			ZCT 192	2			ZKT 296	2									
Elective (E) or Minor (M) courses									#	4	#	4	#	4	ZCE 499 or @	12	30
											#	3	#	3			
University courses (U)	*WUS 101*	2	U*	2	*HFF 225*	2	*HFE 224*	2	U*	2	U*	4	U*	4			18
Total Credit Hours		15		17		14		17		16		15		14		12	**120**

Note:

U* : for details, see Chapter 3 of the BPRP

: Choose any from Part VII List of Elective Courses, and Minor courses if relevant

@ : Choose any 400 level courses from Part VII List of Elective Courses

MINOR AREA OF SPECIALISATION

Some Minor areas of specialisation (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 programme. Please refer to the School concerned for further information on the courses offered. Note that the Minor Programme in Astronomy is offered by the School of Physics.

PHYSICS 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 necessary. However, your academic advisor should be referred to for advice.

PRIZES AND DEAN'S LIST

There is the **Bachelor of Science/Applied Science (Honours) Award** that can be won by students in each academic session after having achieved a certain level of excellence in their academic performance.

There are nine awards that can be won by students in their final year of study:

- **Universiti Sains Malaysia Gold Medal** is awarded to the best graduate of Bachelor of Science (Honours) in the field of Physics, sponsored by Tun Dato' Seri Dr. Lim Chong Eu.
- **Universiti Sains Malaysia Gold Medal** is awarded to the best graduates of Bachelor of Applied Science (Honours) in the fields of Medical Physics and Geophysics.
- **Universiti Sains Malaysia Gold Medal** is awarded to the best graduate of Bachelor of Applied Science (Honours) in the field of Geophysics, sponsored by Profesor Dr. Mohd Nawawi Mohd Nordin.
- **Honourable Dato' Professor Chatar Singh Gold Medal** is awarded to the best graduate in the field of Physics.

- **Dr. Ranjeet Singh Memorial Gold Medal** is awarded to the best graduate in the field of Geophysics.
- **Universiti Sains Malaysia Gold Medal** is awarded to the best graduate in the field of Physics (Optics and Photonic track), sponsored by Professor Emeritus Dato' Lim Koon Ong.
- **Universiti Sains Malaysia Gold Medal** is awarded to the best graduate in the field of Medical Physics.
- **Universiti Sains Malaysia Book Prize** is awarded to the best graduate of Bachelor of Science (Honours) in the field of Physics, sponsored by Datuk Abdul Rahman Yaakub.
- **Universiti Sains Malaysia Book Prize** is awarded to the best graduate of Bachelor of Science (Honours) in the field of Physics (Electronics and Semiconductor Track).

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 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 highly 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 reports including logbook, 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 regarding 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 SCIENCE WITH HONOURS PROGRAMME – PHYSICS

Semester I

Level	Course Code	Title	Pre-requisite
100	ZCA 101/4	Mechanics	
	ZCT 103/3	Vibrations, Waves and Optics	
	ZCA 110/4	Calculus	
	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	(S) ZCT 103/3
	ZCE 275/4	Introduction to Astronomy (minor in Astronomy)	
	ZAE 282/3	Materials Science	(C) ZCT 214/3
	ZCT 293/2	Physics Practical III	(S) ZCT 191/2 or (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
	ZCE 321/3	The Engineer in Society	
	ZKT 327/3	Solid-State Lighting	(C) ZCT 307/3
	ZME 336/4	Medical Instrumentation	(S) ZCT 106/3
	ZGT 374/4	Remote Sensing	(S) ZCA 102/4 and (S) ZCT 103/3
	ZCE 376/4	Principles and Practices in Astronomy (minor in Astronomy)	
	ZCT 398/8	Physics Project (two semesters)	(S) ZCT 294/2 (PP) or (S) ZCT 293/2 (ES) or (S) ZKT 296/2 (OP)
400	ZMT 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
	ZAE 485/4	Applied Spectroscopy	(S) ZCT 215/3
	ZAT 487/4	Semiconductor Fabrication Processor	(S) ZAT 386/4
	ZAT 489/3	Low Dimensional Semiconductor Structures	(S) ZCT 307/3

Semester II

Level	Course Code	Title	Pre-requisite
100	ZCA 102/4	Electricity and Magnetism I	(S) ZCA 101/4
	ZCT 104/3	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) ZCA 110/4 or (S) MAA 101/4
	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 224/3	Electronic and Photonic Materials	(S) ZCT 106/3 and (S) ZCT 210/4
	ZKT 244/4	Workshop Training and Product Design	(S) ZCT 192/2
	ZKT 245/3	Optical Fiber and Photonics Devices	(S) ZCT 106/3 and (S) ZCT 215/3
	ZCE 277/4	Structure of the Universe (minor in Astronomy)	
	ZAT 281/4	Introduction to Microprocessors	(P) ZCT 206/3
	ZAT 283/3	Instrumentation	(P) ZCT 206/3 and (S) ZCT 293/2
	ZCT 294/2	Physics Practical IV	(S) ZCT 191/2 or (S) ZCT 192/2
	ZKT 296/2	Photonics Laboratory	(S) ZCT 293/2
300	ZCT 304/3	Electricity and Magnetism II	(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
	ZCE 341/4	Energy Studies	(S) ZCA 101/4 and (S) ZCA 102/4
	ZCE 378/4	Introduction to Radio Astronomy (minor in Astronomy)	
	ZAT 386/4	Physics of Semiconductor Devices	(S) ZCT 106/3 and (S) ZCT 307/3

			School of Physics
	ZCT 398/8	Physics Project (two semesters)	(S) ZCT 294/2 (PP) or (S) ZCT 293/2 (ES) or (S) ZKT 296/2 (OP)
400	ZME 432/4	Medical Laser	(S) ZCT 104/3
	ZAE 484/4	Laser Technology and Its Application	(S) ZCT 104/3
	ZAE 488/4	Non-Destructive Testing	(S) ZCT 104/3
	ZCE 499/12	Industrial Training	(S) ZCT 398/8 or (S) ZGT 395/8 or (S) ZMT 397/8

Note:

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

SYNOPSES OF CORE COURSES

ZCA 101/4 Mechanics

Unit, dimension. Kinematics. Vectors. Newton's Laws. Work. Conservation of energy and momentum. Collision. Simple harmonic motion. Universal gravitation, gravitational force. Planets' motion. Extended systems, inertia. Angular momentum, rotational dynamics. Rigid body, equilibrium, statics. Elasticity, stress, strain, and torsion. Young's modulus. Compression of fluids, surface tension, hydrostatics, viscosity, viscoelasticity. Hydrodynamics.

Learning Outcomes
Upon completion of this course, students are able to:
1. Describing the principle of basic mechanics.
2. Solve problems related to basic mechanical principles.
3. Analyse application-related problems involving mechanics principles.

ZCA 102/4 Electricity and Magnetism I

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 a 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. Define the electricity and magnetism principles that governed and affect the universe.
2. Illustrate the physical phenomena regarding electricity and magnetism using the appropriate principles of electricity and magnetism.
3. Attribute principles of electricity and magnetism to solve given problems.

ZCT 103/3 Vibrations, Waves and Optics

Simple harmonic motion, damped, forced oscillator. Logarithmic decrement, resonance, and Q factor. Transverse waves and longitudinal waves. Reflection and transmission of waves at boundaries. Stationary waves. Superposition of waves. Dispersion of waves. Electromagnetic wave spectrum. Plane electromagnetic waves in a vacuum. Propagation of light waves, amplitude, and intensity. Doppler effect. Interference. Polarization of lights.

Learning Outcomes
Upon completion of this course, students are able to:
1. Explain the basic principle involved in vibrations, waves, and optics.
2. Solve problems related to the topics of vibration, waves, and optics.
3. Analyze application-related problems involving vibration, waves, and optics.

ZCT 104/3 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 Schrödinger 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. Describes the historical development of relativity theory and quantum theory.
2. Identify basic ideas in the theory of special relativity, conceptual differences between modern and classical Physics in the modeling of the laws of Physics.
3. Describe problems involving the theory of special relativity and concepts between modern and classical Physics in the modeling of the laws of Physics.

ZCT 106/3 Electronics I

Analysis of circuits. Kirchhoff’s laws. Thevenin’s Theorem and Norton’s Theorem. Alternating current circuits. Characteristics of diodes and their uses in circuits, rectifying circuits, doped semiconductors. Signal processing circuits. Bipolar junction transistors and Field effect transistors, input characteristics and output characteristics. Signal amplification, distortion, and frequency response. 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 theorem concept and circuit law.
2. Solve the electronics circuit problems by using theorem and circuit law.
3. Elaborate on the current electronics industry applications by using electronics fundamental knowledge.

ZCA 110/4 Calculus

Sets, real, rational, and complex numbers. Relationships and functions. Sequences and series, convergence tests, function limits, continuity, mean value theorems. Differentiation techniques, implicit differentiation, high-level derivatives, maximum, minimum, Rolle's theorem, L'Hopital tips, use of derivatives, proper and improper integrals, and curve lengths. Circular, logarithmic, exponential, hyperbolic and inverse functions.

Learning Outcomes
Upon completion of this course, students are able to:
1. State the definition and/or properties of basic concepts, theorems and/or rules of calculus.
2. Apply the rules and/or techniques of calculus to solve symbolic and/or graphical problems.
3. Determine the appropriate calculus concepts, rules, and techniques to be used and hence solve symbolic, graphical and/or physical problems.

ZCT 112/3 Linear Algebra and Vector Analysis

Linear Algebra: matrix algebra, determinant, inverse of matrix, systems of linear equations, eigenvalue problem, matrix diagonalisation.
Vector Analysis: vector algebra, scalar and vector fields, vector transformation, unit vectors. Differentiation, gradient, divergence, curl. Multiple integrals, line, surface, and volume integrals. Green's Theorem, Stoke's Theorem, Gauss Divergence Theorem. Coordinate Systems: Cartesian, curvilinear.

Learning Outcomes
Upon completion of this course, students are able to:
1. Explain the basic concepts in major operations for vector calculus and matrix algebra.
2. Solve eigenvalue problems by applying theories in linear algebra.
3. Solve vector integrals using integral theorems using a suitable coordinate system.

ZCT 191/2 Physics Practical I

A selection of experiments which are related to physics subjects namely optics, electronics, heat, mechanics, and radioactivity.

Learning Outcomes
Upon completion of this course, students are able to:
1. Correlate basic concepts of physics with the experiments performed
2. Explain verbally the physical concepts involved in the experiment performed and the results of the experiment achieved.
3. Share ideas and experiment findings with peers in the same group so that the experiment can be carried out smoothly.
4. Demonstrate how to conduct experiments responsibly and with integrity by adhering to the experimental methodology and safety measures given.

5. Organize experimental data in a structured and orderly manner so that data analysis can be carried out in order.
6. Discriminate experimental results based on concepts of physics and to check through analysis of related references to verify the experimental results.
7. Demonstrate, as a team member or leader, knowledge and understanding gained to complete the experimental work with an effective working practice.
8. Evaluate the experiment data and to deduce the accuracy of the experiment using appropriate software for statistical analysis of data.

ZCT 192/2 Physics Practical II

A selection of experiments which are related to physics subjects namely optics, electronics, heat, mechanics, and radioactivity.

Learning Outcomes

Upon completion of this course, students are able to:

1. Correlate basic concepts of physics with the experiments performed.
2. Explain verbally the physical concepts involved in the experiment performed and the results of the experiment achieved.
3. Share ideas and experiment findings with peers in the same group so that the experiment can be carried out smoothly.
4. Demonstrate how to conduct experiments responsibly and with integrity by adhering to the experimental methodology and safety measures given.
5. Organize experimental data in a structured and orderly manner so that data analysis can be carried out in order.
6. Discriminate experimental results based on concepts of physics and to check through analysis of related references to verify the experimental results.
7. Demonstrate, as a team member or leader, knowledge and understanding gained to complete the experimental work with an effective working practice.
8. Evaluate the experiment data and to deduce the accuracy of the experiment using appropriate software for statistical analysis of data.

ZCT 205/3 Quantum Mechanics

Wave function, observables, Hermitian operators, Schrödinger equation, normalization, commutation relation, eigenfunction and eigenvalue, uncertainty principle, postulates of quantum mechanics, solution of time-independent Schrödinger equation for a one-dimensional system subject to various potentials, vector space, Hilbert space, Dirac notation, determinate states, quantum mechanics in three dimensions, orbital and spin angular momentum.

Learning Outcomes

Upon completion of this course, students are able to:

1. Explain various concepts, theorems, principles, laws, and postulates in quantum mechanics.
2. Solve simple quantum mechanical problems using wave mechanics, matrix mechanics, Dirac notation and Hermitian operators.

3. Solve one and multi-dimensional problems in quantum mechanics using time-independent Schrödinger equation.
4. Solve problems involving orbital and spin angular momentum.

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, don't care state, decoder, multiplexer, encoder, and demultiplexer. 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 subtractor. Design of sequential logic systems: state diagram, truth table, and timing diagram. Extension from the exited table, circuit design from truth table and timing diagram. Examples of logic circuit applications: memory system, memory decoding, and basic architecture of microprocessor system."

Learning Outcomes

Upon completion of this course, students are able to:

1. Explain the features of number systems and the basic concepts of the function and application of digital electronic devices.
2. Solve problems involving the construction and interpretation of digital electronic circuits in various forms of representation.
3. Build logic gates that are well functioning.

ZCT 210/4 Complex Analysis & Differential Equations

Complex Analysis: complex numbers, complex functions, differentiation and integration of complex functions, power series of analytic functions, Residue Theorem, applications of Residue Theorem.
Differential Equations: First order and linear second-order ordinary differential equations and methods of the solution including series solutions with power series and Frobenius methods.

Learning Outcomes

Upon completion of this course, students are able to:

1. Explain the theories and basic concepts in ordinary differential equations, and complex numbers including complex functions.
2. Exhibit ability to solve first order and linear second-order ordinary differential equations using suitable techniques.
3. Identify suitable methods and theorems to evaluate contour integrals including using the Residue Theorem and its applications.

ZCT 214/3 Thermodynamics

Simple thermodynamic systems, equation of state, work, heat, first law, internal energy, results of the first law, ideal gas. Carnot cycle and heat engine. Second law and results of

thermodynamics, entropy, irreversible process. Combination of first and second laws, T-S diagram, and thermodynamic relationships. Maxwell, Clausius-Clapeyron and TdS equation.

Learning Outcomes
Upon completion of this course, students are able to:
1. Analyze the problem of a thermodynamic process based on the laws of thermodynamics to calculate the variables.
2. Relate thermodynamic principles to solve thermodynamic process problems for a closed system.
3. Solve a realistic problem using appropriate thermodynamic principles.

ZCT 215/3 Optics

Polarization. Plane and circular polarization. Optical activity. Kerr effect and Faraday effect. Dispersion theory. Diffraction. Cornu spiral and Fresnel Integrals. Zone plates. Fresnel diffraction for straight edges and rectangular aperture. Application of optics: laser, fibre optics and light detection.

Learning Outcomes
Upon completion of this course, students are able to:
1. Explain the basic principles involved in optics.
2. Attribute the principles of optics in the context of applications.
3. Analyze problems that involve principles of optics and relatable applications.

ZCT 219/4 Mathematical Methods

Wave, heat, and Laplace equations: solution by separation of variables technique. Partial differential equations: Sturm-Liouville boundary value problems. Fourier analysis: expansion of functions in terms of sines and cosines, properties, physical examples. Special functions/equations: Gamma, Bessel, Legendre, and associated Legendre. Integral transforms: Laplace and Fourier transform, general properties, applications.

Learning Outcomes
Upon completion of this course, students are able to:
1. Solve problems related to Fourier series representation of periodic functions.
2. Solve the heat, wave and Laplace equations using the method of separation of variables.
3. Solve problems related to Laplace and Fourier integral transforms.
4. Recognize special functions such as the Bessel, Legendre and associated Legendre functions and use them in solving physical problems.

ZKT 224/3 Electronic and Photonic Materials

Classes of materials and their forms. Growth of single-crystal material, thin-film by sputtering, sol-gel epitaxy, etc. Characterization of thin-film and bulk material: electrical, optical, surface etc. Device fabrication process: implantation, lithography, metallization, etc. Type of junctions; Materials for Electronic Devices such as LED, lasers, PD, PC, etc.

Learning Outcomes

Upon completion of this course, students are able to:

1. Identify the class of materials using atomic theory and energy pathways based on their dimensions.
2. Describe how the material is grown, characterised and used for device fabrication.
3. Relate electronic and photonic materials to the basic description of the operation of the devices.

ZKT 244/4 Workshop Training and Product Design

Students will be taught 3D printing, laser cutting, electronics and machining work. They will learn how to design software and micro-controller electronic circuits. They will also experience product designing and project management. At the end of the course, they must produce their own creative prototype and give a presentation.

Learning Outcomes

Upon completion of this course, students are able to:

1. Explains the product design process.
2. Demonstrate the ability to operate 3D printers, laser cutter, electronics circuit and workshop machines following safety procedures.
3. Relate the product design innovation ideas with customer needs to overcome problems.
4. Implement product design projects.

ZKT 245/3 Optical Fiber and Photonic Devices

Fiber Optic Technology: design, fabrication, and application
Optical Communication Devices: Transmitter, Receiver, Modulator, Amplifier, Repeater, Fiber Media, and Multiplexer.
Data Transmission: Modulations (AM, FM, PCM), Multiplexing, and Demultiplexing (TDM, FDM, WDM), data rate, noise ratio, bandwidth, bitrates.
Optical Communication Network System
Photonic Devices: radiometer, interferometer, acousto-optic modulator and electro-optic modulator.
Integrated Optics: Waveguides

Learning Outcomes

Upon completion of this course, students are able to:

1. Explain the basic concepts attributed to optical fiber technology and photonic devices.
2. Construct optical fiber network system based on specific operation principles.
3. Analyse and solving problems in optical fiber networks that consisted of photonic devices.

ZAT 281/4 Introduction to Microprocessors

Design and function of microprocessor systems; internal bus structure, command cycle, machine cycle, command flow in CPU, decoder and controller, program counter, command register tool, address, data, and control. Data transfer and timer diagrams. Microprocessor

and assembly language programming instructions. Compilation and access of software and hardware. Memory interface, input, and output port.

Learning Outcomes
Upon completion of this course, students are able to:
1. Explain the basic microprocessor system.
2. Implement the assembly language program to control the microprocessor system.
3. Prepare assembly language programs to control microprocessor systems.
4. Participate effectively in a group while working on a project.

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. Explain the main elements and related properties of an instrumentation system involving measurement, control, comparison, processing, and actuation.
2. Apply knowledge related to sensors and electronic devices in analyzing and constructing instrumentation.
3. Engage effectively in groups when running a project.

ZCT 293/2 Physics Practical III

A selection of experiments related to physics subjects namely optics, electronics, mechanics, and Modern Physics.

Learning Outcomes
Upon completion of this course, students are able to:
1. Correlate basic concepts of physics with the experiments performed.
2. Explain verbally the physical concepts involved in the experiment performed and the results of the experiment achieved.
3. Share ideas and experiment findings with peers in the same group so that the experiment can be carried out smoothly.
4. Demonstrate how to conduct experiments responsibly and with integrity by adhering to the experimental methodology and safety measures given.
5. Organize experimental data in a structured and orderly manner so that data analysis can be carried out in order.
6. Discriminate experimental results based on concepts of physics and to check through analysis of related references to verify the experimental results.
7. Demonstrate, as a team member or leader, knowledge and understanding gained to complete the experimental work with an effective working practice.
8. Evaluate the experiment data and to deduce the accuracy of the experiment using appropriate software for statistical analysis of data.

ZCT 294/2 Physics Practical IV

A selection of experiments related to physics subjects namely optics, electronics, mechanics, and Modern Physics.

