Transforming Higher Education
for a Sustainable Tomorrow

BACHELOR OF SCIENCE

2019/2020

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2019/2020

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Bachelor of Science

Academic Session 2019/2020

USM Vision

Transforming Higher Education for a Sustainable Tomorrow

USM Mission

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

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ACADEMIC CALENDAR - ACADEMIC SESSION 2019/2020

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

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

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

*Courses During Long Vacation (KSCP)
** This Academic Calendar is subject to change

1.1 General Information

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

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

1.2 Areas of Specialization

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

1.3 Programme Structure

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

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

1.4 Courses Offering

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

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

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

Core Courses

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

Minor Courses

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

Elective Courses

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

Optional Courses

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

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

Audit Courses

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

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

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

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

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

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

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

1.5 Course Codes

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

X - represent each school of sciences as follows:

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

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

1.6 Classification of year equivalent

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

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

1.7 Graduation Requirements

Students must fulfil the following requirements to graduate:

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

2.0 ACADEMIC SYSTEM AND GENERAL INFORMATION

2.1 Course Registration

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

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

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

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

2.1.2 Course Registration Platform

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

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

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

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

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

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

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

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

Access to *E-Daftar* System

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

2. Course Registration at Schools/Centres

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

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

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

2.1.3 General Guidelines before Students Register for Courses

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

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

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

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

   d. Print Cumulative Statement of Grades (Cangred).

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

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

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

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

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

3. Type of course codes during registration:

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

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

   Two (2) other course codes are:

Y = audit courses
Z = prerequisite courses
} Grade and number of units obtained are not considered for graduation

4. Advice and approval of the Academic Advisor

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

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

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

2.1.5 Registration of Language and Co-Curricular Courses

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

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

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

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

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

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

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

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

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

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

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

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

2.1.6 Registration of 'Audit' Courses (Y code)

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

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

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

2.1.7 Registration of Prerequisite Courses (Z code)

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

2.1.8 Late Course Registration and Late Course Addition

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

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

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

2.1.9 Dropping of Courses

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

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

1. All Drop Forms must be completed by the student and signed by the lecturer of the course involved and the Dean/Deputy Dean of their respective Schools and submitted to the general office of the School/Centre which is responsible for offering the courses involved.
2. Students who wish to drop a language course must obtain the signature and stamp of the Dean/Deputy Dean (Academic) of the School of Languages, Literacies and Translation.
3. Students who wish to drop the Co-Curricular courses must obtain the approval of the Director/Co-ordinator of Co-Curricular Programme.

4. The option for dropping courses cannot be misused. Lecturers have the right not to approve the course that the student wishes to drop if the student is not serious, such as poor attendance record at lectures, tutorials and practical, as well as poor performance in coursework. The student will be barred from sitting for the examination and will be given grade 'X' and is not allowed to repeat the course during KSCP.

2.1.10 Course Registration Confirmation Slip

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

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

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

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

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

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

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

2.1.12 Academic Advisor

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

2.2 Interpretation of Unit/Credit/Course

2.2.1 Unit

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

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

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

One unit is equivalent to 40 hours of student learning time

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

2.2.2 Accumulated Credit Unit

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

2.3 Examination System

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

2.3.1 Duration of Examination

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

2.3.2 Barring from Examination

Students will be barred from sitting for the final examination if they do not fulfil at least 70% of the course requirements, such as absence from lectures and tutorials, and have not completed/fulfilled the required components of coursework. A grade 'X' would be awarded for a course for which a student is barred. Students will not be allowed to repeat the course during the *Courses During the Long Vacation* (KSCP) period.

2.3.3 Grade Point Average System

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

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

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

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

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

The formula to compute GPA and CGPA is as follows:

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

where:

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

Example of calculation for GPA and CGPA:

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

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

	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

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

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

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

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

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

The purpose of KSCP is to:

1. Give an opportunity to students who are facing time constraints for graduation.
2. Assist students who need to accumulate a few more credits for graduation.
3. Assist probationary students to enhance their academic status.
4. Assist students who need to repeat a prerequisite course, which is not offered in the following semester.

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

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

<u>The Implementation of KSCP</u>

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

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

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

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

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

2.3.5 Academic Status

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

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

2.3.6 Termination of Candidature

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

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

2.3.7 Examination Results

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

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

2.4 Unit Exemption

2.4.1 Unit Exemption

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

2.4.2 Regulations and Implementation of Unit Exemption

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

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

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

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

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

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

    f. **In order to obtain unit exemption for industrial training**, a student must have continuous work experience

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

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

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

2. **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:

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

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

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

2.4.3 Total Number of Exempted Semesters

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

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

2.4.4 Application Procedure for Unit Exemption

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

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

2.5 Credit Transfer

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

1. <u>Category of Students Who Can Be Considered for Credit Transfer</u>

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

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

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

2. Specific Conditions

a. Basic and Core Courses

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

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

b. Elective or Option Courses

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

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

c. Minor Courses

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

3. General Conditions

a. There is no limit for PRP cases.

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

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

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

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

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

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

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

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

2.5.1 Application Procedure for Attending Courses/Credit Transfer

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

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

2.6 Academic Integrity

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

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

Universiti Sains Malaysia encourages its students to respect and ensure that any matter relating to academic integrity will be well-preserved. Universiti Sains

Malaysia always encourages its students to ensure that manners, ethics and integrity would be essential in academics while focusing on their studies in Universiti Sains Malaysia.

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

1. Cheating

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

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

2. Plagiarism

   The reputation of an academic institution depends on the ability to achieve and sustain academic excellence through the exercise of academic integrity. Academic integrity is based on honesty, trust, fairness, respect, and responsibility, which form the basis of academic work.

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

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

POLICY ON PLAGIARISM OF UNIVERSITI SAINS MALAYSIA

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

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

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

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

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

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

3. Fabrication

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

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

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

4. Collusion

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

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

5. Other violations relating to academic integrity

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

2.6.1 Consequences of Violating Academic Integrity

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

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

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

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

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

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

    a. a warning ;
    b. a fine not exceeding two hundred ringgit;
    c. exclusion from any specific part or parts of the University for a specified period;
    d. suspension from being a student of the University for a specified period; and
    e. expulsion from the University.

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

2.7 USM Mentor Programme

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

Objectives

1. To serve as a co-operation and mutual assistance mechanism for dealing with stress, psychosocial problems and many more in order to ensure the well-being of the USM community.

2. To inculcate the spirit of unity and the concept of helping one another by appointing a well-trained mentor as a social agent who promotes a caring society for USM.

3. To produce more volunteers to assist those who need help.

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 year degree programme) and within the third to seventh semester (4 year degree programme).

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

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

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

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

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

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

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

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

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

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

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

3.0 UNIVERSITY COURSE REQUIREMENTS

3.1 Summary of University Course Requirements

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

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

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

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

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

3.2 General Studies Components (MPU)

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

General studies are divided into four groups as follows:

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

A. U1 Group

Local Students

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

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

The course synopsis is as follows:

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

(ii) LKM400/2 (Bahasa Malaysia IV)

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

Entry requirements for Bahasa Malaysia are as follows:

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

Note:

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

International Students

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

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

B. U2 Group

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

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

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

C. U3 Group

Local students

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

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

International students

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

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

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

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

Code	Type	Credit
LKM100	U	2

D. Group U4

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

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

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

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

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

SISPA (Siswa Siswi Pertahanan Awam Malaysia)	Kelanasiswa (Rovers)	St John Ambulance	Red Crescent Emergency Aid Team
WPA103/2	WLK102/2	WJA102/2	WBM102/2

WPA203/2	WLK202/2	WJA202/2	WBM202/2
WPA303/2	WLK302/2	WJA302/2	WBM302/2

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

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

The courses offered are as follows:

Packaged Courses (3 Credits, 3 Semesters) (Students are required to complete all levels)	
Karate	**Taekwondo**
WSC108/1	WSC115/1
WSC208/1	WSC215/1
WSC308/1	WSC315/1
Non Packaged Courses (1 Credit)	
WSC105/1 –Volley Ball	WSC 125/1- Futsal
WSC106/1 - Golf	WSC 126/1 - Netball
WSC110/1 - Archery	WSC127/1 - Event Management 1
WSC111/1 - Table Tennis	WSC227/1 - Event Management 2
WSC112/1 - Swimming	WSC128/1 - Petanque
WSC113/1 - Aerobics	WSC130/1 - Orienteering
WSC114/1 - Squash	WSC131/1 - Woodball
WSC116/1 - Tennis	WSC124/1 - Sepak Takraw
WSC119/1 - Badminton	

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

(iii) Core of Culture (1 – 6 credits)

The courses offered are as follows:

Packaged Courses (6 Credits, 3 Academic Sessions) (Students are required to complete all levels)	
Jazz Band	**Seni Silat Cekak Malaysia**
WCC108/2	WCC123/2

WCC208/2	WCC223/2
WCC308/2	WCC323/2
Non Packaged Courses (1 Credit)	
WCC105/1 - Gamelan	WCC117/1 - Modern Theatre
WCC107/1 - Guitar	WCC118/1 - Malay Shadow Play
WCC109/1 - Choir	WCC119/1 - Qigong Exercises
WCC115/1 - Modern Dance	WCC124/1 - Musical Kompang
WCC116/1 - Traditional Dance	WCC129/1 - Latin Dance

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

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

The courses offered are as follows:

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

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

(v) Core of Community Service (4 credits)

The courses offered are as follows:

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

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

(vi) Core of Public Speaking (2 credits)

The courses offered are as follows:

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

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

(vii) Core of Sustainability (2 credits)

The courses offered are as follows:

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

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

3.3 Language Skills

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

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

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

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

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

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

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

Note:

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

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

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

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

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

(c) English Language Course

English courses offered as university courses are as follows:

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

5	LSP403/2	Business and Communication English	School of Management School of Communication
6	LSP404/2	Technical and Engineering English	School of Computer Sciences School of Housing, Building and Planning School of Engineering

3.4 Options (1 – 8 credits)

A. Co-curricular course

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

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

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

Students can choose the following courses as an option:

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

The following is the synopsis of the course:

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

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

(ii) HTV201/2 - Thinking Techniques

The following is the synopsis of the course:

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

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

(iv) English language course

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

No	Code/Unit	Course Title
1.	LHP451/2	Effective Reading
2.	LHP452/2	Business Writing
3.	LHP453/2	Creative Writing
4.	LHP454/2	Academic Writing
5.	LHP455/2	English Pronunciation Skills
6.	LHP456/2	Spoken English
7.	LHP457/4	Public Speaking and Speech Writing
8.	LHP458/2	English for Translation *(Offered during Semester II only)*
9.	LHP459/2	English for Interpretation *(Offered during Semester I only)*

(v) Foreign Language Courses

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

course. However, students are not required to complete all four levels of one particular foreign language course. The foreign language courses offered are as follows:

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

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

SCHOOL OF PHYSICS

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

Introduction

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

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

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

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

Vision

Towards global excellence in transdisciplinary research and education in Physics

Mission

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

STAFF AND ADMINISTRATION

DEAN

Prof. Dr. Azlan Abdul Aziz

DEPUTY DEANS

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

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

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[Pure Physics]

Dr. Mohd Mahadi Halim
[Applied Physics]

Dr. Nusakinah Suardi
[Medical Physics]

Dr. Nordiana Mohd Muztaza
[Geophysics]