Learning Outcomes

Upon completion of this course, students are able to:

1. Correlate basic concepts of physics with the experiments performed
2. Explain verbally the physical concepts involved in the experiment performed and the results of the experiment achieved.
3. Share ideas and experiment findings with peers in the same group so that the experiment can be carried out smoothly.
4. Demonstrate how to conduct experiments responsibly and with integrity by adhering to the experimental methodology and safety measures given.
5. Organize experimental data in a structured and orderly manner so that data analysis can be carried out in order.
6. Discriminate experimental results based on concepts of physics and to check through analysis of related references to verify the experimental results.
7. Demonstrate, as a team member or leader, knowledge and understanding gained to complete the experimental work with an effective working practice.
8. Evaluate the experiment data and to deduce the accuracy of the experiment using appropriate software for statistical analysis of data.

ZKT 296/2 Photonics Laboratory

Selected experiments in basic photonics application such as reflection, refraction and optical wave guiding experiments to more complex experiments such as erbium-doped fibre amplifiers and optical network analysis experiments.

Learning Outcomes

Upon completion of this course, students are able to:

1. Relate the basic concepts of Physics to photonic experiments conducted
2. Present orally the concepts of Physics embedded in the photonic experiments.
3. Share opinions and findings of experiments with partners in the same group so that photonic experiments can run smoothly.
4. Demonstrate how to conduct experiments responsibly and with integrity by adhering to the methodology and safety measures of photonic experiments that have been demonstrated.
5. Organise photonic experimental data in a neat and complete manner so that data analysis can be carried out orderly.
6. Implement time control used to complete photonic experimental tasks within the allotted time.
7. Demonstrate knowledge and understanding expressed in the practice of working effectively as a member/leader in the process of completing photonic experimental work.
8. Analyse data using suitable software.

ZCT 304/3 Electricity and Magnetism II

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

Learning Outcomes
Upon completion of this course, students are able to:
1. Explain the definition of fundamental principles of electricity, magnetism, and electromagnetic phenomena.
2. Solve problems related to the derivation of laws that govern the space-time behaviour of electric fields, magnetic fields, and electromagnetic waves.
3. Solve problems related to electricity and magnetism that involve different geometrical configurations and dimensions.

ZCT 307/3 Solid State Physics I

Crystal structure, classification of interatomic binding. 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, effective mass. Semiconductor-intrinsic and extrinsic. Carrier density. Conductivity of impurities, Hall effect.

Learning Outcomes
Upon completion of this course, students are able to:
1. Demonstrate the difference in the crystal structure of various solids.
2. Correlate the characteristics of a crystal to its structure.
3. Compute and solve the problems which are related to solid-state physics.

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. Relate the derivation of physics equations of thermodynamics and statistical mechanics based on statistics/probabilities and micro/quantum states approaches.
2. Solve a few simple physics problems based on statistics/probabilities and micro/quantum states approaches.
3. Study applications of statistical mechanics in more complicated or difficult physical systems.

ZCT 317/3 Solid State Physics II

Introduces basic concepts in solid-state physics, with emphasis on electron energy band in solids, Fermi surface, electron dynamics in the magnetic field, superconductivity, quantum mechanical quasiparticles, dielectric and ferroelectrics, optical properties, and magnetic properties.

Learning Outcomes
Upon completion of this course, students are able to:
1. Explain the theories and principles of solid-state physics.
2. Describe the facts related to solid-state physics including derivation and methods.
3. Compute and solve the problems related to the properties of solid-state physics.

ZKT 327/3 Solid State Lighting

Solid-State Lighting will cover a brief introduction to semiconductor material systems and growth techniques used for producing light-emitting diodes (LEDs). The basics 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. Describe the basic fabrication, structure, characteristics, and operation as well as other applications of light-emitting diodes.
2. Relate the structure, semiconductor material, design, metal contact of the light-emitting diode to the photon emission efficiency.
3. Describe the factors related to the efficiency of photon emission for light-emitting diodes.

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 theories, characteristics of materials and operation of semiconductor devices.
2. Solve problems involved in semiconductor devices.
3. Present operation of semiconductor devices clearly and with confidence.

ZCT 398/8 Physics Project

This course combines basic knowledge and continuous learning and is realized in the form of a scientific project. The success of students is evaluated in terms of the ability to conduct and accomplish the project responsibly in the form of a dissertation which will be assessed based on the quality and the achieved objectives. At the end of the course, students will present the project to be evaluated by supervisors and examiners.

Learning Outcomes

Upon completion of this course, students are able to:

1. Evaluate models, experimental designs, analysis, or scientific observation to meet the objectives of the project.
2. Demonstrate presentation skills needed for effective communication in describing the purpose, scope and conclusions related to the study.
3. Demonstrate accountability and professional ethics in ensuring the authenticity of the research work.
4. Correlate information related to the results of the project studied.
5. Practice good management throughout the project.
6. Evaluate the experiment data and to deduce the accuracy of the experiment using appropriate software for statistical analysis of data.

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 the junction, for 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. Analyse processes involved in the fabrication of wafer and semiconductor devices.
2. Fabricate semiconductor devices on silicon wafers based on the fabrication processes.
3. Present semiconductor fabrication processes clearly and with confidence.

ZAT 489/3 Low Dimensional Semiconductor Structures

The course starts with basic exposure to 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 the characteristics and problems related to low-dimensional systems.
2. Analyse problems in low dimensional systems involving quantum heterostructures and quantum wells.
3. Carry out a literature review and report writing on the role of low dimensional semiconductors in 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 visualisation; interpolation, extrapolation, and fitting of data points; numerical root-finding; solving first and second-order differential equations numerically; numerical integration; visualisation of geometry in two and three dimensions; simulation of motion in classical physics; simulation of wave propagation.

Learning Outcomes
Upon completion of this course, students are able to:
1. Identify how to solve numerical problems and physical modeling using selected computer software packages.
2. Writing programming algorithms to solve numerical problems.
3. Data manipulation using selected computer software packages.
4. Provide solution schemes for physical problems or numerical problems in the form of mini-projects using computerised methods.

ZCE 208/3 Classical Mechanics

Vector calculus, kinematics. Particle motion, system of particles, conservation laws, Newtonian mechanics: resistive motion, central force, rocket equation. Motion in non-inertial frame systems, Coriolis force. Analytical Mechanics: Calculus of variation, Euler equation. Hamilton's principle, Lagrangian and Hamiltonian dynamics. Generalised coordinates. Lagrange equation. Generalised coordinates. Lagrange multiplier. Hamilton's canonical equation.

Learning Outcomes
Upon completion of this course, students are able to:
1. Explain the fundamental concepts in Classical Mechanics.
2. Solve the problems involving Newtonian Mechanics and Lagrangian and Hamiltonian Dynamics.
3. Identify the most suitable solution method in Classical Mechanics for problems in the actual situation.

ZCE 275/4 Introduction to Astronomy

Foundations and history of astronomy; structure of the Universe; coordinate systems; time; charts and catalogues; spherical triangles; light; telescopes; effects of the atmosphere; observation planning and techniques; detectors and CCDs; photometry; astrometry; spectrographs; spectroscopy; observing variable stars and the Sun; astrophotography and image processing; modern astronomy; and night observation sessions.

Learning Outcomes
Upon completion of this course, students are able to:
1. Identify the basics of astronomy.
2. Identify, set up and manipulate astronomical equipment.
3. Present the principles and techniques of astronomical observations.

ZCE 277/4 Structure of the Universe

Introduction to the Universe; electromagnetic waves; the Solar System; exoplanets; the Sun and stars; the interstellar medium; stellar formation, evolution, and explosions; neutron stars and black holes; the Milky Way galaxy; galaxies and dark matter; cosmology and the early Universe; and life in the Universe.

Learning Outcomes
Upon completion of this course, students are able to:
1. Describe the various celestial objects and structures that make up the universe.
2. Explain the characteristics of various celestial objects and the physical processes operating within them.
3. Analyse the evolutionary processes and interactions between several celestial objects.

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. Explain the characteristics of metal, ceramic, polymer, alloy, and composite material.
2. Compute the index of the crystal lattice plane and the crystal structure.
3. Explain the crystal defects and material phase changes through the phase diagram.
4. Determine the measurement and characterization of materials for electronic, magnetic, and photonic materials.

ZCE 305/3 Atomic and Nuclear Physics

Hydrogen atom states. Angular momentum. Many-electron atom. Electron spin. Pauli exclusion principle. Symmetric/antisymmetric wave functions. Spin orbit coupling (LS/JJ). Atomic spectra. Selection rules. One/two valence electron-atom. Zeeman effect (normal/anomalous). Nuclear general properties. Nuclear force, deuteron problem. Radioactivity, alpha/gamma decay, electron capture. Internal conversion. Nuclear reactions. Nuclear models, magic numbers.

Learning Outcomes
Upon completion of this course, students are able to:
1. Explain various atomic and nuclear structures, including the nuclear transformation processes.
2. Solve problems related to the quantum theory of atomic structure.
3. Solve problems related to nuclear structure and nuclear transformation processes.

ZCE 321/3 The Engineer in Society

Engineering profession – Impact of technology on society and environment – responsibility of engineers. Code of ethics – themes of ethics, 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, behavioural management.

Learning Outcomes
Upon completion of this course, students are able to:
1. Explain the field of engineering, the noble qualities of an engineer and the basics of management.
2. Propose solutions to problems in engineering-based projects.
3. Explain ethical issues in the engineering profession.
4. Study issues related to engineering, ethics and management using critical thinking and literature review.

ZME 336/4 Medical Instrumentation

The course will expose the students to the various modern diagnostic instrumentations and will help student to be capable of intelligent self-supervision of such equipments.

Learning Outcomes
Upon completion of this course, students are able to:
1. Describe the physics principles of diagnostic medical instrumentation using ionising and non-ionising radiation.
2. Distinguish the usage and application of diagnostic medical instrumentation.
3. Explain the physics principles and different concepts of diagnostic medical instrumentation.

ZCE 341/4 Energy Studies

History of energy use. Malaysia's energy situation. Renewable energy and its types: solar thermal, solar photovoltaic, biomass, hydro, wind, geothermal. Sunlight, spectrum distribution of sunlight. Solar collectors. Solar cell technology. Biomass, bio-energy. Biomass energy conversion process: direct combustion, pyrolysis, gasification, fermentation, anaerobic digestion. Hydro power. Wind power. Geothermal.

Learning Outcomes

Upon completion of this course, students are able to:

1. Explore the process of generating power from existing alternative energy sources and renewable energy.
2. Analyse alternative energy and renewable energy sources.
3. Propose solutions to overcome the problem of energy issues in groups.

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. Describe the basic concepts used in remote sensing.
2. Analyse remote sensing data for remote sensing applications.
3. Describe remote sensing techniques for remote sensing applications.
4. Propose a mini project in terms of data acquisition plan and data analysis procedures (visual or image processing).

ZCE 376/4 Principles and Practices in Astronomy

Celestial mechanics; continuous spectrum of light; special relativity; interaction of light and matter; stellar spectra and atmospheres; interior of stars; stellar pulsation; degenerate remnants of stars; general relativity and black holes; physical processes in the Solar System; nature and evolution of galaxies; structure of the universe; cosmology; early universe.

Learning Outcomes

Upon completion of this course, students are able to:

1. Explain and clarify the theories used to interpret the physical processes and interactions between celestial objects.
2. Explore various universal phenomena and relate them with astronomical theories and observational data.
3. Analyse and elaborate on the cosmological models that explain the formation and evolution of the universe.

ZCE 378/4 Introduction to Radio Astronomy

Radio observations and radio waves; spectral lines; radio wave propagation; the nature of radio signals; radiometers, spectrometers and polarimeters; single-aperture radio telescopes; the basics of interferometry; aperture synthesis; further interferometric techniques; the Sun and the planets; stars and Nebulae; the Milky Way; pulsars and active galaxies; the contributions to cosmology.

Learning Outcomes
Upon completion of this course, students are able to:
1. Explain the principles, practices and importance of radio astronomy.
2. Relate the radio data received on Earth with the physical processes that happen in the sky.
3. Identify and appreciate the contributions of radio astronomy towards mankind.

ZMT 431/4 Radiation Biophysics

Introduction to the basic of ionising and non-ionising radiation and interaction of radiation with matter. The course also includes the mechanism of production of radionuclides and its use in tracer techniques, interaction of neutrons, alpha particles, heavy nuclei and nuclear fission fragments with the matter, detection and measurement of radiation, radiation dosimetry, radiation dosimetry and biological effects of radiation.

Learning Outcomes
Upon completion of this course, students are able to:
1. Explain the basic and principle of radiation and radioactive with its biological effects on humans.
2. Describe concept in detection and measurement for radiation and radioactive.
3. Explain the basic and principle of radiation and radioactive with its biological effects on humans.
4. Organise and analyse radiation and radioactive information from external resources.

ZME 432/4 Medical Laser

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 the student to understand laser classifications and radiation hazards as well as laser safety and management of laser equipment. Topic on the regulatory aspect of non-ionising radiation (NIR) safety will also be highlighted.

Learning Outcomes
Upon completion of this course, students are able to:
1. Describe the laser principles and their medical application.
2. Describe aspects of safety regulations in the use of lasers.
3. Organize laser application information in the medical field for the purpose of diagnosis and therapy as well as laser safety and hazard aspects.

ZME 438/4 Physics of Medical Imaging

This course introduces the main methods of medical imaging and enables students to develop an understanding of the physics principles underlying these imaging techniques and an awareness of their clinical applications.

Learning Outcomes
Upon completion of this course, students are able to:
1. Correlate all the basic principles in medical image processing.
2. Describe the methods of medical imaging for the main medical imaging tools.
3. Comply with the principles of image processing in the use of medical imaging equipment systems.
4. Analyse medical images using image processing software.

ZCE 451/3 X-Ray Analysis

X-ray production using Coolidge tube and the synchrotron methods with the definition of crystal and its symmetries. Point groups, Laue groups and space groups from triclinic, monoclinic, and orthorhombic systems. Miller indices, zone 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. Bragg's law in equation form as well as in the Ewald sphere construct. Electron map diagrams. X-ray fluorescence, 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. Identify the crystal structure using X-ray diffraction methods.
2. Choose the appropriate method for analysing different materials.
3. Explain the theory and principles of X-ray diffraction work.

ZAE 484/4 Laser Technology and Its Application

This course will focus on the introduction to the 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. Demonstrate the basic properties and characteristics of lasers, types of lasers along with excitation methods.
2. Describe laser design for different applications.
3. Explain the protection and the safety against laser radiation.

ZAE 485/4 Applied Spectroscopy

Introduce common units in spectroscopy using general equipment for absorption, scattering and absorption experiment. Discuss the interaction of electromagnetic radiation with atoms and molecules, symmetry of molecules, rotational spectroscopy, electronic spectroscopy, atomic spectroscopy, diatomic and polyatomic molecules spectroscopy, photoelectron spectroscopy, auger electron spectroscopy and X-ray fluorescence spectroscopy.

Learning Outcomes
Upon completion of this course, students are able to:
1. Solve simple spectrum patterns based on spectroscopy theories.
2. Correlate different spectrums for spectroscopy application.
3. Discuss spectroscopy applications.
4. Present in a clear manner and suitable for audience level regarding spectroscopy applications.

ZAE 488/4 Non-Destructive Testing

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

Learning Outcomes
Upon completion of this course, students are able to:
1. Describe in detail the NDT method for the evaluation and examination of engineering materials.
2. Describe the calibration standards, the scope, and the limitations of the method.
3. Propose appropriate equipment for problem analysis.

ZCE 499/12 Industrial Training

Industrial training will be carried out and last for 6 months in the fourth year, semester 2. Student will be assigned at the industrial, hospital or institution which is identified by the school or the student himself/herself. Student 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. Demonstrate how to communicate effectively with various levels.
2. Implement social skills and be responsible effectively.
3. Practicing ethical and professional values in the workplace.
4. Relate experience in the industry to what is learned in university.
5. Implement the concept of leadership skills in oneself.

Index

Core Courses

Elective Courses

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 instil awareness among chemistry students towards the welfare of 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 35 academic staff and over 38 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 is 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 that can be modified and adjusted from time to time to suit the requirements of an unpredictable future. The School practice a flexible system, dynamics and multi-disciplinary.

Our programmes are recognised nationally by the Malaysian Institute of Chemistry (Institut Kimia Malaysia).

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 1 semester of industrial training with industrial partners, commercial or research laboratories (compulsory for B.App.Sc (Hons.) (Industrial Chemistry)). Students are also encouraged to register for Chemistry Project which covers 2 semesters.

The postgraduate programmes offer M.Sc. and Ph.D. in research mode or the mixed-mode M.Sc. (Chemical Instrumentation) which has 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 for 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 139 postgraduate students engaging in various areas of research including natural products, organic and inorganic synthesis, nanoscience, electrochemistry, liquid crystals, organometallics, environmental chemistry, polymer chemistry, separation, sensor and material chemistry. 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. Mohd Rizal Razali
(Academic, Career & International)

Assoc. Prof. Dr. Ng Eng Poh
(Research, Innovation & Industry-Community Engagement)

PROGRAMME MANAGERS

Dr. Ng Si Ling
Physical Chemistry

Assoc. Prof. Dr. Oo Chuan Wei
Organic & Inorganic Chemistry

Dr. Mardiana Saaid
(Analytical Chemistry)

Assoc. Prof. Dr. Noor Ha Hanif Abu Bakar
(Industrial Chemistry)

MAIN ADMINISTRATIVE STAFF

Mr Muhamad Tarmizi Rahim
Deputy Registrar
(Administration & Postgraduate)

Mr. Mohd. Zuaril Akimi Mohd Shaari
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. Mohd Rizal Razali	3913/3576	mohd.rizal@usm.my
Research, Innovation & Industry-Community Engagement	4049/3576	epng@usm.my
Assoc. Prof. Dr. Ng Eng Poh		
PROGRAMME MANAGERS		
Analytical Chemistry		
Dr. Mardiana Saaid	3569	mardiana@usm.my
Industrial Chemistry		
Assoc. Prof. Dr. Noor Hana Hanif Abu Bakar	6022	hana_hanif@usm.my
Organic and Inorganic Chemistry		
Assoc. Prof. Dr. Oo Chuan Wei	4854	oocw@usm.my
Physical Chemistry		
Dr. Ng Si Ling	6013	slng@usm.my
ADMINISTRATIVE OFFICERS		
Deputy Registrar		
Mr. Muhamad Tarmizi Rahim	3540	tarmizi_rahim@usm.my
Senior Assistant Registrar		
Mr. Mohd Zuaril Akimi Mohd Shaari	3541	mzakimi@usm.my

ACADEMIC STAFF	TELEPHONE EXTENSION	E-MAIL
PROFESSORS		
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		
Faiz Bukhari Mohd Suah, PhD	3686	fsuah@usm.my
Lee Hooi Ling, PhD	3547	hllee@usm.my
Melati Khairuddean, PhD	3560	melati@usm.my
Mohamad Nasir Mohamad Ibrahim, PhD	3554	mnm@usm.my
Mohd Hazwan Hussin, PhD	6378	mhh@usm.my
Mohd. Rizal Razali, PhD	6021	mohd.rizal@usm.my
Ng Eng Poh, PhD	3550	epng@usm.my
Noor Haida Mohd Kaus, PhD	3598	noorhaida@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
Chua Yong Shen, PhD	4022	yschua@usm.my
Farhatun Najat Maluin, PhD	3563	farhatunnajat@usm.my
Hairul Hisham Hamzah, PhD	3480	hishamhamzah@usm.my
Khalid Umar, PhD	3567	khalidumar@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 Mohamad Taib, PhD	3562	mnazmi@usm.my
Mohammad Shahadat, PhD	3559	mdshahadat@usm.my
Mohd Ridhwan Adam, PhD	5146	mohd.ridhwan@usm.my

SENIOR LECTURERS	TELEPHONE EXTENSION	E-MAIL
Muhammad Bisyrul Hafi Othman, PhD	4032	bisyrul@usm.my
Ng Si Ling, PhD	6013	slng@usm.my
Norazzizi Nordin, PhD	4030	azzizi@usm.my
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		
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 OFFICERS	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		
Muhamad Nazri Mahamad Isa	5795	m_nazri@usm.my
Mohd Nazri Saed	3026	mnazri_saed@usm.my
Sobri Aziz	4038/5023	azsobri@usm.my
Inorganic Chemistry Division		
Azhar Ramli @ Harun	5178	azharramli@usm.my
Razly Effendy Khalid@Khalib	3579	razly@usm.my
Organic Chemistry Division		
Nur Asma Ismail	5178	asma_isma@usm.my
Physical Chemistry Division		
Mohd Noor Zakaria	3545	mohdnoorz@usm.my
Sivaraj Panirselvam	3573	sivaraj@usm.my
Analytical Chemistry Division		
Muhammad Fauzan Mat Puzi	4039	mfauzanmp@usm.my
Norhayati Abdul Kadir	4041	rozeyanti@usm.my
Sujayendran Rajagopal	6019	sujayendran@usm.my
Makmal Ujian Perkhidmatan Analisis (MUPA)		
Megat Hasnul Zamani Ismail	4493/6379	mzhasnul@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		
Mohd Fairoz Shahul Hamid	3544	mohdfairoz@usm.my
Glass Blowing Workshop		
Mohd Nazeef Ahmad	6116/3574	mohdnazeef@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		
Kausalya Ramanei	3593	kausi@usm.my
Administrative Assistants		
Amir Afifi Ahmad Nazir	5455	amirafifi@usm.my
Faezah Harun	3543	faezahharun@usm.my
Idzhar Ahmat	4955	idzhar@usm.my
Siti Hajar Abd Malik	3973	hajar_malik@usm.my
Mohd Syafiq Mohd Sukari	3593	syafiqsukari@usm.my
Noor Shamila Zulkefli	4955	shamilazulkefli@usm.my
Nur Syazwani Samsul Kamal	5455	sksyazwani@usm.my
Roziana Mohamed Idros	5459	roziana_idros@usm.my
Chemical Store		
Nur Syazwani Samsul Kamal	3570	sksyazwani@usm.my

MAJOR EQUIPMENT	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
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 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 relationships and cooperation among members and the School for the benefit 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 online 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.)**
For the best final year student in the field of Chemistry.

(f) **USM Gold Medal Award (awarded by the founding lecturers for the Applied Sciences Programme of Analytical Chemistry)**
For the best final year student in the field of Analytical Chemistry.

(g) **USM Book Award (awarded by Hoechst Malaysia Sdn. Bhd.)**
For the best final year student in the field of Industrial Chemistry.

(h) **Dean's List Award**
Awarded to any student in the School of Chemical Sciences who has 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 2022-2024

1. Dato' Dr. Nasehir Khan E. M. Yahaya
   National Hydraulic Research Institute of Malaysia (NAHRIM)
2. Mr Thony Maratin Saba
   Carigali Hess Operating Company, Kuala Lumpur
3. Dr. Yoga Sugama Salim
   MATCOR Technology & Services, Singapore
4. Dr Chan Kah Fai
   Texchem Polymer Sdn. Bhd., Penang
5. Dr. Hj. Mohd Afian Omar
   Advanced Materials Research Centre (AMREC), Kulim, Kedah

POSTGRADUATE STUDIES

Students who are interested to pursue postgraduate studies can choose any of the following programmes:

(a) 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 (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 equipment. 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.Sc. (Hons.)
Core **(T)**	70
Elective **(E)** or Minor **(M)**	32
University **(U)**	18
Total	**120**

For Bachelor of Science (Hons.) (Chemistry), students are allowed to choose between **two (2)** packages offered by the School of Chemical Sciences. **Package 1** is designed to allow the students to register for Industrial Training in the final semester (Semester 8) while **Package 2** is for the students who prefer to take Minor programme.

(ii) Industrial Training

Students are highly encouraged to apply for Industrial Training (KIE461/9) after accumulating at least 95 units.

(iii) Final Year Project

Students are encouraged to register for Chemistry Project (KUE319/6) during their third 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 (KUE319/6) may fulfil the 6 credits requirement by registering for other theory 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, or laboratory reports.

LIST OF COURSES OFFERED

Package 1

B.Sc. (Hons.) (Chemistry)		
(i) Core Courses (T) - 70 Credits		
Selection of 3 credits		**Pre-requisites**
ZCT103/3	Physics III (Vibrations, Waves and Optics)	
BOI102/3	Ecology	
BOI101/3	Organisme Biodiversity	
Compulsory - 61 Credits		**Pre-requisites**
MAA101/4	Calculus for Science Students 1	
KUT100/2	Safety and Security for Chemical Sustainability	
KUT101/2	General Chemistry Practical I	
KUT102/2	General Chemistry Practical II	
KTT112/4	Inorganic Chemistry I	
KOT122/4	Organic Chemistry I	
KFT133/4	Physical Chemistry I	KTT112 (s) or KOT122 (s)
KAT145/4	Analytical Chemistry I	KTT112 (s) or KOT122 (s)
KUT203/2	Inorganic Chemistry Practical	KUT101 (s)
KUT206/2	Organic Chemistry Practical	KUT102 (s), KOT122 (s)
KTT212/3	Inorganic Chemistry II	KTT112 (s)
KOT222/3	Organic Chemistry II	KOT122 (s)
KUT214/2	Physical Chemistry Practical	KUT102 (s), KFT231 (c)
KUT215/2	Analytical Chemistry Practical I	KUT101 (s), KAT249 (c)
KFT231/3	Physical Chemistry II	KFT133 (s)
KAT249/3	Analytical Chemistry II	KAT145 (s)
KTT313/3	Inorganic Chemistry III	KTT212 (s)
KUT306/2	Research Methodology in Chemistry	
KUT317/2	Inorganic and Analytical Chemistry Practical	KUT203 (s), KUT215 (s)
KUT318/2	Physical and Organic Chemistry Practical	KUT206 (s), KUT214 (s)
KOT323/3	Organic Chemistry III	KOT222 (s)
KFT431/3	Physical Chemistry III	KFT231 (s)
Selection of 6 credits		
KUE319/6	Chemistry Project	

or 6 credits	or Other theory courses from Analytical Chemistry, Industrial Chemistry and Pure Chemistry.

(ii) Elective Courses (E) – 32 credits		
(a) Selection of 18 credits or more		**Prerequisite**
KIT257/3	Materials Chemistry	
KAT345/4	Spectroscopic Methods	KAT145 (s)
KIT358/3	Polymer Chemistry	KOT122 (s)
KIE359/3	Green Chemistry and Technology	
KTE411/3	Selected Topics in Inorganic Chemistry	KTT212 (s)
KOE423/3	Selected Topics in Organic Chemistry	KOT222 (s)
KFE432/3	Selected Topics in Physical Chemistry	KFT231 (s)
KAE445/3	Bioanalysis	KAT344 (s) or KAT249 (s)
KIE456/3	Food and Palm Oil Chemistry	
KIT458/3	Chemical Processing	KTT112 (s), KOT122 (s)
KIE461/9	Industrial Training	
An additional **14 credits or less** to fulfil the elective component must be taken from any other schools not limited to School of Physics, Mathematical Sciences, Biological Sciences, Industrial Technology, or Centre for Global Archaeological Research. Recommended courses from School of Physics and School of Biological Sciences are:		
ZCT104/3	Physics IV (Modern Physics)	
BOI117/3	Biodiversity and Ecology Practicals	
BST308/3	Tropical Ecosystem & Climate Change *(Prerequisite: BOI102)*	
BST405/3	Conservation Ecology and Natural Resources *(Prerequisite: BST308)*	

(s) = sequential (course must be taken earlier)
(c) = concurrent (course can be taken concurrently)

Package 2

B.Sc. (Hons.) (Chemistry)		
(i) Core Courses (T) - 70 Credits		
Selection of 3 credits		**Pre-requisites**
ZCT103/3	Physics III (Vibrations, Waves and Optics)	
BOI102/3	Ecology	
BOI101/3	Organisme Biodiversity	
Compulsory - 61 Credits		**Pre-requisites**
MAA101/4	Calculus for Science Students 1	
KUT100/2	Safety and Security for Chemical Sustainability	
KUT101/2	General Chemistry Practical I	
KUT102/2	General Chemistry Practical II	
KTT112/4	Inorganic Chemistry I	
KOT122/4	Organic Chemistry I	
KUT203/2	Inorganic Chemistry Practical	KUT101 (s)
KUT206/2	Organic Chemistry Practical	KUT102 (s), KOT122 (s)
KTT212/3	Inorganic Chemistry II	KTT112 (s)
KOT222/3	Organic Chemistry II	KOT122 (s)
KFT133/4	Physical Chemistry I	KTT112 (s) or KOT122 (s)
KAT145/4	Analytical Chemistry I	KTT112 (s) or KOT122 (s)
KUT214/2	Physical Chemistry Practical	KUT102 (s), KFT231(c)
KUT215/2	Analytical Chemistry Practical I	KUT101 (s), KAT249 (c)
KTT313/3	Inorganic Chemistry III	KTT212 (s)
KFT231/3	Physical Chemistry II	KFT133 (s)
KAT249/3	Analytical Chemistry II	KAT145 (s)
KUE306/2	Research Methodology in Chemistry	
KUT317/2	Inorganic and Analytical Chemistry Practical	KUT203 (s), KUT215 (s)
KUT318/2	Physical and Organic Chemistry Practical	KUT206 (s), KUT214 (s)
KOT332/3	Organic Chemistry III	KOT222 (s)
KFT431/3	Physical Chemistry III	KFT231 (s)
Selection of 6 credits		
KUE319/6 or 6 credits	Chemistry Project or Other theory courses from Analytical Chemistry, Industrial Chemistry and Pure Chemistry.	

(ii) Minor (M) Programme – 32 credits		
Elective (E) Components		
(a) Selection of 12 credits		**Prerequisite**
ZCT104/3	Physics IV (Modern Physics)	
BOI117/2	Biodiversity and Ecology Practicals	
BST308/3	Tropical Ecosystem & Climate Change	
BST405/3	Conservation Ecology and Natural Resources	BST308
KIT257/3	Materials Chemistry	
KAT345/4	Spectroscopic Methods	KAT145 (s)
KIT358/3	Polymer Chemistry	KOT122 (s)
KIE356/3	Green Chemistry and Technology	
KTE411/3	Selected Topics in Inorganic Chemistry	KTT212 (s)
KOE423/3	Selected Topics in Organic Chemistry	KOT222 (s)
KFE432/3	Selected Topics in Physical Chemistry	KFT231 (s)
KAE445/3	Bioanalysis	KAT344 (s) or KAT249 (s)
KIE456/3	Food and Palm Oil Chemistry	
KIT458/3	Chemical Processing	KTT112 (s), KOT122 (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 students of School of Chemical Sciences, subject to the requirements imposed by the School which offers Minor Programmes such as Management, Computer Science, 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 can be taken concurrently)

PROPOSED SCHEDULE BY SEMESTER

B.Sc. (Hons.) (Chemistry) – Package 1

YEAR 1					
COMPONENT	**SEMESTER 1**		**SEMESTER 2**		**CREDIT**
	CODE	**CREDIT HOURS**	**CODE**	**CREDIT HOURS**	
University Courses (U)	WUS101	2	LKM400	2	
Core Courses (T)	KAT145	4	KFT133	4	
	KTT112	4	KOT122	4	
	KUT101	2	KUT102	2	
			MAA101	4	
			BOI101* (Optional)	3*	
Elective (E)					
TOTAL CREDIT HOURS		**14**		**16/19***	**30/33***

YEAR 2					
COMPONENT	**SEMESTER 3**		**SEMESTER 4**		**CREDIT**
	CODE	**CREDIT HOURS**	**CODE**	**CREDIT HOURS**	
University Courses (U)	*HFF225	2	*HFE224	2	
	LSP300	2	U	2	
Core Courses (T)	KOT222	3	KTT212	3	
	KAT249	3	KFT231	3	
	KUT203	2	KUT206	2	
	KUT215	2	KUT214	2	
Elective (E)	Elective	3	Elective	3	
TOTAL CREDIT HOURS		**17**		**17**	**34**

Note: *HFF225/2 (Philosophy and Current Issues) and HFE224/2 (Appreciation of Ethics and Civilisations)

YEAR 3					
COMPONENT	**SEMESTER 5**		**SEMESTER 6**		**CREDIT**
	CODE	**CREDIT HOURS**	**CODE**	**CREDIT HOURS**	
University Courses (U)	LSP402	2	U	2	
Core Courses (T)	KTT313	3	KOT322	3	
	KUT317/ KUT318	2	KUT317/ KUT318	2	
	BOI102/ZCT103 (Optional)	3**	KUE319	3	
			KUT306	2	
Elective (E)	Elective	2	Elective	3	
	Elective	3	Elective	3	
TOTAL CREDIT HOURS		**12/15****		**18**	**30/33****

Note: **Students can choose other science courses between ZCT103/3 or BOI102/3

YEAR 4					
COMPONENT	**SEMESTER 7**		**SEMESTER 8**		**CREDIT**
	CODE	**CREDIT HOURS**	**CODE**	**CREDIT HOURS**	
University Courses (U)	U	2	KIE461 : Industrial Trainning for 1 Semester (18 weeks) with Industry/ Government Agency/ Private Company	9	
Core Courses (T)	KUE319	3			
	KFT431	3			
Elective (E)	Elective	3			
	Elective	3			
TOTAL CREDIT HOURS		**14**		**9**	**23**
GRAND TOTAL CREDIT HOURS					**120**

B.Sc. (Hons.) (Chemistry) – Package 2

YEAR 1					
COMPONENT	**SEMESTER 1**		**SEMESTER 2**		**CREDIT**
	CODE	**CREDIT HOURS**	**CODE**	**CREDIT HOURS**	
University Courses (U)	WUS101	2	LKM400	2	
Core Courses (T)	KTT112	4	KOT122	4	
	KAT145	4	KFT133	4	
	KUT101	2	KUT102	2	
	KUT100	2	MAA101	4	
			BOI101* (Optional)	3*	
Elective (E)/ Minor (M)					
TOTAL CREDIT HOURS		**14**		**16/19***	**30/33***

YEAR 2					
COMPONENT	**SEMESTER 3**		**SEMESTER 4**		**CREDIT**
	CODE	**CREDIT HOURS**	**CODE**	**CREDIT HOURS**	
University Courses (U)	*HFF225	2	*HFE224	2	
	LSP300	2			
Core Courses (T)	KOT222	3	KTT212	3	
	KAT249	3	KFT231	3	
	KUT203	2	KUT206	2	
	KUT215	2	KUT214	2	
Elective (E)/ Minor (M)	Minor	4	Minor	4	
TOTAL CREDIT HOURS		**18**		**16**	**34**

Note: *HFF225/2 (Philosophy and Current Issues) and HFE224/2 (Appreciation of Ethics and Civilisations)

YEAR 3					
COMPONENT	**SEMESTER 5**		**SEMESTER 6**		**CREDIT**
	CODE	**CREDIT HOURS**	**CODE**	**CREDIT HOURS**	
University Courses (U)	LSP402	2	U	2	
Core Courses (T)	KTT313	3	KUE319	3	
	KUT317/ KUT318	2	KUT306	2	
	BOI102/ ZCT103 (Optional)*	3*			
Elective (E)/ Minor (M)	Minor	4	Minor	4	
	Elective	3	Elective	3	
TOTAL CREDIT HOURS		**14/17***		**14**	**28/31***

Note: *Students can choose other science courses between ZCT103/3 or BOI102/3

YEAR 4					
COMPONENT	**SEMESTER 7**		**SEMESTER 8**		**CREDIT**
	CODE	**CREDIT HOURS**	**CODE**	**CREDIT HOURS**	
University Courses (U)	U	2	U	2	
Core Courses (T)	KUE319	3	KOT322	3	
	KFT431	3	KUT317/ KUT318	2	
Elective (E)/ Minor (M)	Elective	3	Elective	3	
	Minor	4			
TOTAL CREDIT HOURS		**15**		**10**	**25**
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	**Cognitive Skills**	• Demonstrate critical thinking and provide practical solutions to chemistry-related issues by employing appropriate and relevant chemistry knowledge and skills.
PO4	**Communication Skills**	• Demonstrate effective communication.
PO5	**Interpersonal Skills**	• Lead and collaborate with diverse team members and demonstrate social responsibility for the well-being of society.
PO6	**Ethics and Professionalism**	• Balance and uphold positive values, ethics and accountability in societal and professional engagement.
PO7	**Personal Skills**	• Manage information and seek new knowledge and skills independently.
PO8	**Entrepreneurial Skills**	• Display relevant and appropriate managerial and entrepreneurial skills.
PO9	**Leadership, Autonomy and Responsibility**	• Demonstrate the ability to work effectively as a leader.
PO10	**Digital Skills**	• Demonstrate the ability to use digital effectively
PO11	**Numeracy Skills**	• Demonstrate the ability to use numerical effectively

SYNOPSIS OF COURSES

KUT100/2 – Safety and Security for Chemical Sustainability

This course includes an introduction to chemicals that are often used in laboratories as well as industry. Students will be exposed to the risks of the chemicals involved, storage methods, proper classification methods and the risks that can arise from those chemicals if not handled properly. This course also discusses the health aspects that may exist especially the effects of prolonged exposure to chemicals and radiation. The topics of chemical securities as well as dual-use chemicals will also be discussed.

Learning Outcomes
Upon completion of this course, students are able to:
1. Understand the basic aspects in classification and handling of hazardous chemicals and their possible risks.
2. Apply scientific knowledge in problem solving related to security and chemical security.
3. Present the aspects of safety and chemical security learned effectively through presentation.

KUT101/2 - General Chemistry Practical I

General chemistry practical on a 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 Sodium 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 Vapour
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, the 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 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 hybridised 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 organic chemistry principles to explain the stereochemistry of organic reactions.

KFT133/4 - Physical Chemistry I **KTT112 (s) or KOT122 (s)**

Properties of gases: gas laws, van der Waals equation, kinetic theory of gases, the 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. The 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 equations of states to distinguish between ideal and real gases.
2. Apply the knowledge of the 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.

KAT145/4 - 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 calculations 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.

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 for the synthesis of inorganic compounds and methods of characterisation.
2. Interpret data associated with the synthesis and the products obtained at a laboratory scale.
3. Use the data obtained to illustrate the inorganic chemistry principles.
4. Demonstrate safety practices in the 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 of 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.

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; Characterisation 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, the 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 magnetic properties. Thermal Properties: Heat capacity, thermal conductivity, thermal

expansion and thermal stress/shock. Optical Properties: Reflection, refraction, absorption and transmission, colour 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 protection. 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.

KUT214/2 - Physical Chemistry Practical I **KUT102 (s), KFT231 (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 the 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 persulphate-iodide reaction. Only 10 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 interpret the experimental data obtained.
4. Demonstrate the ability of scientific communications through written reports.
5. Display safe laboratory practices.

KUT215/2 - Analytical Chemistry Practical I **KUT101 (s), KAT249 (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 based on experimental results and draw correct conclusions.

KFT231/3 - Physical Chemistry II **KFT133 (s)**

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: the physical transformation of pure substances and mixture. Phase diagram, the 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.

KAT249/3 - Analytical Chemistry II **KAT145 (s)**

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.

KUT306/2 - Research Methodology in Chemistry

The student will conduct a comprehensive study on a particular issue or topic related to chemistry. Students will conduct a 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 interpret information, write reports and discuss orally.
4. Demonstrate the ability to manage time for a particular task.

KTT313/3 - Inorganic Chemistry III **KTT212 (s)**

The first part of this course will expose students to the concept of bioinorganic chemistry. The role of metal ions in biological systems. Bioinorganic chemistry of metalloenzymes, metalloporphyrins, oxygen, carbon dioxide, carbon monoxide transportation and storage systems, vitamin B12, chlorophyll and metal in medicine.
The second part of this course will expose students to the concept and the importance of organometallic chemistry of main group elements and transition elements including organotransition catalysts.

Learning Outcomes

Upon completion of this course, students are able to:

1. Demonstrate the role of inorganic chemistry in biological processes.
2. Describe the synthesis, structure and bonding of the organometallic compounds.
3. Apply the organometallic chemistry on their relevant complexes and typical reaction such as in catalysis.