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

Mr. Madhavan Raman Kutty
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Industry and Community Advisory Panel (ICAP)

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

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

Industry and Community Advisory Panel	Position/Organization	Contact
Pure Physics Mr. Mohamad Nasir Osman	Director Manufacturing Oryx Advanced Materials Sdn. Bhd.	Plot 69 (d) & (e), Lintang Bayan Lepas 6, Bayan Lepas Industrial Zone Phase 4, 11900 Bayan Lepas, Pulau Pinang Email: nasir.osman@oryxadv.com Tel: 012-4201156
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Geophysics Mr. Khairool Anwar Laksamana	Senior Geophysicist INTEGRATED GGRE ASIA	8.01 Level 8, Menara Binjai, No.2 Jalan Binjai, Kuala Lumpur 50450 Kuala Lumpur Email: khairoolanwar@ggreasia.com Tel. H/P: 019-8798897
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Applied Physics Mr. Philip Beow Yew Tan	Manager Silterra Malaysia Sdn. Bhd.	Lot 8, Industrial Zone Phase II Kulim Hi-Tech Park 09000 Kulim, Kedah Darul Aman. Email: philiptanbeowyew@gmail.com Tel. H/P: 012-4377288

PROGRAMME STRUCTURE FOR THE DEGREE OF BACHELOR OF 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 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 OBJECTIVES

The objectives of the programme are :

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

PROGRAMME LEARNING OUTCOMES

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

1. gain knowledge in fundamental and broad physics principles,
2. carry out experiments, analyze and construe data,
3. value culture and cultural diversity,
4. perform their tasks professionally with values and ethics,
5. contribute and lead efficiently as a team member to achieve maximum yield,
6. make vital decisions using logical reasoning and critical thinking,
7. learn independently through the ability to locate, assess and exploit resources,
8. build up and administer knowledge to realize specific business, and
9. work as a team.

Core Courses

ZCA	101/4	Physics I (Mechanics)
ZCA	102/4	Physics II (Electricity and Magnetism)
ZCT	103/3	Physics III (Vibrations, Waves and Optics)
ZCT	104/3	Physics IV (Modern Physics)
ZCT	106/3	Electronics I
*ZCA	110/4	Calculus
ZCT	112/3	Linear Algebra and Vector Analysis
ZCT	191/2	Physics Practical I
ZCT	192/2	Physics Practical II
ZCT	205/3	Quantum Mechanics
ZCT	206/3	Electronics II
ZCT	210/4	Complex Analysis and Differential Equations
ZCT	214/3	Thermodynamics
ZCT	215/3	Optics
ZCT	219/4	Mathematical Methods
ZCT	293/2	Physics Practical III
ZCT	294/2	Physics Practical IV
ZCT	304/3	Electricity and Magnetism
ZCT	307/3	Solid State Physics I
ZCT	314/3	Statistical Mechanics
ZCT	317/3	Solid State Physics II
ZCT	390/8	Pure Physics Project

Total: 72 units (22 courses)

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

Elective Courses

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

ZCE 111/4	Computational Approach in Physics Learning
ZCE 208/3	Classical Mechanics
ZCE 275/4	Introduction to Astronomy
ZGE 277/4	Structure of the Universe
ZAE 282/3	Materials Science
ZCE 305/3	Atomic and Nuclear Physics
ZKE 327/3	Solid State Lighting I
ZCE 341/4	Energy Studies
ZAE 376/4	Astronomy Principles and Practices

ZKE 378/4	Introduction to Radio Astronomy
ZAT 386/4	Physics of Semiconductor Devices
ZKE 427/3	Solid State Lighting II
ZCE 431/4	Radiation Biophysics
ZCE 451/3	X-Ray Analysis
ZAE 484/4	Laser and Its Applications
ZAE 488/4	Non-Destructive Testing
ZCE 499/9	Industrial Training

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

Year	Sem	Courses	Units
1	I	ZCA 101/4 ZCT 103/3 ZCA 110/4 ZCT 191/2 U/4	17
	II	ZCA 102/4 ZCT 104/3 ZCT 106/3 ZCT 112/3 ZCT 192/2 U/2	17
2	I	ZCT 206/3 ZCT 210/4 ZCT 214/3 ZCT 215/3 ZCT 293/2 U/2	17
	II	ZCT 205/3 ZCT 219/4 .../4* ZCT 294/2 U/2	15
3	I	ZCT 307/3 ZCT 314/3 *ZCT 390/8*** U/4	14
	II	ZCT 304/3 ZCT 317/3 .../4* *ZCT 390/8*** U/2	16
4	I	.../4* .../3* .../3* .../3* U/2	15
	II	ZCE 499/9	9
		Total	120

Note: * Elective Courses (according to choice)
** Course conducted over two semesters
# Optional, otherwise, to be replaced with other elective cources (same programme).

MINOR AREA OF SPECIALISATION

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

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

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

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

PRIZES AND DEAN'S LIST

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

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

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

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

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

STAFF AND STUDENT COMMITTEE

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

INDUSTRIAL TRAINING PROGRAMME

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

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

MENTOR SYSTEM

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

SCHEME FOR STUDYING ABROAD

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

FACILITIES

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

LIST OF COURSES OFFERED FOR THE DEGREE OF BACHELOR OF SCIENCE WITH HONOURS PROGRAMME - PHYSICS

Semester I

Level	Course Code	Title	Prerequisite
100	ZCA 101/4	Physics I (Mechanics)	-
	ZCT 103/3	Physics III (Vibrations, Waves and Optics)	-
	ZCA 110/4	Calculus	-
	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) MAA101/4
	ZCT 214/3	Thermodynamics	(S) ZCA 102/4
	ZCT 215/3	Optics	(P) ZCT 103/3
	ZCE 275/4	Introduction to 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
	ZKE 327/3	Solid State Lighting I	(C) ZCT 307/3
	ZAE 376/4	Astronomy Principles and Practices	
	ZCT 390/8	Pure Physics Project (two semesters)	(S) ZCT 294/2
400	ZCE 431/4	Radiation Biophysics	(S) ZCT 104/3
	ZCE 451/3	X-Ray Analysis	(C) ZCT 307/3

Semester II

Level	Course Code	Title	Prerequisite
100	ZCA 102/4	Physics II (Electricity and Magnetism)	(S) ZCA 101/4
	ZCT 104/3	Physics IV (Modern Physics)	-
	ZCT 106/3	Electronics I	(C) ZCA 102/4
	ZCE 111/4	Computational Approach in Physics Learning	-
	ZCT 112/3	Linear Algebra and Vector Analysis	(S) ZCA110/4 or (S) MAA 101/4
	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
	ZGE 277/4	Structure of the Universe	-
	ZCT 294/2	Physics Practical IV	(S) ZCT 191/2 or (S) ZCT 192/2
300	ZCT 304/3	Electricity and Magnetism	(P) ZCA 102/4 and (S) ZCT 112/3 and (S) ZCT 210/4
	ZCT 317/3	Solid State Physics II	(S) ZCT 307/3
	ZCE 341/4	Energy Studies	(S) ZCA 101/4 and (S) ZCA 102/4
	ZKE 378/4	Introduction to Radio Astronomy	
	ZAT 386/4	Semiconductor Physics Devices	(S) ZCT 106/3 and (S) ZCT 307/3
	ZCT 390/8	Pure Physics Project (two semesters)	(S) ZCT 294/2
400	ZKE 427/3	Solid State Lighting II	(S) ZKE 327/3
	ZAE 484/4	Laser and Its Applications	(S) ZCT 104/3
	ZAE 488/4	Non-Destructive Testing	(S) ZCT 104/3
	ZCE 499/9	Industrial Training	(S) ZCT 390/8

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

SYNOPSES OF CORE COURSES

ZCA 101/4 Physics I (Mechanics)

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

Learning Outcomes

Upon completion of this cource, students are able to:

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

ZCA 102/4 Physics II (Electricity and Magnetism)

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

Learning Outcomes

Upon completion of this cource, students are able to:

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

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

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

Learning Outcomes
Upon completion of this cource, students are able to:
1. explain the basic principles related to vibrations, waves and optics.
2. explain the basic concepts of simple harmonic motion, forced oscillator, longitudinal and transverse waves, nature of electromagnetic waves, interference of light, diffraction pattern and polarization.
3. analyze and solve problems related to vibrations, waves and optics.

ZCT 104/3 Physics IV (Modern Physics)

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

Learning Outcomes
Upon completion of this cource, students are able to:
1. describe the basic ideas in special theory of relativity and quantum theory.
2. explain the conceptual differences between classical physics and modern physics in framing the law of physics.
3. solve problems related to special theory of relativity and quantum theory.

ZCT 106/3 Electronics I

Analysis of circuits. Alternating current circuits. Thevenin’s Theorem and Norton’s Theorem. Characteristics of diodes and their uses in circuits, rectifying circuits. Signal processing circuits. Bipolar junction transistors and Field effect transistors, input characteristics and output characteristics. Large signal amplifiers, amplification, distortion

and frequency response. Power amplifier. Small signal amplifiers and hybrid parameters. Theory of positive and negative feedback. Operational amplifiers and their applications.

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

ZCA 110/4 Calculus

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

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

ZCT 112/3 Linear Algebra and Vector Analysis

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

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

Learning Outcomes
Upon completion of this cource, students are able to:
1. explain the basic concepts in linear algebra.

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

ZCT 191/2 Physics Practical I

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

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

ZCT 192/2 Physics Practical II

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

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

ZCT 205/3 Quantum Mechanics

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

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

ZCT 206/3 Electronics II

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

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

ZCT 210/4 Complex Analysis & Differential Equations

Complex Analysis: Functions of complex variable - complex functions. Differentiation of complex functions; Cauchy-Riemann equations, analytic functions, singular points, power series of analytic functions, Taylor series. Zeroes, Singularities and Residues. Laurent series. Complex Integration: Cauchy Goursat theorem, path deformation theorem, Cauchy integral formula. Residue theorem. Applications of residue theorem.

Differential Equations: Ordinary differential equations of first order and methods of solution. Ordinary linear differential equations of second order – homogeneous and non-homogeneous equations and methods of solution. Series solution - power series and Frobenius methods.

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

1. perform complex number arithmetic, differential, integration and contour integration.
2. analyze any complex integration in physics problems using suitable techniques discussed in lectures.
3. display the skills of solving any normal first order and linear second order differential equations.

ZCT 214/3 Thermodynamics

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

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

ZCT 215/3 Optics

Polarization. Plane and circular polarization. Reflection and transmission of electromagnetic waves at boundaries. Optical activity. Kerr effect and Faraday effect. Dispersion theory. Diffraction. Fresnel-Kirchhoff equations. Fraunhofer diffraction of a single slit, square and circular aperture. Diffraction gratings and their characteristics. Fresnel diffraction for circular aperture. Cornu spiral and Fresnel Integrals. Zone plates. Fresnel diffraction for straight edges and rectangular aperture. Quantum optics: laser, fibre optics and light detection.