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, spectrofluorimetry, 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 the 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.

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.

KUT317/2 - Inorganic and Analytical Chemistry Practical KUT203 (s), KUT215 (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 the 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.

KUT318/2 - Physical and Organic Chemistry Practical KUT206 (s), KUT214 (s)

Physical Section

Spectrum of a particle in a box. Heat of combustion by bomb calorimetry. Absorption from solution. Determination of surface areas of powders by physical adsorption of gases. Partial molar volumes of water and methyl alcohol mixtures as a function of concentrations. Ampiphilic molecules. Enzyme kinetics. Inversion of sucrose.

Organic Section

This practical course is designed to strengthen the student's understanding of the principles of organic synthesis and reaction mechanisms. The experiments include some selected organic reactions in the preparation of organic compounds The experiments: Wittig reaction. The preparation of *cis*- and *trans*-stilbene. Claisen-Schmidt reaction: The preparation of benzalacetophenone. Reactivity measurement by competitive technique. Phase-transfer catalysis: Synthesis of norcarene. Kinetic and thermodynamic reaction conditions. Selective reduction of *m*-nitroacetophenone with tin and sodium borohydride. Conjugate (Michael) addition to α,β-unsaturated carbonyl.

Learning Outcomes
Upon completion of this course, students are able to:
1. Demonstrate competency in a variety of physico-chemical measurement techniques.
2. Demonstrate competency in a wide selection of organic-chemistry laboratory techniques.
3. Analyse and interpret the experimental data obtained and demonstrate scientific communications through written reports.
4. Perform literature searches to find relevant information about specific substances, groups, reactions and methods of synthesis.
5. Display safe laboratory practices.

KUE319/6 - 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 interpret 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.

KIE359/3 – Green Chemistry and Technology

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 an understanding of the current issues related to industrial chemistry.
2. Apply the fundamentals of chemistry in solving current industrial chemistry problems.
3. Display the ability to discuss the current issues orally and in writing.

KOT332/3 - Organic Chemistry III **KOT222 (s), KUT318 (s)**

Structure, synthesis and reaction of amines, carboxylic acids and carboxylic acid derivatives. Condensations and α-substitution of carbonyl compounds. Carbohydrates, pericyclic reactions, amino acids, peptides and proteins.

Learning Outcomes
Upon completion of this course, students are able to:
1. Predict the products and propose the appropriate mechanisms for the reactions of amines, aldehydes, ketones, carboxylic acids and their derivatives, carbohydrates, amino acids and peptides with various compounds.
2. Display the ability to predict the products and propose the appropriate reactions for Aldol and Claisen condensations, malonic ester and acetoacetic ester syntheses, Michael reaction and Robinson annulation.
3. Use the appropriate carbon-carbon bond formation reaction in organic synthesis.

KTE411/3 - Selected Topics in Inorganic Chemistry **KTT212 (s)**

The coordination chemistry consists of cluster complexes of transition metals, coordination polymer complexes, type and shape of coordination polymer complexes, factors required for the formation of coordination complexes, applications for coordination complexes and supramolecular interaction in coordination chemistry.
The introduction of catalyst, role and implication of catalyst in the reaction. Approach on the general concept of catalysis where the function and catalyst structure, catalyst design, preparation, characterisation and application of catalyst will be emphasised.
Inorganic and organometallic polymers. Application of some of these polymers.

Learning Outcomes

Upon completion of this course, students are able to:

1. Explain the properties and structures of the main group cluster, cage and ring compounds.
2. Differentiate the transition metal cluster complexes based on the structure and bonding properties.
3. Explain the importance of catalysts and their role in the reactions.
4. Explain the preparation, reactivity, properties and processing of inorganic polymers.

KOE423/3 - Selected Topics in Organic Chemistry **KOT222 (s)**

This course contains the following topics. A few topics will be selected for each semester:

1. Methods of determining mechanisms.
2. Tannin and its application.
3. Synthesis of selected biological active compounds.
4. Liquid crystal synthesis.
5. Drug metabolism.
6. Polyimide synthesis.

Learning Outcomes

Upon completion of this course, students are able to:

1. Demonstrate understanding of the current issues related to organic chemistry.
2. Apply the fundamentals of chemistry in solving current organic chemistry problems.
3. Display the ability to discuss the current issues orally and in writing.

KFT431/3 - Physical Chemistry III **KFT231 (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, the 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.

KFE441/3 - Applied Surface Chemistry **KFT231 (s)**

This course contains the following topics. A few topics will be selected for each semester:

1. Physical-chemical treatment of wastewater.
2. Physical aspects of a polymer.
3. Molecular modeling and computational chemistry.
4. Zeolite chemistry.
5. Application of electrochemistry.
6. Clay science.
7. Surface and colloids.

Learning Outcomes

Upon completion of this course, students are able to:

1. Demonstrate understanding of the current issues related to physical chemistry.
2. Apply the fundamentals of chemistry in solving current physical chemistry problems.
3. Display the ability to discuss the current issues orally and in writing.

KAE445/3 - Bioanalysis **KAT344 (s) or KAT249 (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 functional characteristics.
2. Demonstrate an understanding of the latest developments in analytical instrumentations in bioanalysis.
3. Identify suitable chemical and biological methods for the analysis of biological compounds.
4. Demonstrate an understanding of the other related methods in a chemical and biological molecule.

KIE456/3 - Food and Palm Oil Chemistry

Carbohydrates: Classification of structures; dietary utilisation as a 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

(vanillin, saccharin etc). Food additives: Role of acids, bases, salt, chelating agents, antimicrobials and types of sweeteners. Stabilisers and texturisers. Structures and composition of palm oil. Chemical properties and non-fatty components. Physical properties of palm oil. The 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 in 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 the quality of oils and fats.

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.

KIE461/9 - Industrial Training

This course is open to students who have accumulated at least 100 units of the units for graduation requirement. The duration for this industrial training course is 14 weeks. Students are required to undergo industrial training at various industries, organizations or Centres of Excellence. Students who passed the course will be given a Certificate of Completion and the result Pass will appear in their academic transcript.

Learning Outcomes

Upon completion of this course, students are able to:

1. Relate chemical knowledge gained during industrial training in report preparation.
2. Report industrial experience effectively.
3. Demonstrate ethical values and professionalism in their respective fields of specilization.
4. Relate additional knowledge gained during industrial training in report preparation.
5. Adapt to the workplace environment and be able to interact in the organization in a guided manner.

INDEX OF COURSES

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 the ecosystem, biodiversity, plants, animals, microbial and cellular processes in the first year. Towards the end of the first year, students can choose to specialise in either Microbiology or Animal and Plant Biodiversity leading to a Bachelor of Science (Honours) degree in four (4) years. Students are also required to take an internship programme in the last semester of their 4th year. This six (6) 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 ecosystemGood Laboratory Practices and usage of common and advanced laboratory equipment.
d. Ability to design and implement scientific experiments.
e. 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 holistically to ensure a sustainable tomorrow.

Our programmes are recognized internationally by the Royal Society of Biology, United Kingdom (https://www.rsb.org.uk/) starting from the Academic Session of 2019/2020 to 2023/2024.

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.

STAFF AND ADMINISTRATION

DEAN

Professor Dato' Dr. Amirul Al-Ashraf Abdullah

DEPUTY DEANS

Associate Professor Dr. Yahya Mat Arip
(*Academic, Career & International*)

Professor Dr. Latiffah Zakaria
(*Research, Innovation & Industry-Community Engagement)*

PROGRAMME MANAGERS

Associate Professor Dr. Amir Shah Ruddin Md Sah
(*Environmental Biology*)

Associate Professor Dr. Darlina Md Naim
(*Animal and Plan Biology*)

Dr. Kamarul Zaman Zarkasi
(*Biotechnology and Microbiology*)

Dr. Nik Ahmad Irwan Izzauddin Nik Him
(*Agrobiology, Entomology and Parasitology*)

PRINCIPAL ASSISTANT REGISTRAR

Mrs. Siti Aishah Abdul Raffar

SENIOR ASSISTANT REGISTRAR

Mr. Md Badro Hishan Ibrahim

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 - Financial (School)	3961	hasmimi@usm.my
Mr. Nor Azam Samsudin - Academics (Postgraduate)	3961	norazamsamsudin@usm.my
Mrs. Nor Azawati Abd Malek - Academics (Postgraduate)	5132	azawati@usm.my
Mrs. Nor Rafida Abdul Karim - Human Resource	5134	norrafida@usm.my
Mrs. Nur Syazwani Mohd Shariff - Academics (Undergraduate)	5134	syazwanie@usm.my
Mrs. Safiyah Mohd Yusoff - Academics (Undergraduate)	3529	safiyahyusoff@usm.my
Mrs. Shabariah Ahmed - Store (Chemicals)	3529	shabariah@usm.my
Mrs. 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

Dr. Manorenjitha 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
Mrs. Roziana Mat Khairuddin	5879	roziana@usm.my
Mrs. Masthurah Abdullah	4661	masthurah@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

ACADEMIC STAFF

1. AGROBIOLOGY, ENTOMOLOGY AND PARASITOLOGY

Programme Manager

Dr. Nik Ahmad Irwan Izzauddin Nik Him	3505	nikirwan@usm.my

Lecturer

Professor Dr. Latiffah Zakaria	3506	lfah@usm.my
Associate Professor Ts. Dr. Wan Fatma Zuharah Wan Musthapa	6130	wfatma@usm.my
Associate Professor Dr. Zary Shariman Yahaya	6155	zary@usm.my
Associate Professor Ts. Dr. Abdul Hafiz Ab Majid	4893	abdhafiz@usm.my
Associate Professor Dr. Nur Faeza Abu Kassim	5138	nurfaeza@usm.my
Associate Professor Dr. Suhaila Ab Hamid	5874	ahsuhaila@usm.my
Dr. Ahmad Bukhary Ahmad Khair	6664	abukhary@usm.my
Dr. Azlinda Abu Bakar	6253	azlindaab@usm.my
Dr. Mohammad Fadhli Mad' Atari	3087	madatari@usm.my
Dr. Nik Ahmad Irwan Izzauddin Nik Him	3505	nikirwan@usm.my
Dr. Siti Nasuha Hamzah	4061	sitinasuha@usm.my
Dr. Farah Haziqah Meor Termizi	3527	farahhaziqah@usm.my
Dr. Hadura Abu Hasan	3515	hadura@usm.my
Dr. Hafizi Rosli	4954	hafizirosli@usm.my

Dr. Hasber Salim	3011	hasbersalim@usm.my
Dr. Hasnuri Mat Hassan	3962	hasnurimh@usm.my
Dr. Intan Haslina Ishak	5137	intanishak@usm.my
Dr. Masratul Hawa Mohd	4009	masratulhawa@usm.my
Dr. Nik Mohd Izham Mohamed Nor	4002	nikizham@usm.my
Dr. Rosnida Tajuddin	4001	rosnidatajuddin@usm.my

2. ENVIRONMENTAL BIOLOGY

Programme Manager

Associate Professor Dr. Amir Shah Ruddin Md Sah	6201	amirshah@usm.my

Lecturer

Professor Dato' Dr. Tan Shau Hwai	3508	aileen@usm.my
Professor Dr. Chong Shu Chien @ Alexander	5501/4014	alex@usm.my
Profesor Dr. Wan Maznah Wan Omar	3533	wmaznah@usm.my
Associate Professor 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
Dr. Foong Swee Yeok	3511	foong@usm.my
Dr. Hazzeman Haris	6662	hazzeman@usm.my
Dr. Mahadi Mohammad	5912	mahadi@usm.my
Dr. Noor Khalidah Abdul Hamid	3516	khalidah.hamid@usm.my
Dr. Nurul Salmi Abdul Latip	6151	salmi@usm.my
Dr. Shuhaida Shuib	6296	shuhaidashuib@usm.my

3. BIOTECHNOLOGY AND MICROBIOLOGY

Programme Manager

Dr. Kamarul Zaman Zarkasi	6152	kamarul.zarkasi@usm.my

Lecturer

Professor Dato’ Dr. Amirul Al-Ashraf Abdullah	3815	amirul@usm.my

Professor Dr. K Sudesh Kumar A/L C Kanapathi Pillai	4367	ksudesh@usm.my
Associate Professor Dr. Ahmad Ramli Mohd Yahya	6163	armyahya@usm.my
Associate Professor Dr. Amir Hamzah Ghazali	4008	amirhg@usm.my
Associate Professor Dr. Mohd Ghows Mohd Azzam	4005	ghows@usm.my
Associate Professor Dr. Yahya Mat Arip	6156	ymarip@usm.my
Dr. Amira Suriaty Yaakop	6204	amirasuriaty@usm.my
Dr. Kamarul Zaman Zarkasi	6152	kamarul.zarkasi@usm.my
Dr. Nethia A/P Mohana Kumaran	4016	nethiakumaran@usm.my
Dr. Nurul Izza Ismail	4006	nurul.ismail@usm.my
Dr. Siti Khayriyyah Mohd Hanafiah	3517	kye@usm.my
Dr. Yazmin Bustami	6663	ybustami@usm.my
Dr. Chew Bee Lynn	3521	beelynchew@usm.my
Dr. Nur Asshifa Md Noh	6157	nurasshifa@usm.my

4. ANIMAL AND PLANT BIODIVERSITY

Programme Manager

Associate Professor Dr. Darlina Md. Naim	4056	darlina@usm.my

Lecturer

Professor Dr. Ahmad Sofiman Othman	4019	sofiman@usm.my
Professor Dr. Shahrul Anuar Mohd Sah	3524	sanuar@usm.my
Associate Professor Dr. Asyraf Mansor	6153	asyrafm@usm.my
Associate Professor Dr. Rahmad Zakaria	6154	rahmadz@usm.my
Associate Professor Dr. Darlina Md. Naim	4056	darlinamdn@usm.my
Dr. Dahlia Shahbuddin	4095	dahliashah@usm.my
Dr. Farah Alia Nordin	6161	farahalianordin@usm.my
Dr. Khaironizam Md Zain	3531	khaironizam@usm.my
Dr. Nadine Brigitte Ruppert	3513	n.ruppert@usm.my
Dr. Nurul 'Ain Elias	6661	nurulain.elias@usm.my
Dr. Rosazlina Rusly	6203	rosazlinarusly@usm.my
Dr. Sebastien Lavoue	3522	sebastien@usm.my
Dr. Zarul Hazrin 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 PhD. 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 biotechnological industries and medical devices industries. In addition, various governmental and semi-governmental organisations and R&D centres also hire a significant number of graduates. These include the 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 that 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 Dr. 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 Emeritus Dr. Mashhor Mansor.

g. **USM Gold Medal Award –** awarded to the best final year student in the field of Applied Biology (Major in Entomology and Parasitology) by Professor Dr. Lee Chow Yang (beginning from Academic Year 2019/2020).

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 Programmes (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, Innovation & Industry-Community Engagement)
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 the 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 – Strategic Advisor, Green Growth Asia Foundation
2) Y. Bhg. Datuk Haji Daud Amatzin – Chairman, The Incorporated Society of Planters (ISP)
3) Dr. Mohd Aizuddin Kamaruddin – Research and Application Biologist, Agilent Technologies LDA Malaysia Sdn. Bhd.
4) Dr. Lee Leng Choy – Managing Director, HEXTAR R&D International Sdn. Bhd.
5) Dr. Janice Lim – Head of Marketing, BASF (Malaysia) Sdn. Bhd.
6) Mr. Allen Tan Heng Poe – Managing Director, The Habitat Penang Hill.
7) Tuan Haji Shahril Mod Husin, Head of Regulatory & Environmental Science Unit (RES), TNB Research Sdn. Bhd.
8) Mr. Noor Hisham Hamid – Chief Executive Officer, Felda Global Venture
9) Mr. Shahrem Md Ramli – Business Manager, Ensystex (Malaysia) Sdn. Bhd.

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 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 SCIENCE

1. Bachelor of Science Degree Program

Students undertaking the Bachelor of Science degree under the School of Biological Sciences may select to specialise in one of the following two (2) areas of specialisation/major listed below:-

a. Microbiology
b. Animal and Plant Biodiversity

2. Graduation Requirements

Students must fulfil the following requirements to graduate:-

a. Fulfil all the credit requirements of the programme and required units for each component (Core, Elective/Minor and University components).
b. Obtain a minimum CGPA of 2.00 for the Core component/courses.
c. Obtain a minimum CGPA of 2.00 for the overall programme.
d. Obtain a minimum grade C for all of the University courses.

3. Curriculum and Graduation Structure

In order to qualify for the Bachelor of Science degree, students are required to accumulate **128 units**. There are two (2) types of study mode under the Bachelor of 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 • 39 units	**T**	77
	Required • 38 units		
ELECTIVE		**E**	17
MINOR		**M**	16
**** UNIVERSITY**		**U**	18
		TOTAL :	**128**

b. Elective Structure

Course Component		**Course Code Type**	**Minimum No. of Units Required**
CORE	Basic • 39 units	**T**	77
	Required • 38 units		
ELECTIVE		**E**	33
**** UNIVERSITY**		**U**	18
		TOTAL :	**128**

***** Details of University courses offered (Table 1 and Table 2)(page 115)***

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

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	Appreciation Of Ethnics and Civilisition - Course code = *HFE224* (2 units)	2
4	Philosophy and Current Issues - Course code = *HFF225* (2 units)	2
5	Core Entrepreneurship - Course code = *WUS101* (2 units)	2
6	Co-curriculum (Compulsory – 2 units) Skills Courses/Option	2 4
	TOTAL :	**18**

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

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 (Compulsory – 2 units) / Skills Courses/Option	2 6
	TOTAL :	**18**

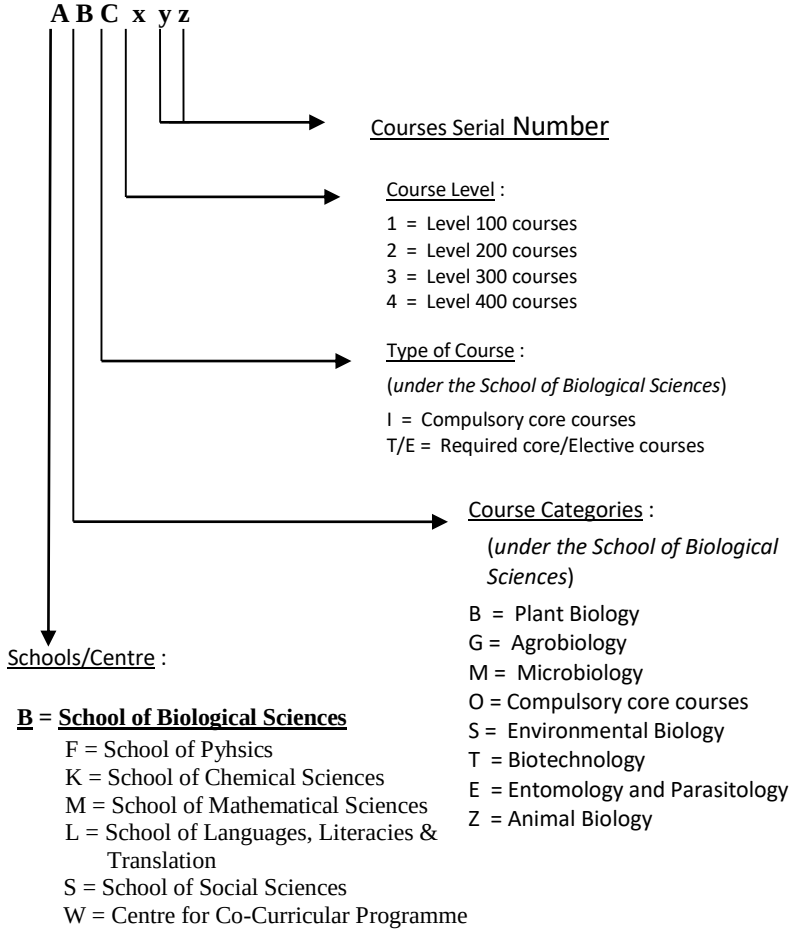
4. Classification of Year Equivalent

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 Science	0 – 30	31 – 61	62 – 92	≥ 93

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'), the Compulsory Core courses ('Teras Wajib'), the Required Core courses ('Teras Perlu') and the Elective Core courses ('Teras Pilihan'). Courses in the Basic Core and Compulsory Core groups are compulsory Level 100 courses where students must attain passing grades.

b. **Elective Courses** (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 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 = **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.

8. 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.

9. Minor package

Offering School/Centre	**Title of Minor Package** - **Choose one (1) Minor package only** - **Minimum 16 units or 20 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 (77 UNITS)

The Core Courses component is made up of courses of level 100, 200, 300 and 400. The courses include the 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 (39 Units)

Basic core courses are offered by the School of Biological Sciences and the School of Chemical 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 **39 units**. The courses are as follows :-

Year	Semester	Course Code	Course Title	Total Units Required
1	1	KOT 122/4	Organic Chemistry I	27
	1 or 2	BOI 101/3	Organisms Biodiversity	
		BOI 102/3	Ecology	
		BOI 103/4	Principles of Biochemistry	
		BOI 104/4	Genetics	
		BOI 105/4	Biostatistics	
		BOI 106/3	General Micorbiology	
		BOI 107/2	Practical of Biodiversity and Ecology	
4	2	BOI 420/12	Industrial Training	12

(ii) REQUIRED CORE COURSES (38 Units)

Required Core courses are those courses offered at Levels 200, 300, and 400 that have been identified according to each specialisation programme, namely **Microbiology, Animal and Plant Biodiversity.** Students must enrol in all required core courses that are listed in their respective field of specialisation.

RESEARCH PROJECT (8 UNITS)

All Biology students are given the option to register for a research project of 8 units which spans over two 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 research project in their respective field of specialisation, the student must have achieved these **minimum cumulative unit requirement**.

- Total overall unit	=	45 – 77 units
- Total unit for Biology courses	=	39 – 54 units

Students who do not register for a research project, with valid reason and approved by the Dean, must substitute the 8 units with BOE 300/4 – Critical Review In Biology (which carries 4 units), while the remaining 4 units are fulfilled by taking elective courses that are suitable with his/her field of specialisation and approved by the Programme Manager.

FIELD OF SPECIALISATIONS

a. MICROBIOLOGY

Objectives: The Microbiology programme is designed to equip students with knowledge on metabolism, growth, genetics, regulation in microorganisms and the various situation where microorganisms are important to humans and other life forms. In the early part of the programme, courses offered will focus on the microbial world, mainly bacteria, fungi, yeast and viruses. Topics will cover the history of the development of microbiology, the status of microorganisms in the world of living things and the diversity of microorganisms based on their morphology, fine structures, physiology, biochemistry and growth. Topics including basic methods in the maintenance of microorganisms, cultivation, isolation, enumeration and methods in sterilisation will also be part of the programme.

Subsequently, students will be exposed in detail on various groups of microorganisms and immunology.

This will then be followed by discussion on microbial classification and aspects related to microbial physiology, biochemistry and genetics. The characteristics of antigens and human immunological response systems will also be part of the immunology course. Students will also be exposed to several applied courses in microbiology which will enable them to understand the role of microorganisms in the field of industrial & food microbiology, agriculture, medicine and environment.

Course code	Course title	Semester	Course prerequisite	
Required Core - Level 200 = 12 Units				
BMT 210/3	Microbial Physiology	1	BOI 101/3 BOI 103/4 BOI 106/3	(S) (S) (S)
BMT 211/3	Virology	1	BOI 106/3	(S)
BMT 222/3	Bacteriology	2	BOI 106/3	(S)
BMT 223/3	Immunology	2	BOI 106/3	(S)
Required Core - Level 300 = 20 Units				
BMT 300/8 or *BOE 300/4	Research Project in Microbiology Critical Review in Biology	1 & 2 1 & 2		
BMT 314/3	Mycology	1	BOI 106/3	(S)

BMT 315/3	Environmental Microbiology	1	BOI 106/3	(S)
BMT 326/3	Microbial Genetics	2	BOI 104/3 BOI 106/3	(S) (S)
BMT 327/3	Soil Microbiology	2	BOI 106/3	(S)
Required Core - Level 400 = 6 Units				
BMT 418/3	Industrial and Food Microbiology	1	BOI 103/4 BOI 106/3	(S) (S)
BMT 419/3	Medical Microbiology	1	BOI 106/3	(S)
* requires 4 more units from Elective courses				
Elective (<u>17</u> units under Elective structure)				
BTT 211/3	Techniques in Biotechnology	1 & 2	BOI 103/4	(S)
BTT 312/3	Fermentation Technology	1	BOI 103/4	(S)
BTT 313/3	Genomics	1	BOI 104/4	(S)
BTT 324/3	Biochemical Engineering	2	KOT 122/4 BOI 103/4	(S) (S)
BTT 415/3	Genetic Engineering	1	BMT 326/3	(S)
BTT 416/3	Protein Structural Bioinformatics	1	BOI 103/4	(S)
BOE 101/3	Biological Instrumentation	1 & 2	BOI 103/4	(C)
BOE 201/3	Microscopy and Histological Techniques	1 & 2		
BOE 202/3	Introduction to Bioinformatics	1 & 2	BOI 104/4	(S)
BOE 311/2	Scientific Communications	1		
Elective (17 units under Minor structure or 33 units under Elective structure) Student **MUST** choose among the listed courses to complete a total of 17 or 33 units for Elective.				

(S) = Course must be taken in sequential order.
(C) = Course can be taken concurrently.

b. ANIMAL AND PLANT BIODIVERSITY

Objectives: This field of specialisation offers training in both basic and applied aspects of animal and plant biodiversity with the aim to equip students with up-to-date knowledge. The ultimate objective is to produce graduates who are knowledgeable, competent, skilled, visionary, highly ethical, responsible and trained in the field of Biological Sciences. These graduates are very important for the sustainable development of the country as well as the well -being of the people as a whole.

Students at level 200 and 300 will be exposed to a few taxa of animals and plants and the focus will be on the relationships based on their structures, development and functions. Students will be trained basic and advance laboratory techniques. In addition, students will be exposed to studies on the physiology and development of both animals and plants as well as the basic principles of plant-animal interactions. During the final year, students are allowed to choose courses that focus on economically important plants and its uses and applications in other related disciplines, e.g., genetics, agriculture, and biotechnology. These specific courses are aimed at providing more detailed knowledge to enhance student understanding in the areas of taxonomy, biology, ecology and reproduction of each taxon.

Course code	Course title	Semester	Course prerequisite	
Required Core - Level 200 = 17 Units				
BDT 204/3	Plant Tissue Culture	2	BOI 101/3	(S)
BDT 211/3	Plant Taxonomy and Phylogenetics	1	BOI 101/3	(S)
BDT 212/4	Plant Physiology and Development	2	BOI 101/3	(S)
BDT 223/4	Invertebrate and Vertebrate Zoology	1	BOI 101/3	(S)
BDT 225/3	Principles of Animal Behaviour	2	BOI 101/3	(S)
Required Core - Level 300 = 15 Units				
BDT 300/8 or *BOE 300/4	Research Project in Animal and Plant Biodiversity Critical Review in Biology	1 & 2 1 & 2		
BDT 316/3	Animal Physiology and Development	1	BOI 101/3	(S)
BDT 327/4	Genetics and Genomics of Plants and Animals	2	BOI 101/3 BOI 104/4	(S) (S)
Required Core - Level 400 = 6 Units				
BDT 418/3	Economic Botany	1	BOI 101/3	(S)

BDT 419/3	Principles of Plant - Animal Interaction	1	BOI 101/3	(S)
* requires 4 more units from Elective courses				
Elective (<u>17</u> units under Elective structure)				
BDE 311/3	Ichthyology	1	BOI 101/3	(S)
BDE 312/3	Fisheries Management	2	BDE311/3	(S)
BDE 411/3	Wildlife Conservation and Management	1	BST 223/3	(S)
BSE 311/3	Introduction to Geographical Information (GIS)	1		
BST 223/3	Population and Community Ecology	2	BOI 102/3	(S)
BST 315/3	Invasive Species and Biosecurity	1	BOI 107/2 BST212/3	(S) (S)
BTE 321/2	Animal Cell Culture Technology	2	BOI 103/4	(S)
BOE 101/3	Biological Instrumentation	1 & 2	BOI 103/4	(C)
BOE 201/3	Microscopy and Histological Techniques	1 & 2		
BOE 202/3	Introduction to Bioinformatics	1 & 2	BOI 104/4	(S)
BOE 311/2	Scientific Communications	1		
Elective (17 units under Minor structure or 33 units under Elective structure) Student **MUST** choose among the listed courses to complete a total of 17 or 33 units for Elective.				

(S) = Course must be taken in sequential order.
(C) = Course can be taken concurrently.

PROGRAMME OUTCOMES

Upon completion of the programme, students will be able to :-

a. Knowledge

- Acquire knowledge and understand the concepts of biology.
- Apply knowledge to solve problems related to 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 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 biology.
- Identify the relationship between biology and other disciplines, the applications and impact of biology in society.

h. Managerial & Entrepreneurial Skills

- Apply basic knowledge and principles of management and entrepreneurship related to biology field.

i. Leadership Skills

- Demonstrate the ability to lead/facilitate teams.

SYNOPSIS OF COURSES

BOI101/3 Organisms 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 of fauna & flora. The students will also be exposed to the problems of loss of species, habitats and ecosystems, 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 end with some discussion on biodiversity hotspots.

Learning Outcomes
Upon completion of this course, students are able to:
1) Define the importance of plant and animal diversity and their relationship with economic values, ecological importance and conservation.
2) Differentiate and identify general characteristics of plants and animals and be able to instill awareness on biodiversity richness especially in the tropics.
3) Discuss on increasing awareness to conserve biodiversity meaningfully at national and international level.

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 term of the basic components, structures and processes that occur in the ecosystems, communities and population together with the analysis and interpretation of organisms distribution patterns.

Learning Outcomes
Upon completion of this course, students are able to:
1) Define the basic concepts of ecology and explain the factors that influence the formation and spread of different ecosystems and uniqueness of each ecosystem.
2) Identify relationships between the impact of human activities on ecosystems's components, structures and processes.
3) Demonstrated teamwork skills and scientific presentations on selected ecosystem and factors influencing the ecosystem.

BOI103/4 Principles of Biochemistry

This course covers two distinct areas of biochemistry. The first part explains the importance of water, functions and hierarchical structure of biological macromolecules such as protein, lipid, carbohydrate and nucleic acid and their assembly into complexes responsible for specific biological processes. The second part will cover the major metabolic pathways and their interconnection into highly regulated networks. The practical

portion of the course will expose students to basic experimental approach in biochemistry such as the importance of buffers, pH and enzyme kinetics.

Learning Outcomes
Upon completion of this course, students are able to:
1) Explain the basic concepts of biochemistry, biomolecules and enzymes in biochemical processes, metabolic pathways and their regulation.
2) Connecting theory (basic knowledge) and laboratory work related to biochemical principles and concepts.
3) Analyze the relationship of basic biochemical concepts to each biochemical process, metabolic pathways and regulation.

BOI104/4 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. This course is a 4 unit course consisting of 3 lectures per week and a 3 hours practical class every fortnight.

Learning Outcomes
Upon completion of this course, students are able to:
1) Identify and describe the genetic concept, Mendel's Laws, population genetics and latest development of genetics technology.
2) Practical of gene regulation, DNA replicationn and chromosome segregation.
3) Relate the genetic concept with the latest DNA technology such as in genetic engineering.

BOI105/4 Biostatistics

Students will be exposed to the fundamentals in biological research and statistical analysis for univariate and bivariate cases via hypothesis testing and modelling. Statistical analysis will cover common parametric and non-parametric tests. Students will be given a chance to conduct a simple biological research in groups with instructor’s guidance.

Learning Outcomes
Upon completion of this course, students are able to:
1) Demonstrate and understand the fundamental concepts of biostatistics.
2) Solve scientific problems using suitable statistical approach.
3) Participate and perform a simple biology project.

BOI106/3 General Microbiology

The course is intended to provide basic knowledge in microbiology. 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. BOI 207 is a three-unit course consisting of lectures (two lectures per week) and laboratory practical (one three-hour practical every other week).

Learning Outcomes
Upon completion of this course, students are able to:
1) Explain the basic concepts of microbiology.
2) Conduct practical on basic techniques in microbiology.
3) Apply and relate knowledge and techniques in microbiology to real life.

BOI107/2 Practical of Biodiversity and Ecology

This field and laboratory-based course introduces students to basic ecological and biodiversity concepts. Introduction to biodiversity will be from a species and ecosystem perspective. Emphasize 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) Execute practical methods to analyze water, soil, animals and plants samples.
2) Analysze and differentitae each ecosystem zone based on physical, chemical and biological factors.
3) Organize field work for environmental cleanup such as collecting, identifying, isolating, measuring and analyzing waste pollution data of one ecosystem such as coastal.
4) Communicate finding from field work to group members.
5) Participate willingly to complete group task.

BOI420/12 Industrial Training

Industrial training is to be conducted for six (6) months in the 8th semester (4 years of study). Through industrial training, students will gain exposure to the real world of work.

Learning Outcomes
Upon completion of this course, students are able to:
1) Apply the practical acquired from the learning lesson/lectures into the real working environment.
2) Receive, giving and understand the instuction very well.
3) Develop excellent collaborative with the organization.
4) Apply the skills and longlife learning principles for career and academic development.
5) Practice ethics and professionalism in workplace.

6) Mastering management skills and explore the entrepreneurial potential in oneself.

BOE101/3 Biological Instrumentation

This course is intended to introduce the theoretical principles and technique used for laboratory equipment. This course is divided into two main parts, namely, theory and practical, and emphasis been given for the practical aspect. The principles and techniques that will be discussed includes extraction, purification and assay principles. Emphasis will be given to the utilisation of extractor equipment (centrifuge, electrophoresis, chromatography, freeze drying) and analysis equipment (pH meter, CO2 meter, O2 meter, atomic spectrophotometer, UV/Vis spectrophotometer, flame photometer and proximate analysis). This course is geared for student interested in courses involved in the study and efficiency use of laboratory equipment for research purpose.

Learning Outcomes

Upon completion of this course, students are able to:

1) Explain the theoretical principal of lab equipment such as extractor and analysis equipment.
2) Show the right technique and utilisation of lab equipment.
3) Analyse and identify the principal and theory of the lab equipment used.

BOE201/3 Microscopy and Histological Techniques

This course is aimed at introducing the basic principles and concepts of microscopy and histological techniques. Basic principles of bright-field, dark-field, phase contrast, fluorescence, confocal and electron microscopes will be taught. Factors of light applications, colour and electromagnetic wave in microscopy will also be discussed. Concepts such as magnification, resolution, contrast, image formation, numerical aperture, illumination, and depth of field will be elaborated. Basic histology of animals and plants involving the structures of cells, tissues and organs related to their functions will be discussed. Students will conduct practical using different techniques of microscopy and basic histology.

Learning Outcomes

Upon completion of this course, students are able to:

1) Explain the basic principles and main functions of a microscope, microscopic images with different techniques and the histological technical principles of animal and plant samples.
2) Operate the use of a compound microscope and perform basic histological techniques.
3) Discuss various latest technologies regarding the use of microscopy and histological techniques.

BOE202/3 Introduction to Bioinformatic

Phylogenetic analyses and molecular evolution are exciting and rapidly developing field of studies and are increasingly important in many different fields of biological research, particularly as advances in molecular genetic techniques have made large DNA sequence

data sets readily available. The molecular data could provide insight into a) understanding how and why DNA sequences and genomes change, and b) reconstructing the evolutionary history of genes, genomes, and organisms. This course covers the basic methods of phylogenetic analysis and their application in fields such as systematics, comparative biology, molecular evolution, population genetics and genomics. Lectures will emphasize the logical basis and computational details of various tree-building algorithms and associated methods of hypothesis testing, as well as novel applications of phylogenetic analysis in various fields of biology. Computer-based projects will give students the opportunity to implement these methods using a variety of phylogenetic and bioinformatics tools. Overall, the fundamental concepts of molecular evolution and their relevance to bioinformatics studies will be emphasized.

Learning Outcomes

Upon completion of this course, students are able to:

1) Identify the basic principles of bioinformatics as well as bioinformatics tools in making genome analysis for phylogenetic and molecular evolution purposes.
2) Conduct bioinformatic analysis on dna and protein data.
3) Apply knowledge of phylogenetics and molecular evolution.
4) Apply the methods of using information and digital technology to assist in the management and analysis of data, information and its application in learning and work.

BOE300/4 Critical Review in Biology

Student will be assigned a topic and supervised by a lecturer at the beginning of sem1 or sem2 (4th year of study). The students will be introduced to written research assignments related to the project proposed by the supervisor.

Learning Outcomes

Upon completion of this course, students are able to:

1) Identifiying the best methods for collecting information based on scientific journals and texts that can be used while conducting scientific studies.
2) Formulate logical analysis and conduct statistical analysis of the findings published in scientific journals.
3) Presents scientifically to deliver effective research results in both oral presentation and in written report.
4) Find and use the latest and relevant information / software for the purpose of writing scientific articles

BOE311/2 Scientific Communications

This is an interdisciplinary course. The student will be introduced to current issues and related emerging challenges in their fields. The course also covers effective communication in biology, such as oral presentation of research findings, thesis writing and manuscript writing and publishing process in scientific journals.

Learning Outcomes

Upon completion of this course, students are able to:

1) Write a summary of scientific articles and draft the thesis content according to the usual standard format.
2) Demonstrate the skill of finding and using various sources of reading material ethically for the purpose of article writing.
3) Find and use the latest and relevant information / software for the purpose of writing scientific articles.
4) Manage, plan and select appropriate materials in article summary writing, presentation and review of reading material.
5) Integration of leadership skills and characteristics while conducting group discussions and presentations.

BDT204/3 Plant Tissue Culture

This course provides a comprehensive overview of 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 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 plant biotechnology.

Learning Outcomes

Upon completion of this course, students are able to:

1) Explain the various techniques of plant tissue culture and the need to establish a tissue culture laboratory.
2) Carry out plant tissue culture techniques such as media preparation, explant sterilization, culture and plantlet multiplication to enhance plant propagation and germplasm cryopreservation.
3) Demonstrate basic conceptual skills, techniques and training on plant genetic manipulation and its application in plant biotechnology
4) Demonstrate clear presentation skills on the application of tissue culture technology and plant biotechnology.

BDT211/3 Plant Taxonomy and Phylogenetics

This course divided into two components; taxonomy and plant phylogenetics. Within taxonomy discussion will focus on the nomenclature, the five kingdoms classification, and taxonomic concept. This course also discusses the application of taxonomic keys. Chemotaxonomy and molecular taxonomy or field of study that utilizes chemical and genetic evidences for classificatory purposes will also be discussed. The information from breeding system, plant geography and ecology including the hybridizing species, isolation

mechanism, patterns of geographical distribution, concepts of disjunction and vicariance, biogeographical hypothesis and ecological differentiation will also be emphasized. Principles and procedures for conducting numerical taxonomy or phenetic analysis will be highlighted. Evolutionary relationships between species from the phylogenetic method will also be emphasized based on character and distance based characters. The application of DNA sequence for constructing phylogenetic trees will also be given.

Learning Outcomes
Upon completion of this course, students are able to:
1) Recognize the vegetative and reproductive characters and terms used to identify flowering plants. To define the principals of plant taxonomy, nomenclature including the evolutionary pattern, speciation pattern, biogeography and flower biology.
2) Demonstrate taxonomic practicals using taxonomy keys for the classifaction and identification of flowering plants.
3) Analyse morphological or molecule data to construct phenetic and phylogenetic trees.