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

ZCT 219/4 Mathematical Methods

Integral transforms: general properties. Laplace transform: general properties, applications in physical problems. Fourier transform: general properties, applications in physical problems. Special functions/equations: Gamma, Bessel, Legendre and

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

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

ZCT 293/2 Physics Practical III

A selection of experiments related to physics subjects namely optics, electronics, mechanics and Modern Physics: Spectrometer Grating, Statistical Analysis for Radioactive Measurement, Micro Wave, Variable Pendulum, Single-Slit and Double Slit Diffraction, Back Scattering Of Beta Ray, Laser Interferometer, Stefan Constant, Vacuum Technique, Tin Lead Phase Diagram, Computerized Spectrometer Grating, Interference Microwaves, DC Power Pack, Franck Hertz, Class A Amplifier, Pulse Circuit, Quinke Method, Tensile Test, Measuring Velocity of Lights, Thermal Expansion, Hall Effect, Beta Ray Absorption, Transistor, Poisson Ratio for Glass.

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

ZCT 294/2 Physics Practical IV

A selection of experiments related to physics subjects namely optics, electronics, mechanics and Modern Physics: Spectrometer Grating, Statistical Analysis for Radioactive Measurement, Micro Wave, Variable Pendulum, Single-Slit and Double Slit Diffraction, Back Scattering Of Beta Ray, Laser Interferometer, Stefan Constant, Vacuum Technique, Tin Lead Phase Diagram, Computerized Spectrometer Grating, Interference Microwaves, DC Power Pack, Franck Hertz, Class A Amplifier, Pulse Circuit, Quinke Method, Tensile Test, Measuring Velocity of Lights, Thermal Expansion, Hall Effect, Beta Ray Absorption, Transistor, Poisson Ratio for Glass.

Learning Outcomes
Upon completion of this cource, students are able to:
1. demonstrate experimental and analytical skills.

2. explain the data and discuss the result.
3. initiate new ideas to overcome problems in experiments.

ZCT 304/3 Electricity and Magnetism

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

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

ZCT 307/3 Solid State Physics I

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

Learning Outcomes
Upon completion of this cource, students are able to:
1. differentiate the crystal structures of various solids.
2. display an understanding how the properties of a crystal are related to its structure.
3. explain problems that are related to crystals.

ZCT 314/3 Statistical Mechanics

Characteristics of macroscopic and microscopic systems. Probability concepts and counting of states. Postulate of equal a priori probabilities. Microcanonical Ensemble. Definition of absolute temperature and entropy. Canonical Ensemble. Statistics of ideal quantum gases. Maxwell-Boltzmann statistics. Bose-Einstein statistics. Fermi-Dirac

statistics. Applications of quantum statistics: specific heat of solids, black body radiation, conducting electrons in solids.

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

ZCT 317/3 Solid State Physics II

Phonon; neutron scattering, thermal conductivity, anharmonic effect. Electron energy band in solids, Fermi surface. Electron dynamics in magnetic field, cyclotron resonance, Hall effect. Superconductivity. Dielectric and optical properties. Ferro-electrics. Magnetic properties. Properties of amorphous materials.

Learning Outcomes
Upon completion of this cource, students are able to:
1. describe the theories and principles of solid state physics.
2. explain facts relating to solid state physics, including developments, categorizations and methods.
3. display thinking, problem solving and assessment skills associated with the course content.

ZCT 390/8 Pure Physics Project (2 semesters)

Project/experiment of related areas of thrust.

Learning Outcomes
Upon completion of this cource, students are able to:
1. demonstrate the ability to work in a team to complete a certain physics project using theoretical knowledge and other related references
2. demonstrate individual skills to overcome unexpected problems in the process of completing a certain project
3. study, compile, present and defend their project results

SYNOPSES OF ELECTIVE COURSES

ZCE 111/4 Computational Approach Physics Learning

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

Learning Outcomes
Upon completion of this cource, students are able to:
1. identify and understand basic concepts of software applications in the development of simple algoritams.
2. explore and apply techniques and strategies of programming to solve problems in physics learning.
3. show potential in computer software package applications for visualization, manipulation and processing of data.

ZCE 208/3 Classical Mechanics

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

Learning Outcomes
Upon completion of this cource, students are able to:
1. explain the basic concepts related to systems of particles and Hamiltonian dynamics.
2. solve problems related to Newtonian mechanics and Hamiltonian dynamics.
3. explain the basic concepts of noninertial reference frame, centifugal and Coriolis forces.

ZCE 275/4 Introduction to Astronomy

History of astronomy; The celestial sphere & coordinate systems; time; Introduction to the structure of the Universe; Charts and catalogues; Applications of spherical triangle; Quantifying Light; Optical telescopes; Effects of the atmosphere; Light detectors; CCD calibrations; Astronomical photometry; Astrometry; Astronomical spectrographs & spectroscopy; Variable stars; Observing the Sun and Moon; Observation planning & techniques (practical field work); Astrophotography & image processing.

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

ZGE 277/4 Structure of the Universe

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

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

ZAE 282/3 Materials Science

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

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

ZCE 305/3 Atomic and Nuclear Physics

Atomic structure: Hydrogen atom. States in hydrogen atom. Angular momentum. Many electron atom. Electron spin. Pauli exclusion principle. Symmetric and Antisymmetric wave functions. Spin orbit coupling. LS and JJ coupling. Atomic spectra. Selection rules.

One valence electron-atom. Zeeman effect, Normal and Anomalous. Nuclear structure: General properties of nuclear - composition, size, form, mass and atomic nuclear charge. Nuclear force and deuteron problem. Radioactivity, alpha decay, gama decay, electron capture. Internal conversion. Nuclear reactions. Nuclear models and magic numbers.

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

ZKE 327/3 Solid State Lighting I

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

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

ZCE 341/4 Energy Studies

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

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

ZAE 376/4 Astronomy Principles and Practices

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

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

ZKE 378/4 Introduction to Radio Astronomy

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

Learning Outcomes
Upon completion of this cource, students are able to:
1. Understand and affirm the principles of radio astronomy.
2. Recognize and elaborate receiving and data processing instruments.
3. Recognize and appreciate the contributions of radio astronomy to knowledge.
4. Relate radio data with physical processes in the region.

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

ZKE 427/3 Solid State Lighting II

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

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

ZCE 431/4 Radiation Biophysics

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

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

ZCE 451/3 X-Ray Analysis

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

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

ZAE 484/4 Laser and Its Applications

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

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

ZAE 488/4 Non-Destructive Testing

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

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

ZCE 499/9 Industrial Training

Industrial training will be carried out and last for 4.5 months in the 4th year, semester 2. Students will be assigned at the industrial, hospital or institution which is identified by the school or the student himself/herself. Students will be directly exposed to the real working environment. Evaluation for this training will be done based on the report from the industrial supervisor/field supervisor, industrial training report or log book and seminar presentation.

Learning Outcomes

Upon completion of this cource, students are able to:

1. relate what you learned during lecture with real working environment.
2. organize and explain findings from training.
3. practice knowledge, skill and ability.

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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 running mathematics courses for various programs in the University degrees.

The Bachelor of Science (Mathematics) program 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.

PROGRAM OBJECTIVES

Graduates of Bachelor of Science (Mathematics) will:

1. have a broad-based and rigorous mathematics education.
2. have a firm foundation to enable the graduate to further advance their knowledge in the Mathematical Sciences.
3. possess professional attitudes, good ethics and leadership qualities.
4. have an educational experience that motivates them to pursue life-long learning.
5. have a solid foundation to be enrolled in a university graduate programme or employed.

PROGRAM LEARNING OUTCOMES

At the end of the program, the students will possess:

1. Knowledge
   i) Fundamental and broad mathematical principles
   ii) Analytical and computational techniques
   iii) Integration of mathematical knowledge in solving problem
2. Practical skills
   i) Relevant computing technologies and software for problem solving
   ii) Technological literacy and skills
3. Social skills and responsibilities
   i) Actively participate in outreach activities at national and international level
   ii) Understand and appreciate culture and cultural diversity
   iii) Seek objectivity and shun bias
4. Ethics, professionalism and humanities
   i) Carry out their responsibilities with professional values and ethics
   ii) Value ethical attitudes and behaviour
5. Communication, leadership and team skills
   i) Communicate effectively and efficiently in both oral and written form
   ii) Reading and listening
   iii) Function effectively as an individual and as team members to achieve common goal
6. Scientific methods, critical thinking and problem solving skills
   i) Use logical reasoning and critical thinking to make informed decisions
7. Lifelong learning and information management
   i) Use mathematical rigour for postgraduate studies and research
8. Entrepreneurship and managerial skills
   i) Assumed leadership roles in teams and engage constructively in various groups.

STAFF AND ADMINISTRATION

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Professor Dr. Hailiza Kamarulhaili

DEPUTY DEANS

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(Academic, Career & International)

Associate Professor Dr. Farah Aini Abdullah
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Applied Science (Mathematical Modelling)

Dr. Norhashidah Awang
Applied Science (Mathematics and Economics)

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

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

ASSISTANT REGISTRARS

Mr. Muhamad Tarmizi Rahim
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Nor ‘Izzati Zaidi	Administrative Assistant (Clerical/Operation)
Nor Rafidah Abd Majid	Administrative Assistant (Clerical/Operation)
Yusnita Yusop	Administrative Assistant (Clerical/Operation)
Syed Mohamed Hussain Syed Osman	Engineering Assistant Officer
Arzahar Ismail	Operational Assistant

PROGRAM REQUIREMENT

Type of Courses	Classification	Unit
Core	T	71
Minor / Elective	M / E	32*
University	U	20
	Total Number of Units	123

The required 71 units for Core are satisfied from compulsory courses (57 units), option choices (8 units) and basic courses (6 units).

* Students who opt for **Minor** need to accumulate 20 units from the courses listed in a minor package, and the remaining 12 units from the set of elective courses.

* Students who opt for **Elective** are required to complete at least 12 units from the Elective Courses and the remaining units from courses offered by the School. Other courses may be taken subject to approval from the Dean.

CORE COURSES

A student has to accumulate **71 units** as follows:

Compulsory (57 UNITS)

MAT100/3 : Mathematical Foundations
MAT101/4 : Calculus
MAT111/4 : Linear Algebra
MAT161/4 : Elementary Statistics
MAT181/4 : Programming for Scientific Applications
MAT201/4 : Advanced Calculus
MAT202/4 : Introduction to Analysis
MAT203/4 : Vector Calculus
MAT223/4 : Differential Equations I
MAT263/4 : Probability Theory
MAT323/4 : Differential Equations II
MAT382/4 : Introductory Numerical Methods
MSS212/4 : Further Linear Algebra
MSS311/4 : Modern Algebra
MSS381/2 : Mathematical Software Laboratory

Option Choices (Choose TWO)

MSS401/4	:	Complex Analysis
MSS402/4	:	Real Analysis
MSS416/4	:	Rings and Field
MSS417/4	:	Coding Theory
MSS418/4	:	Discrete Mathematics
MSS419/4	:	Geometry

Basic (at least 6 UNITS)

BOM111/4	:	Biodiversity
BOM112/4	:	Ecology
CPT112/4	:	Discrete Structures
CPT114/4	:	Logic & Applications
KFT231/4	:	Physical Chemistry I
KOT122/4	:	Organic Chemistry I
KTT112/4	:	Inorganic Chemistry I
KUT101/2	:	General Chemistry Practical I
KUT102/2	:	General Chemistry Practical II
ZCA101/4	:	Physics I (Mechanics)
ZCA102/4	:	Physics II (Electricity and Magnetism)