BDT212/4 Plant Physiology and Development

The course explains various mechanisms involved in plant during physiological processes, water transport, nutrient uptake, cell respiration and photosynthesis. The function of plant hormone and nutrients, internal and external factors in regulating growth and development of a plant at various stages including seedling, flowering, fruiting, maturation, and senescence will be discussedThe importance of nitrogen fixation process, seed dormancy, and apical dominance will also be explained. In the end of the course, knowledge on plant physiology will be relate with plant adaptation mechanism to tolerate environmental stresses.

Learning Outcomes
Upon completion of this course, students are able to:
1) Explain basic biochemistry and plant metabolism regarding photosynthesis process and the role of hormone in plant growth and development, as well as decribe plant physiology and development concept from the perpective of biochemistry and genetic process.
2) Able to conduct practical related to plant physiology and development according to prepared manual.
3) Analyse the relationship between morphology and function in plant and plant adaptation towards environment mainly in extreme environment.
4) Present relationship between genetic concept and environment in modern approach of plant regeneneration.

BDT 223/4 Invertebrate Zoology and Vertebrate Zoology

This course will discuss numerous aspects of Invertebrate Zoology, namely on classification and phylogeny, species evolution, invertebrate's diversity, adaptation, function, system, physiology, and life cycle in various environments. Several phyla will be discussed, including Protozoa, Porifera, Cnidaria, Nematoda, Platyhelminthes, Mollusca, Echinodermata, and Annelida. Vertebrate Zoology is the study of animals with backbones.

Evolution from Hemichordata and Protochordata to modern vertebrates will be discussed. Characteristics and evolutionary success of various vertebrate class such as Agnatha, Placoderma, Ostracoderm, Chondrichthyes, Osteichthyes, Amphibian, Reptilian, Aves and Mammal will be discussed with special references and comparison with vertebrate paleontology and current status in vertebrate studies. Topic will focused on several vertebrate issues such as anatomy, structure, adaptation, life cycles, diversity and conservation for each major class of vertebrate. In addition to the published facts about vertebrates, students will be introduced to important ideas in the areas of evolutionary biology, systematics, morphology, and ecology that form the basis of the conceptual understanding of a selected group of animals.

Learning Outcomes
Upon completion of this course, students are able to:
1) Identify the phylogeny of invertebrate animals & describe the historical background, pioneering scientist and earlier principle in vertebrate zoology.
2) Observe different type of animals and prepare report related to the activities.
3) Describe the diversity, evolution, function, adaptation in the classification of invertebrate and vertebrate animals.

BDT 225/3 Principles of Animal Behaviour

This course will introduce animal behavior (AB) by reflecting on its history, development, principles, structures, and mechanisms. The course will lead students to understand the two approaches of AB, the ultimate and proximate causations. The relationship between AB and genetics, evolution and ecology will be emphasized. Students will learn how to design, implement and analyse simple behavioral experiments.

Learning Outcomes
Upon completion of this course, students are able to:
1) Able to explain the history, development, principles, structures and mechanisms of animal behavior.
2) Able to carry out a project on Animal Behavior and demonstrate skills for data analysis and interpretation.
3) Able to analyse the principles of animal behavior with evolutionary ecological and genetic concepts.
4) Able to demonstrate skills in preparing scientific presentations on specific topics in animal behavior.

BDT 300/8 Research Project in Animal and Plant Biodiversity

In this course, the final year student is offered a research project that introduces the students to research methods for solving a scientific problem. This course will require the student to manage time as well as carrying out scientific research to develop a hypothesis at the end of the project. At the end of this course student will have hands-on experience in solving a scientific problem 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) Implement research projects and use laboratory / field equipment to obtain data related to the field of Plant-Animal Biodiversity.
2) Adhere to Good Laboratory Practices (GLP), as well as demonstrate the ability to follow and comply with safety requirements and regulations, legal and ethical principles, and codes of ethics in Plant-Animal Biodiversityresearch.
3) Demonstrate skills and principles of lifelong learning in academic and career development, as well as use information management and ICT systems to enhance practice in Plant-Animal Biodiversity research.
4) Adopt a quality management system and demonstrate entrepreneurial skills inplant-Animal Biodiversity.
5) Demonstrate leadership qualities and social skills in research laboratories and field research teams and are able to collaborate with other professional Plant-Animal Biodiversity.

BDT 316/3 Animal Physiology and Development

The course deliver physiological concepts utilizing the anatomy, functional and comparative approaches. The concept of homeostasis and its regulation will be introduced. The course will then elaborate on all the major physiological systems in animals including the muscular and skeletal, circulation, nerve, endocrine, digestion, water balance and reproductive system utilizing the concepts of comparative, anatomy and functional approaches.

Learning Outcomes

Upon completion of this course, students are able to:

1) Explain and apply the knowledge of animal physiology in solving problems in nutrition, reproduction, bone structure, osmotic balance for animals.
2) Solve problems related to animal physiology creatively and critically.
3) Communicate information on animal physiology to the general public as well as stakeholders in the field of animal biology
4) Collaborate in doing projects / assignments on animal physiology issues in groups.
5) Conduct practical evaluations in a laboratory setting for animal physiology studies

BDT327/4 Genetics and Genomics of Plants and Animals

This course emphasizes the genetics as a discipline and genetic analysis as a tool to understand biology and the role of genome in biology. Topics that will be covered in this course includes Mendelian Law and probability, polymorphism, molecular genotyping, genetic genealogy and soma basic topics on genome and its applications. Some basic techniques on chromosome mapping and DNA sequencing will also be emphasized in this course.

Learning Outcomes

Upon completion of this course, students are able to:

1) Identify the main causes of genetic and genome variation and describe the principles of inheritance patterns in animals and plants.
2) Conduct practicals related to the topics studied and make inferences about the results obtained as well as understand the relationship between genome and the molecular genetic techniques used.
3) Distinguish and make assessments and relationships between genetic, biochemical and cell biology approaches in dismantling biological processes at the molecular level and be able to analyse and interpret data obtained through these methods.

BDT418/3 Economic Botany

To study the relationship between plants and humans (the origins of agriculture, the contribution of plants to the world's economy).Important crops, major producing countries, strategies in improving quality and productivity, processing methods and plant's chemical active ingredients are also discussed. Components of ethnobotany that study on the traditional use of plant especially by the indigenous people is also stressed.

Learning Outcomes

Upon completion of this course, students are able to:

1) Apply knowledge in economic botany to identify various commercial plants as world important food source.
2) Carry out practical experiment in the laboratory, analise data and produce scientific report.
3) Solve problems related to economic botany logically and scientifically by providing appropriate steps or new ideas and discoveries.
4) Generate ideas, identify current demand, manage business plans, develop products from plants and then market those products taking into account capital costs as well as balance of profits and losses.

BDT419/3 Principles of Plant-Animal Interaction

The students are exposed to a deeper understanding and discussion on the level of interaction.This course re-examines all of these interactions from both the perspective of animals and plants. This course looks into the mechanisms that are involved in the interactions, such as signals, attraction, deception, attack, defence and tolerance.

Learning Outcomes

Upon completion of this course, students are able to:

1) Evaluate, explain and distinguish interactions between plants and animals (for example, mutualism and antagonism).
2) Conduct experiments on the relationship between plants and animals in the laboratory as well as in the field.
3) Identify and resolve issues and problems in plant-animal interaction in a critical, creative, and innovative manner.
4) Present the results of studies/experiments/assignments on the interaction between plants and animals clearly.

BDE311/3 Ichthyology

This course will discuss various aspects of biology, taxonomy, evolution and ecology of fish. Emphasis will be placed on aspects of adaptation of life in aquatic habitats, based on morphology and anatomy closely related to fish physiology such as respiration, circulatory system, nutrition, excretion, sensory nerves, movement and reproduction. The importance of fish from economics, zoogeography and ecology were also discussed.

Learning Outcomes

Upon completion of this course, students are able to:

1) Identify and understand the basic concepts in biology, taxonomy, classification, biodiversity, ecology, genetic, evolution and economical value of fish.
2) Differentiate and to classify the fish in laboratories and field based on its morphological and anatomical characteristics as well as to understand the importance of fish in biological research and its relationships with fish stock assessment and management and biogeography.
3) Understand, identify and differentiate the role and function of morphology, anatomy and structures of fish organs in skeletal, excretory, circulatory, respiratory, nervous, feeding, reproductive, growth and development systems in relation to fish adaptation in aquatic environment.

BDE312/3 Fisheries Management

This course covers legislation, regulations and governance in the conservation and management of terrestrial and marine fisheries and aquaculture in Malaysia and world. The basics of catch fishing based on fishing gears as well as sustainable catching techniques will be discussed. The principles of fisheries management based on ecosystems and communities based on fisheries industry products and marketing strategies are also touched.

Learning Outcomes

Upon completion of this course, students are able to:

1) Demonstrate and understand the fundamental concepts, objectives and the goals of fisheries management and stock assessment in the fisheries industry
2) Execute a simple research study to manage fishery resources by using suitable fisheries management and stock assessment approached.
3) Analyze and solve fisheries problems using suitable fisheries management and stock assessment approaches
4) Interact appropriately to acquire / disseminate fisheries information / plan.

BDE411/3 Wildlife Conservation and Management

This course focuses on important matters in the ecology and management of wildlife species and ecosystems found in Malaysia and other countries. The course also covers the topics of wildlife diseases, legislation and wildlife protection.

Learning Outcomes
Upon completion of this course, students are able to:
1) Analyse the ecological and conservation concepts in wildlife management.
2) Differentiate various wildlife management strategies.
3) Seek solution to wildlife conservation and management issues in Malaysia

BMT210/3 Microbial Physiology

This course begins with a discussion on microbial growth, aerobic and anaerobic metabolism, energy production, fermentation pathways and 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 e.g. 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 involving microbial cell content, microbial growth and the various metabolic pathways involved and their regulation.
2) Relate the theory and laboratory work on the concepts of microbial physiology and metabolic pathways.
3) Analyse the relation of microbial physiology concepts to their metabolic pathways and their regulation and adaptation to microbes with the environment.
4) Demonstrate clear presentation skills on the fundamentals and applications of microbial physiology.

BMT211/3 Virology

This course aims at given better understanding and deeper knowledge of virology. The focus of discussion would be on the three major and largest groups which are bacteriophage, plant virus and animal virus. The molecular virology aspect of this course would take the students into the detail's components of viruses, as well as virus-host interaction. The significant of each of the virus groups would also be discussed, i.e., in term of diseases or problems caused by the viruses and various virus applications.

Learning Outcomes
Upon completion of this course, students are able to:
1) Explain virus diversities.
2) Show various laboratory practical on virology.
3) Compare virus applications in various fields.

BMT222/3 Bacteriology

This course starts with brief discussion on prokaryotic (archaea and bacteria) systematics which cover classification, taxonomy, nomenclature, identification, phylogeny and concept of species. Students will be introduced to the characterisation of prokaryotes by morphological, biochemical, physiological, metabolic, ecological and genetic characteristics, by molecular biological techniques. This will be followed by detailed discussion on chemical constituents of prokaryotic fine structures and their functions. The various groups of prokaryotes will be surveyed to relate their characteristics to their importance to daily life of other organisms. Finally, discussion will be centred on methods of enrichment, isolation and maintenance/preservation of prokaryotic cultures.

Learning Outcomes

Upon completion of this course, students are able to:

1) Explain the chemical components and functions of artistic structure for archaea and bacteria.
2) Conduct practical for bacteriological techniques, isolation, culture, characterisation and identification of bacteria and fungi.
3) Relate the characteristics of archaea and bacteria based on their importance to the daily life of other organisms.

BMT223/3 Immunology

This course describes the principles and basic concepts of immunology in states of health and disease This course covers the historical development and the scope of immunology, natural immunity, acquired immunity, the complement system, antigen, antibodies, antigen-antibody interactions, fundamentals of cellular immune responses, immunodeficiencies, hypersensitivity (allergy) – immediate and late type, graft immunity, autoimmunity and immunity against cancer, and finally applications of immunology in the development of therapeutics and diagnostic testing. The laboratory component provides students the opportunity to simulate antibody production in bacterial infection in animal models (chicken and rabbit) through immunizations. The students would then assess the humoral immunity response using standard diagnostic tests.

Learning Outcomes

Upon completion of this course, students are able to:

1) Explain and give interpretations as well as justifications on the basic concepts of immunology, immune response in infection, immune disorders (immune disorders) and applications in the field of immunology.
2) Show animal immunisation practices and diagnostic tests based on serology.
3) Apply the concepts of immunisation and diagnostic tests.

BMT300/8 Research Project in Microbiology

In this course, the final year student is offered a research project that introduces the students to research methods for solving a scientific problem. This course will require the student to manage time as well as carrying out scientific research to develop a hypothesis at the end of the project. At the end of this course student will have hands-on experience in solving a scientific problem 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) Carry out research projects by using lab/field equipment to obtain related data in the microbiology field.
2) Implement the research ethics in laboratory/field and thesis writing following the correct procedures.
3) Ability to find and use relevant latest information/software and discuss the scientific ideas clearly and effectively.
4) Manage research activities in lab/field and thesis writing.
5) Present scientific data and leadership in carrying out a research project.

BMT314/3 Mycology

The course provides basic knowledge on various aspects of fungi which include fungal origin and phylogeny, habitat, mode of life, general and specific characteristics, methods in fungal nomenclature and classification, and examples from various fungal groups. Other aspects include the economic importance of fungi such as fungal application in industries, medically important fungi, fungi as food spoilage, spoilage of timber products and fungi as plant pathogens.

Learning Outcomes

Upon completion of this course, students are able to:

1) Identify the basic and specific features of fungi from different classes.
2) Conduct practical concerns on the way fungi living and their role in the ecosystem and environment.
3) Apply various aspects of fungi, such as in the food, medicine and agriculture industries.
4) Demonstrate group work to identify and characterize different fungal groups.

BMT315/3 Environmental Microbiology

The course emphasizes on the principles of microbial behaviour in an ecosystem, growth kinetics in open and closed system, the role of microorganisms in the natural ecosystem such as terrestrial, aquatic, animal, extreme environments, air borne microbial dispersion, development of microbial community and microbial activities, which have economic and social implications. In relation to that, fields such as nitrogen fixation, food spoilage by microorganisms, air pollution and its prevention, the role of microorganisms in sewage and domestic treatment and

biodegradation of complex chemical compounds and recalcitrant, will also be discussed. At the end of the course, the students should be able to understand the importance of microbial interactions and the effects on the environment.

Learning Outcomes
Upon completion of this course, students are able to:
1) Explain the principles of treatment of microorganisms in ecosystems.
2) Conduct practical to explain the role of microorganisms in natural ecosystems and identify the activities of microorganisms that have significant economic and social implications.
3) Select and study specific microorganisms that produce value-added products for improving consumer health and environmental sustainability.
4) Present a clear presentation and discuss the mechanism of adaptation of microorganisms to changes in environmental conditions that occur.

BMT326/3 Microbial Genetics and Genomics

This course will discuss the basic concept and principles of microbial genetics and genomics which include characteristics of bacterial and viral chromosomes, mutagenesis and mutants, genetic transfer in bacteria such as transformation, transduction and conjugation and recombination 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 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) Describe the characteristics of bacterial and viral chromosomes, the process of mutagenesis and DNA repair, gene transfer in bacteria and DNA recombination, plasmid and transposon characteristics, principles of gene regulation, bacteriophage genetics as well as microbial and bioinformatic genomics.
2) Carry out practical on the relationship between microbial genetic systems and gene regulation.
3) Apply basic knowledge of microbial genetics and how genes are regulated for use in microbial genetic research and biotechnology.

BMT327/3 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) Explain the principle of microorganism behaviour in the soil ecosystem.
2) Conduct practical to describe microorganisms in soil ecosystems and identify the activities of microorganisms that have significant implications for nature.
3) Possess skills to optimize land use and management towards the development of soil-specific organisms and their functions.
4) Present a presentation to discuss the role mechanisms, adaptations and effects of microorganisms on fertility retention and soil function in the environment.

BMT418/3 Industrial and Food Microbiology

The course provides theoretical and practical exposures to the students about the relationship among biochemistry, physiology, nutrition and growth of industrially important microorganisms other than its relationship with food. Strains isolation, selection, improvement and maintenance will be discussed for the production of alcohols, organic acids, amino acids and cell biomass through various major industrial fermentation processes. These are important products in various industries. Besides that, the production of various products/metabolites including fermented food by submerged and solid-state fermentations will be highlighted. Roles of microorganisms in various industries including food and beverages, fuel and energy, pharmaceutical, agriculture, for environmental bioremediation and waste treatment will also be discussed.

Learning Outcomes

Upon completion of this course, students are able to:

1) Describe the methods of isolation, screening, selection, growth and maintenance of industrially important microorganisms.
2) Conduct practical on fermented food production and the desired metabolite production by selected microorganisms.
3) Apply and benefit microorganisms for metabolite production in various industries such as food, agriculture, pharmaceutical industries and the environment.
4) Present a presentation on examples of the fermentation process, and microorganisms use in various industries through the latest research references.
5) Discuss and explain in groups the application of microbiology in various industries.

BMT419/3 Medical Microbiology

This course focuses on wide aspects of microbes especially the bacteria, fungi, and viruses as causative agents of diseases in human and the host defence mechanisms against microbial invasion. The topics that will be discussed cover general characteristics of pathogenic microorganisms, host-pathogen interactions, immune-pathogenesis, antigen structures, laboratory diagnosis, and epidemiology, roles of chemotherapeutic agents and vaccine, and drug resistance. Passive immunization for the prevention and control of infectious diseases will also be discussed. The manipulation of viruses in gene therapy would also be introduced.

Learning Outcomes

Upon completion of this course, students are able to:

1) Explain and give interpretations as well as justifications on the concepts of epidemiology, pathogenicity, interactions between pathogens and host cells, bacterial, fungal, and viral infections, isolation and identification, chemotherapy, and resistance.
2) Show various laboratory practical related to medical microbiology.
3) Apply the concepts of vaccine development, anti-virus development and gene therapy.

BST223/3 Population and Community Ecology

This course is intended to provide exposure on the basic principles and progress in population ecology and the current knowledge whether in theory and practical. Lecture and practical will explore the dynamics of the population ecology of animals and plants, particularly in the regulation of the population size and the management of natural abundance of organisms.

Learning Outcomes

Upon completion of this course, students are able to :

1) Explain the basic and developed principles in population and community ecology.
2) Analyze ecological information and estimating population size, population life table, the patterns of vegetation and distribution of community.
3) Cooperate in a group to obtain ecological data.

BST315/3 Invasive Species and Biosecurity

At the end of this course, students will i) know the basic concepts of invasive species and biosecurity; ii) Identify threats and impacts of invasive species on biodiversity and socio-economy; iii) Assess the impact of invasive species on natural and man -made systems.
iv) Study national and international invasive species management strategies

Learning Outcomes

Upon completion of this course, students are able to :

1) Explain and identify the ecology and spread of invasive species, and their

roles in the context of biosecurity.
2) Demonstrate the influence of invasive species and compare biosecurity measures in managing the impact of invasive species nationally and internationally.
3) Explain and present the results of assignments in groups or individually.

BSE311/3 Introduction to Geographic Information System

The course provides a hands-on introduction to geographic information system as a tool for geographical analysis in natural sciences and presentation of spatial data. During the course basic principles for coordinate systems and map projections, cartography, spatial data models, spatial analyses, geostatistics and GIS applications in environmental and conservation sciences are discussed.

Learning Outcomes

Upon completion of this course, students are able to :
1) Describe the basic concepts and theories of geographic information systems and science.
2) Obtain appropriate spatial data for use in GIS.
3) Arrange and analyse digital spatial data.
4) Plan and conduct an independent project with spatial analysis and present the results.

BTT211/3 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 principals 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) Explain the techniques of DNA recombinant technology, protein purification and fermentation process.
2) Apply DNA recombinant techniques and fermentation (invention, characteristics and functions of the main components of bioreactors as well as a variety of downstream processes, purification and enrichment technique).
3) Conduct practical cloning techniques, electrophoresis, protein purification and fermentation.