ELECTIVE COURSES

MAT363/4	:	Statistical Inference
MSG422/4	:	Fluid Mechanics
MSG489/4	:	Numerical Methods for Differential Equations
MSS401/4	:	Complex Analysis
MSS402/4	:	Real Analysis
MSS414/4	:	Topics in Pure Mathematics
MSS415/4	:	Introductory Functional Analysis and Topology
MSS416/4	:	Rings and Field
MSS417/4	:	Coding Theory
MSS418/4	:	Discrete Mathematics
MSS419/4	:	Geometry
MSS482/4	:	Graphing Technology in Mathematics and Sciences
MSS492/4	:	Minor Project

SKILL / OPTIONAL COURSES

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

COURSE PRE-REQUISITE AND SEMESTER OF OFFERING

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

	Code & Title of Courses			Prerequisite	Semester Offered
1.	MAT100/3	:	Mathematical Foundations	-	1
2.	MAT101/4	:	Calculus	-	2
3.	MAT111/4	:	Linear Algebra	-	2
4.	MAT161/4	:	Elementary Statistics	-	1, 2
5.	MAT181/4	:	Programming for Scientific Applications	-	1, 2
6.	MAT201/4	:	Advanced Calculus	MAT101 (S)	1
7.	MAT202/4	:	Introduction to Analysis	MAT201 (S)	2
8.	MAT203/4	:	Vector Calculus	MAT201 (S)	2
9.	MAT223/4	:	Differential Equations I	MAT101 (S) and MAT111 (S)	1
10.	MAT263/4	:	Probability Theory	MAT161 (S) and MAT201 (S)	2
11.	MAT323/4	:	Differential Equations II	MAT223 (S)	1
12.	MAT363/4	:	Statistical Inference	MAT263 (S)	1
13.	MAT382/4	:	Introductory Numerical Methods	MAT181 (S)	1
14.	MSG422/4	:	Fluid Mechanics	MAT323 (S)	2
15.	MSG489/4	:	Numerical Methods for Differential Equations	MAT382 (S) and MAT323 (S)	1
16.	MSS212/4	:	Further Linear Algebra	MAT111 (S)	1
17.	MSS311/4	:	Modern Algebra	MAT111 (S)	2
18.	MSS381/2	:	Mathematical Software Laboratory	MAT181 (S)	2
19.	MSS401/4	:	Complex Analysis	MAT201 (S)	1
20.	MSS402/4	:	Real Analysis	MAT202 (S)	2
21.	MSS414/4	:	Topics in Pure Mathematics	With permission from the lecturer	1
22.	MSS415/4	:	Introductory Functional Analysis & Topology	MAT111 (S) and MAT202 (S)	1
23.	MSS416/4	:	Rings and Fields	MSS311 (S)	2
24.	MSS417/4	:	Coding Theory	MAT111 (S) and MSS311 (S)	1
25.	MSS418/4	:	Discrete Mathematics	MAT111 (S)	2
26.	MSS419/4	:	Geometry	MAT203 (S)	1
27.	MSS482/4	:	Graphing Technology in Mathematics and Science	MAT111 (S), MAT263 (S) and MAT223 (S)	1

28.	MSS492/4	:	Minor Project	MAT202 (S) and MSS311 (S), CGPA at least 2.00	2
29.	BOM111/4	:	Biodiversity	-	1
30.	BOM112/4	:	Ecology	-	1
31.	CPT112/4	:	Discrete Structures	-	2
32.	CPT114/4	:	Logic & Applications	-	1
33.	KFT 231/4	:	Physical Chemistry I	KOT122 (S) or KTT112 (S)	2
34.	KOT122/4	:	Organic Chemistry I	-	2
35.	KTT112/4	:	Inorganic Chemistry I	-	1
36.	KUT101/2	:	General Chemistry Practical I	KTT112 (C) (S) and KAT141 (C) (S)	1, 2
37.	KUT102/2	:	General Chemistry Practical II	KFT231 (C) (S) and KOT122 (C) (S)	1, 2
38.	ZCA101/4	:	Physics I (Mechanics)	-	1
39.	ZCA102/4	:	Physics II (Electricity and Magnetism)	ZCA101 (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
3	MAT323	4	MSS311	4
	MAT382	4	MSS381	2
4	*MSS401	4	*MSS402	4
	*MSS417	4	*MSS418	4
	*MSS419	4	*MSS416	4
	**MSS415	4	**MSS492	4
	**MSS482	4	**MSG422	4
	**MSS414	4		
	**MAT363	4		
	**MSG489	4		

*Core Courses: Choose 2 from 6 listed courses indicated by **

*Elective Courses: Choose 3 from 13 listed courses indicated by * and ** (excluding 2 which have been taken as core)*

MATHEMATICS MINOR PROGRAM

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

Mathematics minor students have to accumulate 20 units and it is compulsory for them to take both MAA 101/4 and MAA 111/4 either as core or minor courses. Courses which they have taken to fulfill the core requirements must be replaced by the above listed courses. Please refer to the minor program guide book for further details.

SCHOOL'S FACILITIES

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

GENERAL INFORMATION

Awards

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

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

The Dean Lists certificates are awarded every semester to 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 program. A student of a CGPA of 3.7 and above in an academic session is qualified to be considered for this award.

Mathematical Sciences Society

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

Graduate Program

The School also offers the following graduate programs:

- Master of Science (Mathematics) by research
- Master of Science (Statistics) by research
- Mixed Mode Master of Science (Mathematics)
- Mixed Mode Master of Science (Statistics)
- Master of Science (Teaching of Mathematics) by course-work
- Doctor of Philosophy by research

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SYNOPSIS OF COURSES

MAT100/3 Mathematical Foundations

This course is designed to provide first year students with appropriate mathematical foundations in the topics of sets, functions, graphs and the number systems. It also exposes students to methods of mathematical proving which includes the technique of direct proof, contrapositive, counterexample, mathematical induction and proof by cases. Having completed this course, students will have a solid foundation to undertake the first year level mathematics courses, particularly Calculus and Linear Algebra.

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

MAT101/4 Calculus

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

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

MAA101/4 Calculus for Science Students I

This is a course on basic concepts of differential and integral calculus. Some of the concepts being discussed are limit, continuity, derivative and integral. Techniques of differentiation and integration will also be taught. Some of the applications of differentiation and integration, like finding the maximum and minimum, the area and volume of revolution, are covered.

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

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

MAA102/4 Calculus for Science Students II

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

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

MAT111/4 Linear Algebra

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

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

MAA111/4 Algebra for Science Students

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

Learning Outcomes
Upon completion of this course, students are able to:
1. use the Gauss-Jordan method to solve problems involving systems of linear equations and matrices
2. compute the determinant of a matrix and apply properties of determinant in the computation
3. explain concepts of vectors spaces and how to find bases and dimensions of subspaces
4. apply the theory on eigenvalue and eigenvector to determine the diagonalizability and diagonalization of a matrix

MAT161/4 Elementary Statistics

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

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

MAA161/4 Statistics for Science Students

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

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

MSG162/4 Applied Statistical Methods

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

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

MAT181/4 Programming for Scientific Applications

This course introduces basic computer concepts, algorithm development, problem solving methods and programming techniques using the C++ language. Topics covered include types of data, variables, input/output and file manipulation, computation and arithmetic expression, control structure, modular program design, arrays, pointers, structure and file processing. Application problems will be discussed.

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

MAT201/4 Advanced Calculus

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

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

MAT202/4 Introduction to Analysis

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

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

MAT203/4 Vector Calculus

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

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

MSS212/4 Further Linear Algebra

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

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

MAT223/4 Differential Equations I

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

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

MAT263/4 Probability Theory

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

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

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. For group theory, students will learn about properties of groups, normal subgroups, factor groups, homomorphism, finitely-generated abelian groups and symmetric groups. Basic ring theory will also be introduced.

Learning Outcomes
Upon completion of this course, students are able to:
1. identify equivalence relations and partitions on a set
2. describe types of groups and subgroups from a binary system
3. solve problems that are related to group homomorphisms, normal subgroups and factor groups
4. show whether two groups are isomorphic
5. identify different types of rings

MAT323/4 Differential Equations II

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

Learning Outcomes
Upon completion of this course, students are able to:
1. analyze the local stability of plane autonomous systems
2. solve the regular Sturm-Liouville eigenvalue problem
3. performs analysis of solutions to Euler and Euler-Cauchy equations for Dirichlet, Neumann and Robin boundary conditions
4. solve partial differential equations through method of characteristics and d'Alembert
5. solve partial differential equations using separation of variables method

MAT363/4 Statistical Inference

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

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

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 mathematical software for interactive computation
2. generate and export plots for use in reports and presentations
3. demonstrate the ability to use appropriate technology for research in mathematics
4. formulate ways of using technology effectively in investigating and developing understanding of mathematical ideas
5. practice the use of technological methods and tools in the subsequence courses

MAT382/4 Introductory Numerical Methods

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

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

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. have a firm understanding of the structure of the complex plane, and the basic concepts and theory of analytic functions of a complex variable
2. differentiate functions, evaluate contour integrals, and determine convergence of series

3. construct rigorous arguments and proofs, as well as demonstrate applications of several key theorems
4. demonstrate the inter-relationship as well as several interesting differences between functions of a real and a complex variable
5. write mathematical reports and assignments

MSS402/4 Real Analysis

This course introduces the basic concept and theory of the 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 mode of convergences. 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. demonstrate the weakness of the theory of Riemann integral
2. interpret the concept of measurability and understand its importance
3. demonstrate examples about several key theorems
4. distinguish between the two integral theories: Riemann integral and Lebesgue integral
5. prove mathematical statements

MSS414/4 Topics in Pure Mathematics

This course treats selected advanced topics in mathematical sciences to cater to new and emerging trends in research priority areas. The thematic topic offered under this course in a particular year will depend on current interest. It is intended for advanced undergraduate students with the required prerequisites.

Learning Outcomes
Upon completion of this course, students are able to:
1. demonstrate mastery skills of the mathematical principles in the subject
2. manipulate the mathematical principles in the subject to solve some mathematical problems
3. give an oral presentation or a written report of an independent study

MSS415/4 Introductory Functional Analysis & Topology

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. distinguish between the metric spaces, the normed spaces and the inner product spaces and understand their relationships
2. identify the linear operators as linear transformations on abstract vector spaces
3. Restate the three fundamental theorems of functional analysis
4. know the topological spaces and its topological properties, particularly those related with the real analysis

MSS416/4 Rings and Fields

This course studies ring theory which encompasses integral domains, zero divisors, ideals, homomorphism and isomorphism, quotient rings, the field of quotients of an integral domain, polynomial rings and field theory that covered up to algebraic closures. 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 types of field extensions.

Learning Outcomes
Upon completion of this course, students are able to:
1. identify types of rings
2. solve problems related to homomorphisms of rings and ideals
3. determine the reducibility of a polynomial
4. construct a field extension using a given polynomial

MSS417/4 Coding Theory

This course involves the discussion of the application of theory of algebra in the theory of coding. The focus will be on the connection between the theory of codes and algebraic structures such as vector spaces, polynomial rings and finite fields. Constructions of codes including the design of its encoding and decoding algorithm are 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 bounds.

Learning Outcomes
Upon completion of this course, students are able to:
1. explain the mechanism of how coding and decoding of a code can be used to detect and correct error
2. construct vector spaces over a finite field and use it in the construction, coding and decoding of linear codes
3. construct a finite field and use it in the construction, coding and decoding of cyclic codes
4. design a code together with a coding and decoding algorithm along with the verification of the code's optimization

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 notions of finite geometry are also dealt with.