BTT312/3 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 biotransformation involving free and immobilised cells/enzymes. The technology and fermentation kinetics will also be discussed.

Learning Outcomes

Upon completion of this course, students are able to :

1) Explain the basic fermentation process, preparation of medium substrate and inoculum.
2) Conduct practical fermentation process in shake flask and bioreactor.
3) Describe microbial metabolism in the production of specific fermentation products.
4) Present a presentation on examples of the fermentation process through the latest research references.
5) Discuss and explain in groups the basics of the fermentation process through appropriate examples in the form of written assignments.

BTT313/3 Genomics

This course introduces fundamental concepts and related tools in 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 and biotechnology.

Learning Outcomes

Upon completion of this course, students are able to :

1) Explain the process involved in bioinformatics and genomic technology, and genome evolution and characteristics.
2) To carry out practical on genome analysis using bioinformatics process.
3) Analysing and using basic knowledge on genomics and process.
4) Demonstrate the ability to choose and apply genomic data using suitable software.

BTT415/3 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) Explain the fundamental concept of genetic engineering.
2) Carry out practical and bioinformatic analysis in producing recombinant organisms.
3) Analyse the concept of DNA manipulation.

BTT416/3 Protein Structural Bioinformatics

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 on the internet and how they 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) Explain the protein structure level, enzyme catalysis and mechanism, protein structure prediction techniques, and prediction confirmation methods, molecular modelling and application of protein structure information.
2) Conduct practical on protein crystallisation, identification of enzyme mechanism and protein structure prediction based on the existing database.
3) Apply information obtained to understand protein function.
4) Demonstrate skills in choosing protein data from databases and application of data using suitable software for the given assignments.

BTE321/3 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) Explain the basic principles and advanced systems of animal cell culture.
2) Conducting various practical techniques in animal cell culture systems.
3) Present and discuss the latest technologies in animal cell culture as well as safety and bioethical issues.

Index

SCHOOL OF MATHEMATICAL SCIENCES

SCHOOL OF MATHEMATICAL SCIENCES
(math.usm.my)

INTRODUCTION

The School of Mathematical Sciences was established on May 29, 1974. As with the other science schools, the School of Mathematical Sciences offers the Bachelor of Science and Bachelor of Applied Science degrees. In addition, the school is also involved in running mathematics courses for various programme in the University degrees.

The Bachelor of Science (Mathematics) programme is formulated in an effort to produce graduates who are well-trained in the Mathematical Sciences to meet the nation's manpower needs. The curriculum is devised so as to provide a broad-based and rigorous mathematics education. The skills obtained at the end of the program will provide a firm foundation for the graduates to further advance their knowledge in Mathematical Sciences.

VISION

To be a recognized 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 society aspiration; the country's vision and universal aspirations.

PROGRAMME OBJECTIVES

Graduates of Bachelor of Science (Mathematics) will:
1. Excel in mathematical practices in various sectors.
2. Establish themselves as leaders in their career.
3. Enrol for an advanced degree or professional certificate.

PROGRAMME LEARNING OUTCOMES

At the end of the programme, the students will possess:
1. Knowledge
   - Describe and apply fundamental knowledge of Mathematics and Applied Mathematics in various activities.
2. Practical skills
   - Select and apply practical skills such as mathematical techniques, tools and resources to various activities.
3. Cognitive Skills
   - Identify and analyse problems to formulate solutions using logical reasoning, critical thinking and scientific skills.
4. Communication Skills
   - Communicate effectively and efficiently in both oral and written form whether as an individual, or in a team setting.
5. Interpersonal Skills
   - Demonstrate effectively social skills, teamwork and also social responsibilities as an individual.
6. Ethics and Professionalism
   - Demonstrate and practice appropriate values, attitudes and professionalism at all times.
7. Personal Skills
   - Apply acquired knowledge to adapt with latest information whilst constantly learning new skills and capabilities.
8. Entrepreneurial Skills
   - Apply knowledge and understanding of project management and acquire entrepreneurial skills in handling various projects and activities.
9. Leadership, Autonomy and Responsibility
   - Possess the characteristics of an articulate, decisive, innovative and responsible leader.
10. Digital Skills
    - Gain the ability to apply programming knowledge in problem solving.
11. Numeracy Skills
    - Employ the mathematical and statistical knowledge in providing precise and accurate computational solutions.

STAFF AND ADMINISTRATION

DEAN

Professor Dr. Hailiza Kamarulhaili

DEPUTY DEANS

Associate Professor Dr. Lee See Keong
(Academic, Student & International)

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

PROGRAMME CHAIRPERSONS

Dr. Ahmad Lutfi Amri Ramli
Bachelor of Science (Mathematics)

Dr. Fam Pei Shan
Bachelor of Applied Science (Applied Statistics) & Bachelor of Applied Science (Mathematics and Economics)

Assoc. Prof. Dr. Saratha Sathasivam
Postgraduate

Dr. Maisarah Haji Mohd
Alumni, Marketing & Income Generation Co-ordinator

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

ASSISTANT REGISTRARS

Madam Nur Akmar Idris
Principal Assistant Registrar

Mr. Ahmad Wafi Sahedan
Assistant Registrar

ADMINISTRATION

	E-mail
DEAN	
Prof. Dr. Hailiza Kamarulhaili	dean_mat@usm.my
DEPUTY DEAN (ACADEMIC, STUDENT & INTERNATIONAL)	
Assoc. Prof. Dr. Lee See Keong	ddsa_mat@usm.my
DEPUTY DEAN (RESEARCH, INNOVATION & INDUSTRY-COMMUNITY ENGAGEMENT)	
Assoc. Prof. Dr. Farah Aini Abdullah	ddpg_mat@usm.my

PROGRAMME CHAIRPERSONS

BACHELOR OF SCIENCE (MATHEMATICS)	
Dr. Ahmad Lutfi Amri Ramli	alaramli@usm.my
BACHELOR OF APPLIED SCIENCE (APPLIED STATISTICS) & BACHELOR OF APPLIED SCIENCE (MATHEMATICS AND ECONOMICS)	
Dr. Fam Pei Shan	fpeishan@usm.my
POSGRADUATE	
Assoc. Prof. Dr. Saratha Sathasivam	saratha@usm.my
FACILITY & TEACHING DEVELOPMENT CO-ORDINATOR	
Dr. Yazariah Mohd. Yatim	yazariahmy@usm.my
ALUMNI, MARKETING & INCOME GENERATION CO-ORDINATOR	
Dr. Maisarah Haji Mohd	maisarah_hjmohd@usm.my
PRINCIPAL ASSISTANT REGISTRAR	
Madam Nur Akmar Idris	nur_akmar@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
Hailiza Kamarulhaili, Dr	3648	hailiza@usm.my
Michael Khoo Boon Chong, Dr	3941	mkbc@usm.my
ASSOCIATE PROFESSOR		
Andrew Rajah, Dr	4780	andy@usm.my
Ang Miin Huey, Dr	4772	mathamh@usm.my
Farah Aini Abdullah, Dr	4765	farahaini@usm.my
Husna Hasan, Dr	4773	husnahasan@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		
Adila Aida Azahar, Dr	3641	adilaazahar@usm.my
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
Kong Voon Pang, Dr	3943	kongvp@usm.my
Johnny Lim Khai Yang, Dr	3967	johnny.lim@usm.my
Maisarah Haji Mohd, Dr	4488	maisarah_hjmohd@usm.my
Md Yushalify Misro, Dr	3658	yushalify@usm.my
Mohd Hafiz Mohd, Dr	3656	mohdhafizmohd@usm.my
Muhammad Fadhil Marsani, Dr	3657	fadhilmarsani@usm.my
Nabilah Najmuddin, Dr	3958	nabilah.najmuddin@usm.my
Ng Zhen Chuan, Dr	5337	zhenchuanng@usm.my
Noor A'lawiah Abd Aziz, Dr	4775	nooralawiah@usm.my
Noor Saifurina Nana Khurizan, Dr	4989	saifurina@usm.my
Norazrizal Aswad Abdul Rahman, Dr	3940	aswad.rahman@usm.my
Norhashidah Awang, Dr	4774	shidah@usm.my
Norshafira Ramli, Dr	4764	norshafiraramli@usm.my
Nur Fariha Syaqina Mohd Zulkepli, Dr	2671	farihasyaqina@usm.my
Nur Nadiah Abd Hamid, Dr	2356	nurnadiah@usm.my
Nurul Syafiah Abd Naeeim, Dr	3944	nsyafiah@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
Siti Noor Farwina Mohamad Anwar Antony, Dr	3965	farwina@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

SUPPORT / TECHNICAL STAFF

Siti Salmah Harun	Office Secretary
Azizah Ibrahim	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)
Nur Insyirah Abd Manaf	Administrative Assistant (Clerical/Operation)
Syed Mohamed Hussain Syed Osman	Engineering Assistant Officer
Muhammad Faiz Roslan	Operational Assistant

PROGRAMME REQUIREMENT

Type of Courses	Classification	Unit
Core	T	70
Minor / Elective	M / E	36*
University	U	20
	Total Number of Units	126

The required 70 units for Core are fulfilled from the courses listed below.

* Students who opt for **Minor** need to accumulate 20 units from a minor package, and the remaining 16 units from the elective courses in a specific track.

* Please refer to the book of Minor Programmes Guideline. Any Minor Programme offered by other schools can be taken by the Mathematics students, subject to the requirements imposed by the school which offers the Minor Programme. Examples of popular programmes are Management, Computer Science, Communications, Psychology, English or other Sciences.

* Students who opt for **Elective** are required to complete 36 units from Elective Courses or any courses offered by the School of Mathematical Sciences. Other courses may be taken subject to approval from the Dean.

CORE COURSES

A student has to accumulate 70 units as follows:

MAT100/4 : 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
MAT223/4 : Differential Equations I
MAT251/4 : Introduction to Operations Research
MAT263/4 : Probability Theory
MSS212/4 : Further Linear Algebra
MSS311/4 : Modern Algebra
MAT323/4 : Differential Equations II
MSG328/4 : Introduction to Modelling
MSS381/2 : Mathematical Software Laboratory
MAT382/4 : Introductory Numerical Methods
MSS492/4 : Project

ELECTIVE COURSES (Track 1)

MAT363/4	:	Statistical Inference
MSS401/4	:	Complex Analysis
MSS402/4	:	Real Analysis
MSS415/4	:	Introductory Functional Analysis
MSS416/4	:	Rings and Fields
MSS417/4	:	Coding Theory
MSS418/4	:	Discrete Mathematics
MSS419/4	:	Geometry
MSS482/4	:	Graphing Technology in Mathematics and Science

ELECTIVE COURSES (Track 2)

MSG332/4	:	Introduction to Machine Learning
MSG370/4	:	Mathematics of Finance
MSG384/4	:	Introduction to Geometric Modelling
MSS417/4	:	Coding Theory
MSS419/4	:	Geometry
MSG422/4	:	Fluid Mechanics
MSG427/4	:	Environmental Modelling
MSS482/4	:	Graphing Technology in Mathematics and Science
MSG488/4	:	Mathematical Algorithms for Computer Graphics
MSG489/4	:	Numerical Methods for Differential Equations

ELECTIVE COURSES (Track 3)

MSG352/4	:	Linear and Integer Programming
MSG354/4	:	Network Flows
MSG355/4	:	Inventory Control
MAT363/4	:	Statistical Inference
MSG453/4	:	Queuing System and Simulation
MSG455/4	:	Game Theory
MSG456/4	:	Mathematical Programming

OPTIONAL UNIVERSITY COURSES

In order to fulfil 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 PRE-REQUISITE AND SEMESTER OF OFFERING

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

	Code & Title of Courses			Prerequisite	Semester Offered
1.	MAT100/4	:	Mathematical Foundations	-	1
2.	MAT101/4	:	Calculus	-	2
3.	MAT111/4	:	Linear Algebra	-	2
4.	MAT161/4	:	Elementary Statistics	-	2
5.	MAT181/4	:	Programming for Scientific Applications	-	1
6.	MAT201/4	:	Advanced Calculus	MAT101 (S)	1
7.	MAT202/4	:	Introduction 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 Equation I	MAT101 (S) and MAT111 (S)	1
11.	MAT251/4	:	Introduction to Operations Research	MAT111 (S) and MAT161 (S)	2
12.	MAT263/4	:	Probability Theory	MAT161 (S) and MAT201 (S)	2
13.	MSS311/4	:	Modern Algebra	MAT111 (S)	2
14.	MAT323/4	:	Differential Equation II	MAT223 (S)	1
15.	MSG328/4	:	Introduction to Modelling	MAT223 (S)	2
16.	MSG332/4	:	Introduction to Machine Learning	MAT111 (S), MAT181 (S) and MAT263 (S)	2
17.	MSG352/4	:	Linear and Integer Programming	MAT251 (S)	1
18.	MSG354/4	:	Network Flows	MAT251 (S)	2
19.	MSG355/4	:	Inventory Control	MAT251 (S)	2
20.	MAT363/4	:	Statistical Inference	MAT263 (S)	1
21.	MSG370/4	:	Mathematics of Finance	MAT201 (S)	1
22.	MSS381/2	:	Mathematical Software Laboratory	MAT181 (S)	2
23.	MAT382/4	:	Introductory Numerical Methods	MAT181 (S)	1
24.	MSG384/4	:	Introduction to Geometric Modelling	MAT181 (S) and MAT201 (S)	2
25.	MSL399/4	:	Industrial Training	At least accumulated 90 units	1
26.	MSS401/4	:	Complex Analysis	MAT201 (S)	1
27.	MSS402/4	:	Real Analysis	MAT202 (S)	2
28.	MSS415/4	:	Introductory Functional Analysis	MAT111 (S) and MAT202 (S)	1

29.	MSS416/4	:	Rings and Fields	MAT111 (S) and MSS311 (S)	2
30.	MSS417/4	:	Coding Theory	MAT111 (S) and MSS311 (S)	1
31.	MSS418/4	:	Discrete Mathematics	MAT111 (S) and MAT263 (S)	2
32.	MSS419/4	:	Geometry	MAT111 (S) and MAT203 (S)	1
33.	MSG422/4	:	Fluid Mechanics	MAT203 (S) and MAT323 (S)	2
34.	MSG427/4	:	Environmental Modelling	MSG328 (S)	1
35.	MSG453/4	:	Queuing System and Simulation	MAT181 (S) and MAT263 (S)	1
36.	MSG455/4	:	Game Theory	MAT251 (S)	1
37.	MSG456/4	:	Mathematical Programming	MAT201 (S) and MAT251 (S)	1
38.	MSS482/4	:	Graphing Technology in Mathematics and Science	MAT111 (S), MAT223 (S) and MAT263 (S)	1
39.	MSG488/4	:	Mathematical Algorithms for Computer Graphics	MSG384 (S)	1
40.	MSG489/4	:	Numerical Methods for Differential Equations	MAT382 (S)	1
41.	MSS492/4	:	Project	MAT202 (S) and MSS311 (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.

Concurrent prerequisite (C) means if course A is a concurrent prerequisite (C) to course B, then course A and course B can be taken at the same time (concurrently).

CORE AND ELECTIVE COURSES REGISTRATION GUIDE

Year of Study	Semester 1	Units	Semester 2	Units
1	MAT100	3	MAT101	4
	MAT181	4	MAT111	4
			MAT161	4
2	MAT201	4	MAT202	4
	MSS212	4	MAT263	4
	MAT223	4	MAT203	4
			MAT251	4
3	MAT323	4	MSS311	4
	MAT382	4	MSS381	2
	*†MAT363	4	MSG328	4
	†MSG352	4	^MSG332	4
	^MSG370	4	†MSG354	4
			†MSG355	4
			^MSG384	4
4	*MSS401	4	MSS492	4
	*MSS415	4	*MSS402	4
	*MSS417	4	*MSS418	4
	*^MSS419	4	*MSS416	4
	*^MSS482	4	^MSG422	4
	^MSG427	4		
	†MSG453	4		
	†MSG455	4		
	†MSG456	4		
	^MSG488	4		
	^MSG489	4		

*- Track 1, ^ - Track 2, † - Track 3

SCHOOL'S FACILITIES

The School of Mathematical Sciences has three computer laboratories for class and learning sessions. These laboratories use Microsoft Windows operating system and are equipped with mathematical software. Postgraduate research students are given their cubicles to do research work. The school also provides student learning spaces for the students.

GENERAL INFORMATION

Awards

Besides awards from the University, there are three 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 for the best final year student in the field of Mathematical Sciences.
3. Telesol Sdn. Bhd. Gold Medal Award for the best final year student in the field of Applied Sciences (Mathematics).

Dean's List certificates are awarded every semester to excellent students who have obtained a GPA of at least 3.5 and accumulated at least 14 units.

The Dean Award will be conferred to a student who has excelled in both the academic and co-curriculum activities. Only one award is available for each year of study from each programme. 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 Programme

The School also offers the following graduate programme:

- 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 coursework
- Doctor of Philosophy by research

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

1. **Mr. Ahmad Shukor b. Hj. Md Salleh**
   Head Channel Management
   Celcom Mobile Sdn Bhd
   Northern regional Office, Tingkat 8, Menara KWSP
   Jalan Sultan Ahmad Shah, 10150 Penang

2. **Mr. Tan Soon Keong**
   Senior Director of Technology
   Infineon Technologies Sdn. Bhd.
   Jalan A7, Kulim Hi-tech Park,
   09000 Kulim, Kedah.

3. **Dr. Mohd. Azizi Bin Chik**
   Acting Head
   Supply Management, Planning and Industrial Engineering
   SilTerra Malaysia Sdn. Bhd.
   Lot 8, Industrial Zone Phase 2, Kulim Hi-tech Park,
   09000 Kulim, Kedah

4. **Yusniza Md Yamin**
   Senior Manager
   Commodity Risk Management Group
   Risk Management
   PETRONAS

SYNOPSIS OF COURSES

MAT100/4 Mathematical Foundations

Introduction to Mathematical Statements:
Open sentence and statement; negation of statement, disjunction and conjunction of statements; implication and biconditional; logical equivalence; universally quantified statement; existentially quantified statement.

Revision of Sets Using Formal Definition:
Description of and symbolic representation of sets; subsets; special sets; set operations, indexed collection of sets; partition of set; Cartesian product of sets.

Method of Proving:
Introduce the following method of proving using statements primarily concerning basic properties of even and odd properties of integers; the divisibility of integers; real number; inequality and modulus; sets; and functions.

1) Methods to prove universally quantified statements
   - Direct proving,
   - Contrapositive proving,
   - Prove by cases,
   - Counterexample (negation of cases),
   - Proving by contradiction
   - Principle and general principle of mathematical induction proving
2) Methods to prove existentially quantified statements
   - create example
3) Methods to prove statements which have both the universal and existential quantifiers

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

1. interpret mathematical statement and proof with logical match
2. write logical statement, set and complete proof for each proving method related to numbers, sets and functions.
3. deliver ideas to solve problems related to logic and method of proving.
4. display the effort to search and learn from the textbook in order to start and execute a task on logic and proving method

MAT101/4 Calculus

This course discusses the concepts of calculus with some applications. It introduces the formal definitions of limit, derivative, and definite integral. The theory of limits, continuity, differentiation, and integration of functions of one variable is developed up to the fundamental theorem of calculus. The natural exponential function, which is defined as the inverse of the natural logarithmic function, is studied. Various techniques of integration are discussed as well. Finally, applications of differentiation and integration on curve sketching, optimization problem, and finding of areas and volumes are also presented.

Learning Outcomes
Upon completion of this course, students are able to:
1. describe basic concepts of calculus of one variable correctly
2. explain clearly and accurately the argument in concluding concepts in calculus
3. display the willingness to start and execute a task related to calculus of one variable

MAT111/4 Linear Algebra

This course covers the basic concepts of linear algebra such as matrices, system of linear equations, real vector spaces, inner product and inner product space, linear transformations, as well as diagonalization problems.