Learning Outcomes
Upon completion of this course, students are able to:
1. identify discrete methods inherent in many problems and structures
2. apply and use the tools learnt in counting techniques using their own creativity
3. construct graph models by identifying phenomena in other areas of study
4. efficiently solve problems that require mathematical reasoning and analysis

MSS419/4 Geometry

This course introduces students to several types of 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 geometry. The concept of basic transformation will be presented and several theorems in Euclidean geometry will be proved using transformation geometry. 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 geometry will be discussed.

Learning Outcomes
Upon completion of this course, students are able to:
1. recognize and explain about various types of geometry
2. apply Euclid Axiom in the proof of Euclidean geometry Theorem
3. explain concepts and solve geometrical problems with coordinate, vector and image methods
4. restate the concepts and applications of perspective geometry and projective geometry
5. show understanding on concepts of non-euclidean geometry

MSG422/4 Fluid Mechanics

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

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

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

MSS482/4 Graphing Technology in Mathematics and Science

This course introduces graphing technology enhanced with a computer algebra system (CAS) to the third or fourth year mathematics students. The focus will be around the capabilities of the technology to enhance the understanding and learning of mathematical concepts and theories through scientific visualization and laboratory type explorations. The course content includes various topics in mathematics such as calculus, differential equation, statistics etc.

Learning Outcomes
Upon completion of this course, students are able to:
1. display the ability to construct and interpret graphs using technology
2. show a better understanding on functions and variables
3. performs the solution of algebraic problems in application context
4. analyze data collected from a scientific experiment
5. modify and develop a lesson plan which involves mathematical exploration with the integration of graphing technology

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. identifying appropriate numerical methods for solving differential equations
2. interprete numerical solutions of the differential equations
3. solving scientific problems involving differential equations using numerical methods

MSS492/4 Minor Project

This course (Minor Project) 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 give a presentation.

Learning Outcomes
Upon completion of this course, students are able to:
1. manage a simple research project
2. join in on a meaningful discussion of a mathematical topic

3. illustrate and display results of the study through oral and writing

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

SCHOOL OF BIOLOGICAL SCIENCES

SCHOOL OF BIOLOGICAL SCIENCES

(www.bio.usm.my)

Introduction

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

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

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

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

Vision

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

Mission

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

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GENERAL INFORMATION

1. Career

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

2. Alumni

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

3. Awards and Dean's Certificate

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

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

Mansor.

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

4. Clubs and Society

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

5. Graduate 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, Postgraduate and Networking)
School of Biological Sciences
Universiti Sains Malaysia
11800 Minden
Penang, Malaysia

Tel : 604-653 3503/5016

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

6. Industry and Community Network

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

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

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

7. Facilities

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

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

DEGREE IN BACHELOR OF SCIENCE

1. Bachelor of Science Degree Program

Students undertaking the Bachelor of Science degree under the School of Biological Sciences may elect to specialise in one of the following three (3) areas of specialisation/major listed below :-

a. Microbiology
b. Animal Biology
c. Plant Biology

2. Graduation Requirements

Students must fulfill the following requirements to graduate :-

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

3. Curriculum and Graduation Structure

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

a. Minor Structure

Course Component		Course Code Type	Minimum No. of Units Required
CORE	Basic • 38 units	**T**	73 - 76
	Required • 35 - 38 units		
ELECTIVE		**E**	14 – 15
MINOR		**M**	16
**** UNIVERSITY**		**U**	18
		TOTAL :	**122 – 124**

b. Elective Structure

Course Component		Course Code Type	Minimum No. of Units Required
CORE	Basic • 38 units	**T**	73 – 76
	Required • 35 - 38 units		
ELECTIVE		**E**	30 – 31
**** UNIVERSITY**		**U**	18
		TOTAL :	**122 – 124**

***** Details of University courses offered (Table 1 and Table 2)(page 14)***

(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	Islamic Civilisation and Asian Civilisations (TITAS) - Course code = *HTU223* (2 units)	2
4	Ethnic Relations - Course code = *SHE101* (2 units)	2
5	Core Entrepreneurship - Course code = *WUS101* (2 units)	2
6	Co-curriculum/ Skills Courses/Option	6
	TOTAL :	**18**

(ii). Table 2 : ***For international 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/ Skills Courses/Option	6
	TOTAL :	**18**

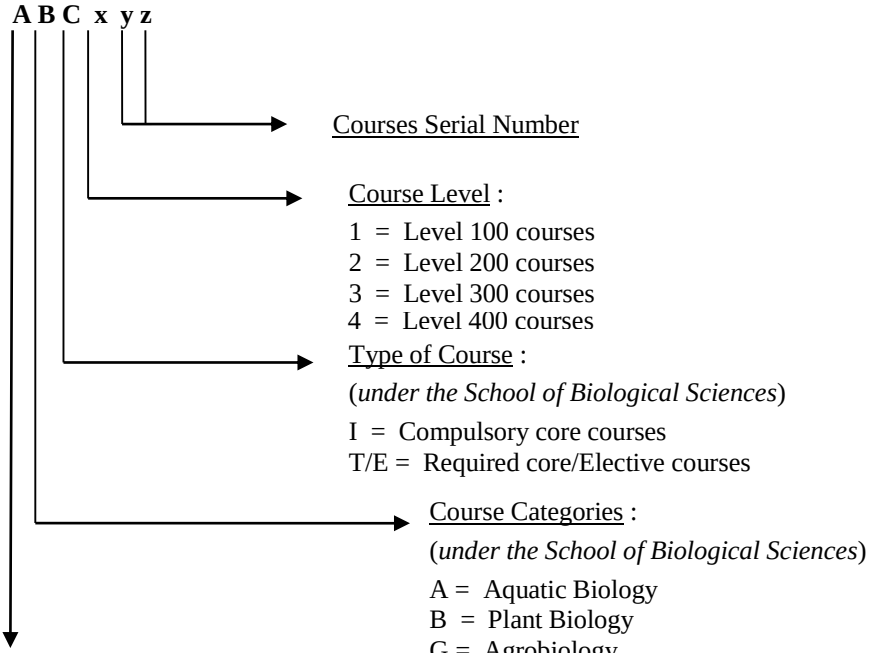
4. Classification of Year Equivalent

Students are classified as being in the first, second, third or fourth year based on the number of credits accumulated as follows:

Degree	**Year equivalent based on total units accumulated**			
	First	**Second**	**Third**	**Fourth (Final)**
Bachelor of Science	0 - 32	33 - 62	63 - 94	≥ 95

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.

7. Prerequisite Courses (Course code type = **Z**)

Student are allowed to register for any course provided they fulfill the prerequisites of the course. There are 3 types of prerequisites.

a. Pass (**P**)

If a Pass in Course A is a prerequisite for Course B, then student must take Course A and obtain the mínimum of a Grade C before he/she is allowed to take Course B.

b. Sequential (**S**)

If Course A is a sequential prerequisite (S) for Course B, then a student must take Course A and sit for the examination before he/she is allowed to take Course B.

c. Concurrent (**C**)

If Course A is a concurrent prerequisite for Course B, then a student must take Course A and sit for the examination at the same time as Course B.

8. Minor package

Offering School/Centre	Title of Minor Package - Choose one (1) Minor package only - Minimum 16 units 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

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 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 (73 - 76 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 (38 Units)

Basic core courses are offered by various science schools which are School of Biological Sciences, Physics, Chemical Sciences and Mathematical Sciences. All undergraduate students of the School of Biological Sciences must enrol and attain passing grades for these courses. Students must obtain a total of 38 units. The courses are as follows :-

Year	Semester	Course Code	Course Title	Total Units Required
1	1	KOT 122/4	Organic Chemistry I	24
	2	KTT 112/4	Inorganic Chemistry I	
	1 or 2	MAA 101/4	Calculus (for First Year Science Students)	
		BOI 102/3	Ecology	
		BOI 115/3	Plants and Animals Biodiversity	
		BOI 116/4	Genetics	
		BOI 117/2	Biodiversity and Ecology Practical	
2	1 or 2	BOI 205/4	Biostatistics	11
		BOI 206/4	Principles of Biochemistry	
		BOI 207/3	General Microbiology	
4	1	BOI 401/3	Scientific Writing, Seminar and Current Topics in Biology	3

(ii). Required Core Courses (35 - 38 Units)

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

FINAL YEAR PROJECT (8 UNITS)

All final year Biology students are given the option to register for a final year project of 8 units which spans over 2 semesters. At the end of the second semester, a thesis based on the existing regulations and format must be submitted for examination.

Before a student is allowed to register for the final year project in their respective field of specialisation, the student must have achieved these **minimum cumulative unit requirement**.

- Total overall unit = 93 – 94 units
- Total unit for Biology courses = 63 – 64 units

Students who do not register for a final year project must substitute the 8 units with BOE 400/2 – Special Topics in Biology (which carries 2 units), while the remaining 6 units are fulfilled by taking elective courses that are suitable with his/her field of specialisation and approved by the programme chair person.

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 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 sterilization 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 microbiology, agriculture, medicine and environment.

Course code	Course title	Semester	Course prerequisite
Required Core - Level 300 = 21 Units			
BMT 306/3	Virology	1	BOI 207/3 (S)
BMT 308/3	Mycology	1	BOI 115/3 (S)
BMT 310/3	Bacteriology	1	BOI 207/3 (S)
BMT 305/3	Microbial Physiology	2	BOI 115/3 (S) BOI 206/4 (S) BOI 207/3 (S)
BMT 307/3	Environmental Microbiology	2	BOI 207/3 (S)
BMT 309/3	Microbial Genetics	2	BOI 207/3 (S)
BMT 311/3	Immunology	2	BOI 207/3 (S)
Required Core - Level 400 = 14 Units			
BMT 402/3	Medical Microbiology	1	BOI 207/3 (S)
BMT 403/3	Industrial Microbiology	2	BOI 207 /3 (S)
BMT401/8 or * BOE 400/2	Microbiology Project or Special Topics in Biology	1 & 2 1 & 2	
* requires 6 more units from Elective courses			
Elective (15 units under Elective structure)			
BOE 201/3	Biological Instrumentation	1 & 2	BOI 206/4 (C)
BTT 306/3	Techniques in Biotechnology	1 & 2	BOI 206/4 (S)
BOT 205/3	Microscopy and Histological Techniques	1 & 2	
BOA 301/4	Industrial Training	2	
BET 304/4	Introductory Parasitology	1	BOI 115/3 (S)
BTT 305/3	Protein Biochemistry	2	BOI 206/4 (S)
BGT 301/3	Plant Pathology	1	BGT 302/2 (C)
BGT 302/2	Basic Practical in Plant Pathology	1	BGT 301/3 (C)
BTT 402/3	Fermentation Technology	1	BOI 207/3 (S) BOI 206/4 (S)
BET 403/3	Medical and Veterinary Protozoology	2	BET 304/3 (S)
BTT 404/3	Genetic Engineering	1	BMT 309/3 (S)
BET 405/3	Medical and Veterinary Helminthology	2	BET 304/4 (S)
BME 401/3	Soil Microbiology	2	BOI 207/3 (S)
BME 402/3	Microbial Genomics	2	BOI 207/3 (S)
Elective (15 units under Minor structure or 31 units under Elective structure) Student **MUST** choose among the listed courses to complete a total of 15 or 31 units for Elective.			

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

b. ANIMAL BIOLOGY

Objectives : This field of specialisation offers training of in both basic and applied aspects of animal biology with the aim to equip students with up-to-date knowledge. The ultimate objective is to produce quality graduates who will be successful in their careers.

Students at level 200 will be exposed to a few taxa and the focus will be on the relationships based on their structures, development and functions. Students will be trained to use culture techniques of laboratory animals and to maintain numerous equipment. During the final year, students are allowed to choose courses that focus on certain animal groups. These specific courses are aimed at providing more detailed knowledge to enhance student understanding in the areas of taxonomy, biology, ecology and reproduction as well as the economic importance of each taxon.

Course Code	Course Title	Semester	Course Prerequisite
Required Core - Level 200 and 300 = 19 Units			
BOT 205/3	Microscopy and Histological Techniques	1 & 2	
BZT 304/3	Invertebrate Zoology	1	BOI 115/3 (S)
BZT 305/3	Vertebrate Zoology	1	BOI 115/3 (S)
BZT 308/2	Animal Taxonomy Practical	1	BOI 115/3 (S) BZT 304/3 (C) BZT 305/3 (C)
BZT 306/3	Animal Behaviour	2	BOI 115/3 (S)
BZT 307/3	Animal Physiology	2	BOI 115/3 (S)
BZT 309/2	Animal Physiology and Behaviour Practical	2	BZT 306/3 (C) BZT 307/3 (S)
Required Core - Level 400 = 17 Units			
BZT 401/8 or *BOE400/2	Project in Animal Biology Special Topics in Biology	1 & 2 1 & 2	
BZT 402/3	Biology of Vertebrate Pest Animals	1	BOI 115/3 (S)
BZT 403/3	Plant - Animal Interaction	1	BOI 115/3 (S)
BZT 404/3	Animal Conservation Genetics	2	BOI 115/3 (S) BOI 116/4 (S)
* requires 6 more units from Elective courses			

Elective (<u>14 units under Minor structure</u> or 30 units under Elective structure)				
BOE 201/3	Biological Instrumentation	1 & 2	BOI 206/4	(C)
BOA 301/4	Industrial Training	2		
BET 304/4	Introductory Parasitology	1	BOI 115/3	(S)
BET 305/4	Insect Biology and Systematics	1	BOI 115/3	(S)
BST 307/3	Population and Community Ecology	2	BOI 102/3	(S)
BAT 307/3	Ichthyology	1	BOI 115/3	(S)
BAT 305/3	Benthic Biology and Ecology	2	BOI 102/3	(S)
BST 308/3	Tropical Ecosystems and Climate Change	2	BOI 102/3	(S)
BET 406/3	Integrated Pest Management	2	BET 305/4	(S)
BST 405/3	Conservation Ecology and Natural Resources	1	BST 308/3	(S)
BST 402/3	Ecology of Invasive Species	1	BOI 102/3 BOI 117/2	(S) (S)
BST 404/3	Wildlife Ecology & Management	2	BST 307/3	(S)
Elective (14 units under Minor structure or 30 units under Elective structure) Student **MUST** choose among the listed courses to complete a total of 14 or 30 units for Elective.				

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

c. PLANT BIOLOGY

Objectives : Students who major in Plant Biology will be taught various disciplines within plant biology, which include taxonomy, plant function, biosystematics and environment. Single cells and multicellular plants will be used as examples in studying these disciplines. In addition, plant genetics studies based on classical and molecular approaches, as well as plant tissue culture are also included.These aspects are important in relation to other subjects, as for example, biotechnology. Knowledge in botany is the basis for the development and advancement of Plant Biotechnology. Studies in Botany encompass all aspects of plant biology both in the pure and applied sciences. This programme is tailored to train students the basics of plant biology, its uses and applications in other related disciplines, such as agriculture, genetics and biotechnology.

Course Code	Course Title	Semester	Course Prerequisite
Required Core - Level 300 = 18 Units			
BBT 308/3	Tropical Plant Ecology	1	BOI 115/3 (S)
BBT 309/4	Plant Structure and Evolution	1	BOI 115/3 (S)
BBT 305/4	Plant Physiology and Development	2	BOI 115/3 (S)
BBT 306/4	Plant Biosystematics and Taxonomy	2	BOI 115/3 (S)
BBT 307/3	Enthnobotany	2	BOI 115/3 (S)
Required Core - Level 400 = 20 Units			
BBT 401/8 or *BOE 400/2	Project in Plant Biology or Special Topics in Biology	1 & 2 1 & 2	
BBT 402/3	Plant Genetics	1	BOI 116/4 (S) BOI 206/4 (S)
BBT 404/3	Economy Botany	1	BOI 115/3 (S)
BBT 403/3	Plant Molecular Biology	2	BOI 116/4 (S) BOI 206/4 (S) BBT 402/3 (S)
BBT 405/3	Plant Tissue Culture	2	BOI 115/3 (S) BOI 206/4 (S)
* requires 6 more units from Elective Courses			

Elective (<u>14 units under Minor structure</u> or 30 units under Elective structure)				
BOE 201/3	Biological Instrumentation	1 & 2	BOI 206/4	(C)
BOT 205/3	Microscopy and Histological Techniques	1 & 2		
BOA 301/4	Industrial Training	2		
BGT 301/3	Plant Pathology	1	BGT 302/2	(C)
BST 306/3	Soil Science and Environment	1	BOI 102/3	(S)
BST 308/3	Tropical Ecosystems and Climate Change	2	BOI 102/3	(S)
BMT 308/3	Mycology	1	BOI 115/3	(S)
BST 307/3	Population and Community Ecology	2	BOI 102/3	(S)
BST 405/3	Conversation Ecology and Natural Resources	1	BST 308/3	(S)
BST 402/3	Ecology of Invasive Species	1	BOI 102/3 BOI 117/2	(S) (S)
BGT 302/2	Basic Practical in Plant Pathology	1	BGT 301/3	(S)
BGT 404/3	Horticultural Science	2	BOI 116/4	(S)
BZT 403/3	Plant- Animal Interaction	1	BOI 115/3	(S)
Elective (14 units under Minor structure or 30 units under Elective structure) Student **MUST** choose among the listed courses to complete a total of 14 or 30 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

BOI102/3 Ecology

This is an introductory course on general ecology for students to understand various principles of ecology. The concept of ecology will be defined in terms of basic components, structures and processes that occur in ecosystems, fundamental populations ecology, communities and ecosystems together with the analysis and interpretation of the distribution patterns of organisms. Biotic and abiotic factors which characterize terrestrial, freshwater and marine ecosystems will also be discussed. The productivity of these ecosystems will be compared. At the end of this course, knowledge in ecology will be applied to evaluate human impacts towards ecosystems, which have caused environmental disasters such as greenhouse effect, depletion of ozone layer and eutrophication. The definition, reasons and aims of conservation will also be defined.

Learning Outcomes

Upon completion of this course, students are able to:

1) Interpret basic concepts in ecology.
2) Describe factors that could influence formation and dissemination of different ecosystems and the uniqueness inherent in each and all ecosystems.
3) Verify relationships between effects of human activities with components, structures and processess occuring in ecosystems.

BOI115/3 Plants and Animals Biodiversity

This course covers elements of biodiversity involving genes, species and ecosystem. Emphasis will be on biological diversity including discussion on characteristics of various biological groups. Students will also be exposed to the problems of species loss, habitat and ecosystem and the importance of biodiversity conservation as well as efforts taken by the government in biodiversity conservation. Discussion will also include topics on legislations and international agreements for the protection of biodiversity and will conclude with discussion on biodiversity hotspots.

Learning Outcomes

Upon completion of this course, students are able to:

1) Understand the importance of plant and animal diversity as well as importance of the relationship between biodiversity with economic values, ecological importance and conservation.
2) Differentiate and identify general features of plants and animals, and will be able to apply awareness about the richness of biodiversity especially in the tropical area.
3) Understand and enhance awareness on the meaningful preservation of biodiversity nationally and internationally.

BOI116/4 Genetics

This course covers topics on basic concepts and principles of genetics including Mendelian laws, molecular and population genetics, and advances in genetic technology. The aim of the course is to introduce the principle or concept of basic genetics which is important in understanding various aspects of biology.

Learning Outcomes
Upon completion of this course, students are able to:
1) Understand Mendel's Law and extensions, linkage and crossovers concepts, statistical analysis to confirm the results of breeding and genetic population studies.
2) Understand mitosis and meiosis, different types of mutations, which cause and impact on life, how DNA and RNA has been shown to be the genetic material and recognize the composition and structure of DNA, RNA and chromosomal organization.
3) Understand the concept of central dogma which include transcription, replication, translation and reverse transcription, the regulatory gene (*lac* and *trp* operon) and genetic engineering of basic concepts and methods employed.
4) Perform basic genetics techniques and experiments.

BOI117/2 Biodiversity and Ecology Practical

This field and laboratory based course will introduce students to basic concepts in ecology and biodiversity. Introduction to biodiversity will be done from species and ecosystem perspective. Emphasise will be given to practical and hands-on approach. Students will be taken on field sampling trips to study forest, coastal, river and soil ecosystems. Students will be introduced to the biodiversity of both plants and animals in laboratory based practicals.

Learning Outcomes
Upon completion of this course, students are able to:
1) Recognize and comprehend research methods in the laboratory and field in the field of biodiversity and ecology.
2) Conduct field work such as sample collection, preparation, identification, processing and storage.
3) Use practical methods to analyze animal, plant, water and soil samples.
4) Show skills pertaining to analysis and interpretation of data.

BOI205/4 Biostatistics

The course includes discussion on variability in biological data; probability distribution for binomial, Poisson and normal distributions. Basic training on the use of statistics for data analysis in biological research will be given. Topics to be discussed include variability of biological data, hypothesis testing (including non-parametric), as well as correlation and regression. After taking this course, students are expected to acquire skills and ideas in presenting their data appropriately and will be able to analyze their data using suitable statistical method/s to produce accurate inferences and conclusions of their research results.

Hypothesis testing for one and two samples, including parametric and non-parametric methods; correlation and regression. The second part of this course will discuss sampling designs and sample sizes (for one and two samples), one and two way analysis of variance, experimental design such as randomized complete block and Latin square, factorial experiments and special techniques in biology. Students will also be introduced to software used for statistical analysis.

Learning Outcomes

Upon completion of this course, students are able to:

1) Understand the concept of basic statistic.
2) Interpret, arrange and conclude data based on descriptive statistics.
3) Describe the results of big datasets using inferential statistics and solve problems in biological studies using applications in biostatistics.
4) Apply computer software to analyse and understand results.

BOI206/4 Principles of Biochemistry

This course is an integrated introduction to the structure of macromolecules and a biochemical approach to protein function. It covers two distinct areas of biochemistry. The first part explains the importance of water, function of buffers and understanding of pH and pKa in biochemical processes. This part also addresses the hierarchical structure of biological macromolecules such as protein, lipid, carbohydrate and nucleic acid and their assembly into complexes responsible for specific biological processes. Students will also learn protein functions which includes enzyme kinetics.

The second part of this course will cover the major metabolic pathways and their interconnection into highly regulated networks. This involves basics of metabolism, enzymes as catalyst of metabolic pathways and energetics principles in general. Details on vital metabolic pathways and processes such as glycolysis, fermentation of sugars, pentose phosphate pathway, gluconeogenesis, citric acid cycle, electron transport chain, oxidative phosphorylation, fatty acid oxidation and biosynthesis, photosynthesis as well as their regulation will be covered in detail.