Learning Outcomes
Upon completion of this course, students are able to:
1. describe basic concepts of linear algebra in real vector space accurately
2. justify problems related to linear algebra in real vector space correctly
3. perform tasks related to linear algebra in real vector space

MAT161/4 Elementary Statistics

This is an introductory course in descriptive statistics, probability theory, random variables, inferential statistics of one and two populations, and analysis of categorical data which provide the basic statistical concepts and techniques for data analysis. Descriptive statistics provides the techniques for organizing, summarizing and displaying data. Probability theory measures the likelihood of events or phenomenon under conditions of uncertainty. The concept of probability is extended to random variables and probability distributions. Inferential statistics uses sample data to make estimations, decisions and draw conclusions about the population. Parametric and nonparametric procedures are used in making inferences for a single population and in comparing two populations. Statistical methods of analysing categorical 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 the appropriate statistical techniques using descriptive statistics, probability theory, and inferential statistics
2. express idea clearly and effectively in writing using descriptive statistics, probability theory, and inferential statistics.
3. analyse detailed examination of data for interpretation, prediction and decision making using descriptive statistics, probability, and statistical inferences.

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. apply appropriate programming techniques/structures and strategies in transforming the description of a problem into executable computer codes
2. construct accurate and efficient programs using simple and advanced programming structures (modular programming, files manipulation, pointers) which add values to the computer programs
3. complete a programming project assignment in a team in a responsible and organized manner
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. Convergence of sequences and series, as well as improper integrals are discussed. Representations of functions as power series are studied. The second half of the course focuses on the theory of limits, continuity, differentiation and integration of functions of several variables, up to double integration.

Learning Outcomes
Upon completion of this course, students are able to:
1. explain the fundamental concepts and theories related to functions of one and several variables
2. describe clearly the concepts for functions of several variables and their occurrences in the real-world
3. display effort to investigate or search information in completing a task related to functions of one and several variables

MAT202/4 Introduction to Analysis

This course introduces basic concepts of analysis: real numbers, sequences and series, functions and continuity, and topology on set R of real numbers. 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. The course also reviews some important notations in topology such as type of points in R, closed and open sets, compact sets and connected sets. Continuity, 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. describe basic concepts of introductory real analysis correctly
2. explain clearly and accurately the concepts of real analysis in writing

3. practice responsibility in completing a written assignment ethically for introductory real analysis

MAT203/4 Vector Calculus

This course consists of a brief review of vector 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 (vector fields) with applications such as curl and divergence will also be introduced. The concept of integration in a single variable calculus is extended to two and three variables with applications in computing the areas in a region, the volume of a solid bounded by surfaces. Green's theorem is introduced together with the line integral. The last topic covered will be on surface integrals, Stoke's and Divergence Theorems.

Learning Outcomes

Upon completion of this course, students are able to:

1. identify the characteristic and equations for conics, quadric surfaces as well as curves and surfaces in parametric representation
2. formulate and solve geometric (distance, area, volume) and physics problems by applying rules, concepts and theorems in vector analysis
3. justify the use of mathematical software or web-based technological tools in visualizing conics, quadric surfaces, parametrized curves and surfaces
4. perform calculations involving vectors, vector valued function and integrals of scalar or vector functions over parametrized curves and surfaces

MSS212/4 Further Linear Algebra

This course covers the classical theory of determinant that involves permutations, complex vector space concept, 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. justify problems related to complex vector space and power matrices problem in further linear algebra
2. present assignments clearly in further linear algebra
3. practice responsibility ethically in completing assignments in further linear algebra
4. perform assignments in an organised manner to solve problems in further linear algebra

MAT223/4 Differential Equation 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, power series solutions as well as Laplace transform. 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. correlate fundamental theory and concept of differential equation precisely to solve real world problem
2. perform appropriate responsibility in various learning activities as a team particularly in solving differential equation problems
3. solve differential equation problems using suitable differential equation methods and techniques on appropriate environmental issues

MAT251/4 Introduction to Operations Research

The course introduces the field of operations research. It starts with the art of mathematical modelling of a simplified practical real world problem. Various classes of problem will be modelled and formulated, including transportation, assignment and project scheduling. Students will learn how best to formulate a problem and solve using several variations of the Simplex Method. Students will also learn to perform sensitivity analysis and interpret the results in terms of the real world. 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. interpret the understanding of fundamental knowledge in Linear Programming
2. formulate a problem into a Linear Programming problem
3. solve and perform sensitivity analysis for Linear Programming problems

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. apply knowledge of probability theory in proving basic theorems in probability in finding the probability of certain event

2. identify daily problem using knowledge of probability theory and appropriate techniques to develop a solution
3. demonstrates ideas and knowledge in probability theory clearly and effectively in writing
4. analyse problems related to probability theory

MSS311/4 Modern Algebra

This course introduces basic abstract algebra concepts, in particular, group theory. Concepts such as equivalence relation, binary operation and congruence modulo will be discussed. In group theory, students will learn about properties of groups, normal subgroups, factor groups, homomorphism, finitely-generated abelian groups and permutation groups. Basic ring theory will also be introduced.

Learning Outcomes
Upon completion of this course, students are able to:
1. justify problems related to groups and rings in modern algebra
2. practice responsibility ethically in completing written assignments in modern algebra
3. perform an assignment in an organised manner to summarise groups of small order
4. participate effectively to complete assignments in modern algebra

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. display the solution of a differential equation using computational tools
2. share ideas about solutions of ordinary and partial differential equations effectively in group assignments
3. participate effectively in describing basic theoretical principles, general procedures and mathematical techniques in analysing ordinary and partial differential equations
4. analyse solutions of ordinary and partial differential equations

MSG328/4 Introduction to Modelling

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

Learning Outcomes
Upon completion of this course, students are able to:
1. solve mathematical modelling problems correctly using various techniques such as differential equation and optimization methods
2. establish knowledge and understanding in constructing mathematical model from an oral description or data based on physical laws through group activities
3. engage effectively in solving mathematical modelling problems through various group activities
4. Construct suitable mathematical modelling on the application of any appropriate environmental issues

MSG332/4 Introduction to Machine Learning

This course introduces fundamental knowledge and techniques of supervised and unsupervised machine learning. Topics such as linear and logistic regression, Naive Bayes, Support Vector Machines (SVM), decision tree, clustering and neural network will be covered in this course. Students are expected to obtain hands-on experience during practical to address real world problems using a suitable programming language.

Learning Outcomes
Upon completion of this course, students are able to:
1. construct programs to solve machine learning problems
2. explain the fundamental concepts and applications in machine learning including model evaluation
3. practice teamwork in completing a machine learning project
4. apply machine learning algorithms to solve real world problem

MSG352/4 Linear and Integer Programming

This course exposes students to topics in Linear (LP) and Integer Programming (IP). Topics in LP are the Revised Simplex Method, Duality Theory, Sensitivity Analysis and the Dual Simplex Method. In IP, topics include formulating IP problems, and solving IP problems using the Branch-and-Bound Method, Implicit Enumeration and the Cutting Planes Method. This course also touches on modelling and solving multi-objective problems as Goal Programming problems.

Learning Outcomes
Upon completion of this course, students are able to:
1. interpret understanding of fundamental knowledge in Linear Programming, Duality Theory, Integer Programming, and Goal Programming
2. formulate a problem into a Linear Programming, Integer Programming or Goal Programming model
3. present ideas related to Linear Programming, Integer Programming or Integer Programming effectively

4. demonstrate professionalism and a responsible attitude when conducting individual or group work related to Linear Programming, Integer Programming or Goal Programming
5. solve problems related to Duality Theory, Linear Programming, Integer Programming or Goal Programming using the appropriate solution method

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. interpret understanding of underlying theorems for Network Flows problem
2. formulate a problem into a Network Flows problem
3. present ideas related to Network Flows problem effectively
4. practice leadership effectively in completing assignments related to Network Flows
5. solve Network Flows problem using the appropriate algorithms

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, an industrial talk or an industrial case study that focuses on the real-world applications of inventory control.

Learning Outcomes

Upon completion of this course, students are able to:

1. demonstrate the understanding of fundamental knowledge in Inventory Control
2. formulate a problem into an Inventory Control model
3. practice professionalism and a responsible attitude when conducting work related to Inventory Control
4. demonstrate entrepreneurial characteristics in solving problem related to Inventory Control
5. solve Inventory Control problems using the appropriate solution method

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. understand problems on probability theory, joint distributions of random variables and random vectors
2. solve problems on point estimation and confidence intervals for population mean, population standard deviation and population proportion
3. present ideas effectively to formulate equations and problems in mathematical statistics
4. solve hypotheses testing problems to verify a certain claim

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 effective interest and discount rates, simple and compound interest, force of interest, present and future values, and nominal interest and discount rates. These terms are applied into annuity-due and annuity-immediate, perpetuity, discrete and continuous annuities. For loan schemes, loan balance is computed through amortization schedule and sinking fund. Finally, students are exposed to other financial instruments such as security, bond, callable bond, mortgage and option.

Learning Outcomes
Upon completion of this course, students are able to:
1. explain theory of interest towards basic financial modelling based on simple and compound theory – annuities, loan/financing, bonds and securities
2. demonstrate the idea about Present Value (PV), Future Value and Current Value (CV) towards real financial problems
3. present the interest theory ideas mathematically in designing financial models
4. evaluate basic financial modelling problems based on simple and compound theory

MSS381/2 Mathematical Software Laboratory

The course provides fundamental knowledge in mathematical software 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 appropriate Matlab/Mathematica software to analyse mathematical computation problems
2. relate the computational mathematical results to social environment
3. organize the use of technological methods and tools in mathematical computation in an organized manner

4. solve mathematical problems related to mathematical computation

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. construct the computational concept to effectively solve calculus, algebra or interpolation problems using numerical methods
2. relate numerical methods discussed in class to other method in solving problems in managing real-life problems
3. involve effectively towards explaining the use of numerical methods in solving problems in calculus, algebra and interpolation
4. analyse various numerical methods to effectively solve calculus, algebra and interpolation problems

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. apply the knowledge of geometric modelling in curves and surfaces design
2. analyse the geometric properties of curves and surfaces with mathematical representations
3. participate in groups for preparing mathematical solutions from the aspect of geometric modelling
4. produce geometric model with the aids of computer or electronic devices

MSL399/4 Industrial Training

This course gives exposure to the students in exploring the real working environment. Students will be able to enhance their skills and knowledge, which consequently would boost their performance in their future career. The students are required to undergo 10 weeks training at industries, organizations, government agencies or statutory bodies. Evaluation for this training is based on the evaluation of the supervisors at USM and the result (Pass/Fail) will be written in their academic transcript.

Learning Outcomes
Upon completion of this course, students are able to:
1. integrate knowledge and skills into working environment
2. display ability to report an idea clearly and effectively in completing tasks
3. display ability to schedule by creating a plan and timetable in completing a task

MSS401/4 Complex Analysis

This first course in complex analysis deals primarily with the theory of differentiation and integration of complex-valued functions. It is intended to familiarize the students with the fundamental theory and methods of complex analysis and its applications. Familiarity with the calculus of real functions is assumed, and while not critical, it would be expedient for students to also have had some exposure to introductory real analysis. Similarities as well as several interesting differences between the calculus of complex-valued functions with real functions will be made evident in this course. The course begins with the introduction of complex numbers and open sets, before moving on to the areas of differentiation and integration of functions, and closing with a discussion on mapping properties of several basic functions. Thus it would be useful not only for students in mathematics, but also to those interested in the applications of complex analysis.

Learning Outcomes
Upon completion of this course, students are able to:
1. justify problems related to complex analysis in the complex plane correctly
2. perform tasks related to complex plane
3. participate effectively in completing assignments in complex analysis

MSS402/4 Real Analysis

This course introduces the basic concepts in measure theory and Lebesgue integral on the real line. Important concepts such as outer measures, measurable sets and measurable functions are to be studied. The construction of Lebesgue integral will be investigated from different point of views. The difference between the Riemann integral and the Lebesgue integral are emphasized. This is pursued with the discussion of several modes of convergence. Metric, normed and inner product spaces will also be discussed, in particular the theory of the L^p spaces.

Learning Outcomes
Upon completion of this course, students are able to:
1. justify problems related to measure theory and Lebesgue integral in real analysis
2. perform an assignment in measure theory clearly and efficiently in both oral and writing
3. display effort to investigate or search information in completing a task related to real analysis

MSS415/4 Introductory Functional Analysis

This course studies basic concepts in functional analysis and general topology. Important properties of metric spaces, normed spaces and inner product spaces, along with linear operators on these spaces, particularly the bounded linear operator and the continuous linear operator, will be investigated. Topological properties of basis, closed set, product topology and compactness will be explored.

Learning Outcomes
Upon completion of this course, students are able to:
1. describe basic concepts of functional analysis
2. show detailed written arguments in real analysis to establish facts in function spaces and linear operators
3. display effort to investigate or search information in completing a task related to functional analysis

MSS416/4 Rings and Fields

This course studies ring theory which encompasses zero divisor, integral domains, ideals, homomorphism and isomorphism, quotient rings, the field of quotients of an integral domain, polynomial rings and field theory that covered up to splitting field of a polynomial. The focus will be on the investigation of the close relations among polynomial rings, factorization of polynomials over fields, zeros of a polynomial and the field extensions.

Learning Outcomes
Upon completion of this course, students are able to:
1. write the concepts and arguments related to rings and fields correctly and clearly
2. practice responsibility ethically in completing assignments in rings and fields
3. display the effort to search and learn from text books to start and complete a task on rings and fields theories
4. integrate related mathematical skills in solving numerical problems in rings and fields

MSS417/4 Coding Theory

This course involves the discussion of the application of theory of algebra in the theory of coding. Focus will be on the connection between the theory of codes and algebraic structures such as vector spaces, polynomial rings and finite fields. Thus 80% of the course learning is emphasized on the family of linear codes and cyclic codes. Constructions of codes including the design of its encoding and decoding algorithm are also emphasized. In addition, verification of optimized code also will be discussed by introducing a few important bounds such as Hamming bound, Singleton bound and Plotkin bound.

Learning Outcomes
Upon completion of this course, students are able to:
1. integrate the mathematical concepts related to the study of code on the matter of error detecting or correcting by using the theory of vector spaces, ring theory or field theory
2. display effort to search and learn from textbooks to start and complete a task on coding theory
3. participate effectively in a prerequisite topic via group discussion
4. integrate related mathematical skills in solving numerical problems in coding theory

MSS418/4 Discrete Mathematics

This course introduces topics in two main areas of discrete mathematics: combinatorics and graph theory. Under combinatorics counting techniques, permutations and combinations, recurrence relations and generating functions are covered. Under graph theory, Eulerian and Hamiltonian graphs, connectivity, planarity, colouring and digraph are covered. Besides these an introductory notion of finite geometry are also dealt with.

Learning Outcomes
Upon completion of this course, students are able to:
1. demonstrate good comprehension of discrete mathematical theory by applying the skills and knowledge to solve various problems
2. formulate a solution for word problems through graph representation or combinatorial reasoning (whichever relevant) by using appropriate theories
3. present results of an assignment orally with fluency and correct understanding of the discrete mathematical theory discussed
4. displays result of an assignment on a given or chosen discrete mathematical topic individually or by group

MSS419/4 Geometry

This course introduces students to several types of modern geometry starting with Euclidean geometry based on Euclid's Axioms and proving theorems in Euclidean geometry related to polygons and circles. Then the geometry will be approached through algebra by coordinate and vector. The concept of basic transformation will be presented and several theorems in Euclidean geometry will be proved by using transformation. Also the concept and the application of perspective and projective geometry, in particular in computer graphics, will be discussed. The last topics will be on Non-Euclidean geometry. The differences between Euclidean and non-Euclidean geometries will be discussed.

Learning Outcomes
Upon completion of this course, students are able to:
1. show detailed written arguments in geometries to establish facts about Euclidean geometry, projective geometry and Non-Euclidean geometry
2. describe the concepts for geometries and their occurrences in the real world
3. display effort to investigate or search information in completing a task related to geometries

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. practice responsibility and team work in solving fluid mechanics problems
2. display the effort to obtain information in completing task in fluid mechanics
3. formulate the governing equations using appropriate methods to solve fluid mechanics problems

MSG427/4 Environmental Modelling

In this course, techniques introduced in prerequisites courses are used to analyse models of environmental problems, with a particular emphasis on water environment. These models are developed from first principles and the ramifications are analysed using mathematical and numerical analysis.

Learning Outcomes
Upon completion of this course, students are able to:
1. display understanding of an environmental issue through an awareness video recording
2. assess environmental problems by using numerical software
3. assess environmental problems by using analytical and numerical methods

MSG453/4 Queuing 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. Students will also be exposed with industrial perspective and real-world problems. This course will include either an industrial visit, an industrial talk or an industrial case study that focuses on the real-world applications of queuing system.

Learning Outcomes
Upon completion of this course, students are able to:
1. interpret the understanding of fundamental knowledge in Queuing Models
2. formulate a real-world problem into a Queuing System or Simulation Model
3. display interpersonal skills in performing tasks related to Queuing System
4. demonstrate entrepreneurial characteristics in solving problems related to Queuing System
5. solve problems related to Queuing Models and Simulation using appropriate method.

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 perfect, 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. demonstrate the understanding of fundamental knowledge in Game Theory
2. formulate a real-world problem into a Game Theory Model
3. display Interpersonal skills in performing task related to Game Theory
4. demonstrate professionalism and a responsible attitude when conducting work related to Game Theory
5. solve problems related to n-person game models with complete and incomplete information using the appropriate solution method

MSG456/4 Mathematical Programming

This course introduces students to some techniques and algorithms used in solving unconstrained and constrained Nonlinear Programming problems (NLPs), along with Dynamic Programming problems (DPs). Students will be exposed to some case studies involving NLPs and DPs.

Learning Outcomes
Upon completion of this course, students are able to:
1. interpret understanding of fundamental knowledge in Nonlinear Programming (NLP) and Dynamic Programming (DP)
2. formulate a problem into a NLP or DP problem
3. present ideas related to NLP or DP effectively
4. demonstrate entrepreneurial characteristics in solving problems related to NLP and DP
5. solve NLP and DP problems using the appropriate solution method

MSS482/4 Graphing Technology in Mathematics and Science

This course introduce graphing technology and graphics to the third and fourth year mathematics students that can be used to solving mathematics problems and data analysis. The capability of the technologies used in enhancing their understanding and learning of concepts and theories of mathematics/statistics through scientific visualization and laboratory are also highlighted. Topics covered includes calculus, linear algebra, differential equation and statistics.

Learning Outcomes
Upon completion of this course, students are able to:
1. solve the given mathematical problems properly and clearly, and able to show robust understanding of the topic being tested
2. perform data analysis after identifying the proper statistical technique by producing a written report, and efficient and correct solutions
3. justify the reason in choosing the solving method for the given problems and successfully proposed the appropriate technology to apply
4. display the ability and effort in relevant self-learning towards the exploration of the technology introduced

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 the fundamental concept of mathematical algorithms in computer graphics
2. report well both orally and in writing on geometric design activities
3. acquire new knowledge and information specifically in geometric design with self-learning
4. generate accurate curves and surfaces with the aids of computer or electronic devices

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. analysing differential equation to be solved using numerical methods involving initial value problem and boundary value problem

2. relating numerical methods discussed in the class with other methods in solving various differential equation
3. participate effectively in solving differential equation using numerical methods
4. generating solution for differential equation using numerical methods

MSS492/4 Project

This course requires students to do research and/or study on a topic under the supervision of a lecturer. At the end of the course students are required to submit a report to be evaluated and also to give a presentation.

Learning Outcomes

Upon completion of this course, students are able to:

1. reproduce the ideas and concepts learned from reading the materials related to the research topic
2. present clearly and efficiently the presentation on the progress and results of the research
3. join in on a meaningful discussion of a mathematical topic
4. practise responsibility in completing written assignments ethically
5. display effort to investigate or search information in completing a task related to the project
6. organize well research activities according to a stipulated timeline

Note: Each student is required to find a supervisor individually and decide on the project topic prior to registering for the course. The student must fill-up the "Project Minor Form" and submit it to the general office after obtaining the supervisor's signature.

Index to Undergraduate Courses