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

Learning Outcomes

Upon completion of this course, students are able to:

1) Understand the importance of water and buffers in biochemical processes, important biological macromolecules and their properties, enzymes as biocatalysts, bio-energy, and the basis of a variety of metabolic pathways and regulatory.
2) Analyze the relevance of each metabolic pathway and regulators involved.
3) Use basic knowledge on how various metabolic pathways are regulated for use in biochemistry, microbiology, genetics and biotechnology research.

BOI207/3 General Microbiology

The course is intended to provide basic knowledge in microbiology and students will gain both background and experimental experience in the broad field of microbiology, setting the foundation needed for more advanced and specialized courses. Topics that would be covered include the historical development of microbiology field, basic cell biology, structures and functions of cell components, prokaryote microbes, eukaryote microbes, viruses, microbial taxonomy, basic techniques in microbiology (media, microbe cultures, growth) and various microbe applications. The laboratory component would expose the students to basic microscopy, slide preparation and observation, aseptic techniques, pure culture techniques, bacterial population counts and bacterial growth curve.

Learning Outcomes

Upon completion of this course, students are able to:

1) Explain microbiology as a specialisation in general biology.
2) Describe various basic groups of microbiology (bacteria, archaea, virus and eukaryotic microbes) and the differences between them.
3) Clarify the basic concepts in microbiology and its applications in life.
4) Show competency in basic techniques in microbiology.

BOI401/3 Scientific Writing, Seminar and Current Topics In Biology

It is an interdisciplinary course incorporating biology, chemistry, ecology, molecular biology and biotechnology for botany, agrobiology, microbiology, entomology and parasitology, plant biology, animal biology, environmental biology and aquatic biology majors. This course was designed to introduce students to current issues and related emerging challenges in their fields. Students are expected to use critical thinking, scientific approach and major information resources for scientific discipline to examine and discuss current issues and related problems in their fields. The course also covers effective communication in biology, such as oral presentation of research findings, thesis writing and publishing process in scientific journals.

Learning Outcomes

Upon completion of this course, students are able to:

1) Understand current issues and challenges in the field of life sciences, building generic skills to conduct research and analyze information critically.
2) Understand and possess the ability to develop methods / scales to examine current issues / events in life sciences.
3) Discuss / perform scientific presentations at the general level. In addition to verbal communication skills, students will also gain insights into journal publication process and thesis writing.

BBT305/4 Plant Physiology and Development

The course introduces the principles of bioenergetics which involves energy metabolisms and assimilation of C and N. The next emphasize is on cell and plant water relations and the uptake of mineral nutrients. The next subjects are plant growth and development and their control by hormones, light and temperature. Discussion proceeds to the physiology and biochemistry of plant acclimation to environment and biotic stress. Lastly, the importance of plant physiology in modern biotechnology will also be reviewed. This organization of ideas represents a logical flow of concepts and information essential to an understanding of plant forms and functions. Students will understand the importance of sunlight as the ultimate source of energy for the planet in order to understand the critical dependence of water relations, growth, development and metabolisms on the fundamental principles of energy flow.

Learning Outcomes

Upon completion of this course, students are able to:

1) Explain the physiology concept and development of plants from the perspective of the biochemical and genetic process.
2) Explain the fundamentals of biochemistry and metabolism of plant photosynthesis and the role of hormones in the growth and development of plants
3) Explain the relationship between morphology and function in plants and plant adaptations to the environment, especially in extreme environment
4) Relate the concepts of genetics and environment in modern methods of plants regeneration of high economic importance

BBT306/4 Plant Biosystematics and Taxonomy

The course is divided into two components; taxonomy and plant biosystematic. 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) Describe the vegetative and reproductive as well as the terminology for the identification of flowering plants
2) Distinguish the principles of plant taxonomy, nomenclature, including the pattern of evolution, speciation pattern, biogeography and floral biology

3) Use taxonomic keys for the identification of flowering plants
4) Analyze morphological and molecular data to produce phenetic and phylogenetic trees

BBT307/3 Ethnobotany

Ethnobotany is a study on how community of a particular region utilize of their indigenous plants. The use of plants by the world communities has a long history and depends very much on their practice, belief and knowledge. Ethnobotanical data are collected by the cooperation of local communities. At the end of this course, the knowledge of ethnobotany will be applied to enhance public awareness towards forest conservation and for sustainable forest management. The knowledge will also contribute to local community development by commercializing the valuable forest products.
Ethnobotanical data may also be used in drug discovery research to provide clues and chances of finding active compounds from plants as compared to random approach. This course also requires the understanding of several other fields, such as botany (for identification of plants and collection of voucher specimens), anthropology (to understand the origin, physical and cultural development, biological characteristics, social customs, and beliefs of humankind), ecology (for describing the environmental factors and habitat of plants), economy (to determine the value of various forest products), and ethno-medicine (for documentation of the information from traditional medicinal usage).

Learning Outcomes
Upon completion of this course, students are able to:
1) Provide an overview of the importance of tropical rain forest resources inherited from generation to generation.
2) Explain the relationship between humans and plants on the importance of study of ethnobotany.
3) Relate the culture, practices, customs, and beliefs of ethnobotany.
4) Plan a variety of methods, analyze and prepare documentation related to ethnobotany.

BBT308/3 Tropical Plant Ecology

This course is aim to give exposure to the students on multiple basic aspects of tropical plant ecology. Students will be introduced to the main component of tropical plants in Peninsular Malaysia. In depth discussion will be on the contribution, interaction and latest status of plant in a tropical region. Woody plant will be the main component studied as a basic knowledge for students in understanding the importance of plant to human, ecology and environment. Through the practical classes, this course will question students how a tropical plant and forest are studied in term of their importance. Finally, at the end of the course students can understand the overall importance of tropical plant and its relation to the health of tropical forest.

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

1) Understand basic composition of tropical forest flora referring to the types of forest in Malaysia.
2) Explain the relationship that exists and importance of tropical forest plants to other organisms.
3) Understand issues related to the management of forest and tropical forest vegetation contribution to the economy and human ecology.
4) Apply quantitative and qualitative sampling theory on the ecology of tropical forest plants.

BBT309/4 Plant Structure and Evolution

This course is aimed to guide students towards understanding principle of vascular plant structures including morphology and anatomy. The hands on observation of vegetative and reproductive organs modification related to adaptations towards several types of environment will be conducted through practical. The evolution of sexual diversity will also be discussed using the local plant for examples. Lectures are to emphasize on the vegetative development, pollination system, embryology, seeds dissemination and other factors that effect the survival and domination of plants on earth.

Learning Outcomes
Upon completion of this course, students are able to:
1) Understand the difference between systematic groups in the vascular plants, ferns, gymnosperms and angiosperms.
2) Explain evolutionary changes in plant structures in a way to learn the basic components of plant cells, tissues and organs and are subsequently able to relate this knowledge to the structure in a variety of specialized cells, tissues and functions.
3) Relate the life cycle of a seeded plant in a complex with the structures of plants that may be in different stages of plant breeding.
4) Adapt understanding of seeded plant anatomy and its evolution with other disciplines in biology, including taxonomy, cell biology, plant physiology, genetics, biochemistry and ecology.

BBT401/8 Project in Plant Biology

A final year research project that aims to expose students to research methods for solving various scientific questions related to Plant Biology field. At the end of this course, students are able to carry out scientific research in Plant Biology and present their research work in written thesis and scientific oral presentations.

Learning Outcomes
Upon completion of this course, students are able to:
1) Understand a research topic on plant biology.
2) Understand methods and protocols of doing laboratory analysis and handling equipment in the field and laboratory to obtain data related to plant biology.
3) Carry out scientific research in plant biology field and present their research work in written thesis and oral presentation.

4) Perform data analysis and interpretation.
5) Present scientific ideas clearly and effectively.

BBT402/3 Plant Genetics

The course is tailored to provide a comprehensive understanding in the area of plant genetics. Emphasis will be given on the areas of advanced Mendelian and non-Mendelian genetics (quantitative genetics) together with their application in agriculture. Various types of mutations and their consequences and also the behaviour of chromosomes in euploids and aneuploids will be discussed. The effect of transposition will also be discussed. Various types of plant breeding systems will also be discussed.
Emphasis will also be given on the areas of evolution and chromosomal changes, gene mutation, linkage and gene mapping as well as the application of recombinant DNA technology in plant. In addition the characteristics of the three plant genomes will be discussed. Answering evolutionary and plant population questions using numerous genetic / molecular approaches will be provided.

Learning Outcomes
Upon completion of this course, students are able to:
1) Describe Mendel's genetics and Mendelian genetics advanced stage extension and application of Mendelian genetics in agriculture.
2) Describe the behavior of chromosomes in euploids and aneuploids as well as eukaryotic gene biology and RNA processing, mobile genetic elements and their impact after the transposition and gene mapping on chromosome
3) Describe the factors that are required for Hardy-Weinberg equilibrium and in violation of the balance and the factors that contribute to phenotypic variation.
4) Relate the structure and function of three plant genomes.

BBT403/3 Plant Molecular Biology

Students will learn about the size and complexity of plant genome. Insights into the plant nuclear, plastid and mitochondrial DNA, their organization and interactions will be highlighted. They will also be exposed to the process and stages of embryogenesis, seed development and germination, the genes, hormones and regulation involved. One of the vital topics of plant biotechnology that is genetic engineering of plants will also be taught in which an overview about recombinant DNA technology, the strategies for transformation and controlling gene expression and case studies of genetically modified plants/crops will be discovered. The students will also be exposed to various components of a plant cells, functions and synthesis. The concept of differential gene expression will be discussed. The genetic basis of flowering, incompatibility, *Agrobacterium* infection leading to crown gall formation, and nitrogen fixing nodules in the roots will also be discussed.

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

1) Describe the process and the level of embryogenesis, seed development and germination, including genes involved, hormones and regulation involved at every level.
2) Distinguish nuclear DNA, plastid and mitochondrial plant, organization and interaction of each.
3) Explain the concepts of biotechnology, especially in genetic recombinant DNA technology, strategies for transformation and gene expression.
4) Demonstrate the function of various components of plant cell including membranes and formation of the cell wall.

BBT404/3 Economic Botany

This course covers relationship between plants and man. The lectures begin from the origins of agriculture to understanding that led to the influences of plants on the history, economy and culture of man. Aspects of plant diseases and their consideration concerning world problems about plant usage, food sources and the future of plants will be discuss in detail. Emphasis is also on evolution of cereal plants like rice, maize and wheat; centre of origin, Vavilor's theory about economic plants, the green revolution and problems of food resources. Last but not least, the module looks at plant genetic resources, erosion of plant genetic, resources variability and plant conservation.

Learning Outcomes
Upon completion of this course, students are able to:
1) Explain basic concepts and applications of economic botany.
2) Explain importance of plants to human history and culture as well as their economic importance.
3) Explain the significance of plant group, product, disease and genetic resources.
4) Explain the relationship between economic plant and human.

BBT405/3 Plant Tissue Culture

This course provides a comprehensive overview on various aspects of conventional and current development of plant tissue culture technology. Some of these techniques were used as tools for propagation of plantlets and germplasm conservation. The course also covers the history of plant tissue culture development, the basic requirements of a plant tissue culture laboratory, preparation of culture medium, the establishment of aseptic tissues, factors affecting 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 the area of plant biotechnology.

Learning Outcomes
Upon completion of this course, students are able to:
1) Understand various techniques of plant tissue culture and the need to establish a tissue culture laboratory.

2) Provide an overview of plant tissue culture to enhance plant propagation, preservation of germplasm and production of new hybrids.
3) Explain basic concepts, techniques and training of genetic manipulation of plants and applications in biotechnology.
4) Provide exposure to the application of tissue culture technology in the field of agro-industry.

BME401/3 Soil Microbiology

Soil microbiology study encompasses soil and the organisms living in it. This field of study includes 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 soil environment to the presence and functioning of species and communities of soil organisms Sustainable land use and management which affects soil organisms, methods of determining diversity and functioning of soil microorganisms, means to optimize land use and management towards development of specific soil organisms and their functions will be discussed further. Other topics for this course include soil ecosystem, measurement of soil microbial biomass and the diversity, energy transformations and metabolic activities of soil microbes, process control in soil, soil enzymes as indicators of ecosystem status, the rhizosphere and mycorrhizosphere, nitrogen fixation process and the principles of bioremediation.

Learning Outcomes
Upon completion of this course, students are able to:
1) Understand the principles of microorganismal behaviour in soil ecosystem.
2) Manage the soil and optimise it towards development of specific organisms and their functions.
3) Study the role of microorgansims in the soil ecosystem and identify microbial activity that has a huge impact on its surrounding.

BME402/3 Microbial Genomics

This course introduces fundamental concepts and related tools in microbial genomics and bioinformatics. The course emphasizes the strong interdependence of the field of genomics and bioinformatics. Genomics produces large scale data sets that require bioinformatic methods for analysis of raw DNA sequence data, data storage, handling and analysis. This course will also give students the ability to understand genome-based gene expression such as transcriptomics, proteomics as well as metagenomics and relate this knowledge to current applications in the field of microbiology.

Learning Outcomes
Upon completion of this course, students are able to:
1) Understand the process involved in the technology of genomics and bioinformatics, in addition to the characteristics and the evolution of microbial genome.
2) Analyse microbial genome using bioinformatics tools.

3) Apply basic knowledge on microbial genomes and bioinformatics processes in the study of microbiology and biotechnology.

BMT305/3 Microbial Physiology

This course begins with a discussion on microbial growth, aerobic and anaerobic metabolism, energy production, fermentation pathways, autotrophic metabolism. This course also introduces the following topics: cell constituents from chemical elements, macromolecule, biopolymer and its assembly to form cellular components like membrane dan flagella, regulation of macromolecule synthesis, the different types of regulation eg. feedback inhibition and repression, global control networks, microbial stress response and modern techniques to study microbial physiology.

Learning Outcomes
Upon completion of this course, students are able to:
1) Explain the basic concepts of microbial physiology.
2) Clarify basic concept on aerobic and anaerobic metabolism.
3) Apply basic knowledge on microbial physiology in cultivation of microorganisms.

BMT306/3 Virology

This course aims at giving better understanding and deeper knowledge of virology. The focus of discussion would be on the three major and largest groups of viruses which are bacteriophage, plant virus and animal virus. The molecular virology aspect of this course would take the students into the details 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 concepts in molecular virology.
2) Explain the importance of bacteriophage.
3) Discuss the importance of plant and animal virus and sub-viruses.

BMT307/3 Environmental Microbiology

The course emphasizes on the principles of microbial behavior 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) Understand the importance of microbial interactions and the effects on the environment.
2) Describe the principles of microbial behavior in an ecosystem.
3) Understand roles of microorganisms in the natural ecosystem and microbial activities which have economic and social implications.

BMT308/3 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 basic and special characteristics of different fungal classes.
2) Explain fungal life cycle and their role in the ecosystem.
3) Apply knowledge on fungus in the production of food, medicines and agriculture.

BMT309/3 Microbial Genetics

This course will discuss the basic concept and principles of microbial genetics which include characteristics of bacterial and viral chromosomes, mutagenesis and mutants, genetic transfer in bacteria such as transformation, transduction and conjugation, recombination and gene mapping using all of the above mechanisms. The characteristics and importance of plasmids and transposons will also be discussed. The second half of the course will discuss the principles of operons and gene regulations using the lactose, and tryptophan operons as well as the complexity of the bacteriophage genetic system as examples. The development of the field of microbial genomics and bioinformatics will also be covered.

Learning Outcomes
Upon completion of this course, students are able to:
1) Understand the characteristics of bacterial chromosomes and virus, mutagenic processes and DNA repair, gene transfer and DNA recombination, plasmid and transposon characteristics, principles of genetic regulation, bacteriophage genetics, microbial genomics and bioinformatics.
2) Analyse the relationship between each microbial genetic system and gene regulation.
3) Use basic knowledge on microbial genetics and gene regulation in future genetics and biotechnology research.

BMT310/3 Bacteriology

This course starts with brief discussion on prokaryotic (archaeae 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. Various groups of prokaryotes will be surveyed to relate their characteristics to their importance to daily life of other organisms. Finally discussion will be centered on methods of enrichment, isolation and maintenance/preservation of prokaryotic cultures.

Learning Outcomes
Upon completion of this course, students are able to:
1) Explain microbial feature of archaea and bacteria.
2) Show the existence of bacteria and archaea and explain the importance of culturing them.
3) Relate the characteristics of bacteria and archea and its importance to the life of other organisms.

BMT311/3 Immunology

This course describes the principles and basic concepts of immunology. The areas to be studied include the historical development and the scope of immunology, natural immunity, acquired immunity, the complement system, antigen, antibodies, antigen-antibody interactions, fundamental of cellular immunity responses, hypersensitivity (allergy) – immediate and late type, graft immunity, autoimmunity and immunity against cancer. The application of immunology in the development of diagnostic testing would also be included. The laboratory component would give the students the chances to simulate bacterial infection in animal models (chicken and rabbit). The students would assess the humoral immunity respond by using one of the diagnostic tests.

Learning Outcomes
Upon completion of this course, students are able to:
1) Explain basic concepts on immunology and immune disorders.
2) Apply basic immunological to face infection and immunity.
3) Apply basic immunological knowledge in diagnostic tests.

BMT401/8 Microbiology Project

A final year research project that aims to expose students to research methods for solving various scientific questions related to Microbiology field. At the end of this course, students are able to carry out scientific research in Microbiology Project and present their research work in written thesis and scientific oral presentations.

Learning Outcomes
Upon completion of this course, students are able to:
1) Understand a research topic on Microbiology Project.
2) Understand methods and protocols of doing laboratory analysis and handling equipment in the field and laboratory to obtain data related to Microbiology Project.
3) Carry out scientific research in microbiology field and present their research work in written thesis and oral presentation.
4) Perform data analysis and interpretation.
5) Convey/present scientific ideas clearly and effectively.

BMT402/3 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 epidemiological concepts, pathogenesis, interaction between host cell and pathogen, bacterial infection, fungi and virus, isolation and identification, chemotherapy and resistance.
2) Explain the concept of vaccine development, development of anti-virus and gene therapy.
3) Isolate and identify pathogenic microorganisms including bacteria and fungi (dermatophytes).

BMT403/3 Industrial Microbiology

The course provides theoretical and practical exposures to the students about the relationship among biochemistry, physiology, nutrition and growth of industrially importance microorganisms especially bacteria, streptomycetes, yeasts and fungi. 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. Besides that, fermentation products by submerged and solid substrate fermentations in suitable fermentors, followed by the downstream processes in products recovery will be discussed. Roles of microorganisms in food and beverage, pharmaceutical, agriculture, biomining and in management of industrial waste treatment and oil spill will also be discussed. Last but not least, the understanding on ethical issues in production microbiology such as standards laboratory procedures, Biological Safety Acts and in-plant responsibility will be emphasized.

Learning Outcomes
Upon completion of this course, students are able to:
1) Understand and competent in isolation techniques, selection, cultivating and maintenance of industrially important microoganisms.
2) Explain the concept of producing desired products using special microbes and its optimum cultivation in submerged and solid-state fermentation at laboratory and industrial scale, undestand downstream processing and recovery of products.
3) Apply microorganisms in treatment of environmental pollutions, industrial and agricultural wastes, the advantage of using microorganisms in the production of industrial foods and drinks, pharmaceutical and biomining.
4) Understand the ethical issues in the manipulation of microorganisms and the production of microbial products for humans.

BZT304/3 Invertebrate Zoology

This course will discuss numerous aspects of invertebrate zoology, namely on classification and phylogeny, species evolution, invertebrates 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.

Learning Outcomes
Upon completion of this course, students are able to:
1) Identify phylogeny species of invertebrates.
2) Distinguish features based on invertebrates general appearance, function, system and life cycle.
3) Know the diversity, evolution, function and adaptation of invertebrates in various ecosystems.
4) Build the classification of invertebrates such as Protozoa, Porifera, Cnidaria, Nematoda, Platyhelminthes, Mollusca, Echinodermata, Arthropoda and Annelida.

BZT305/3 Vertebrate Zoology

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) Describe the historical background, the main scientists and the earliest principles of vertebrate zoology.
2) Differentiate between various leading group in the vertebrate animals.
3) Describe the diversity, evolution, function, adaptation and conservation of vertebrate animals.
4) Understand vertebrate distribution and their ecological functions.

BZT306/3 Animal Behaviour

This course will introduce animal behaviour by reflecting on the history and development of this field, especially in relation to the contribution to leading figures of animal behaviour research such as Niko Tinbergen dan Konrad Lorenz. The course will then lead students to understand two appoaches in animal behaviour, which are the ultimate and proximate causations. The differences, weakness and strengths of both approaches will be discussed. The relationship between animal behaviour and the fields of genetics, evolution and ecology will also be emphasized.

Learning Outcomes
Upon completion of this course, students are able to:
1) Understand the history and development of the field of animal behavior.
2) Distinguish the ultimate and proximate concepts in animal behaviour.
3) Relate the concept of animal behavior with the principles of evolution, ecology and animal genetic.

BZT307/3 Animal Physiology

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) Understand the basic concepts and history of animal physiology.
2) Explain the concept of homeostasis regulators.
3) Identify the muscular system, circulatory, nervous, sensing, endocrine, digestion, water balance and animal breeding.
4) Identify the concepts of anatomy and comparative physiological functions in animals.

BZT308/2 Animal Taxonomy Practical

Students will be given an exposure in basic animal classification of invertebrates and vertebrates, adaptation and structural comparison and anatomy of animals to survive in their respective environments. Students will examine museum specimens, learn through video presentation and field visits. Students will conduct a short research on classification and life cycle of selected animal in the laboratory and in the field. At the end of the practical, students are expected to be able to understand the practical approach in basic taxonomy and classification of animals.

Learning Outcomes

Upon completion of this course, students are able to:

1) Identify and be able to classify animals into phyla level and the level of taxonomic classes, based on morphological characteristics.
2) Identify the structures of the animal body and their functions.
3) Analyz the importance of organizational aspects of the animal's body, including symmetry, the layers of the body, body cavities, segmentation, appendage and organ system.
4) Demonstrate concepts (the cycle of life, way of life) associated with the biology and natural history of animals.

BZT309/2 Animal Physiology and Behaviour Practical

This course exposes students to important aspects of the physiology and behaviour of animals. Using a combination of laboratory classes, mini-project and seminar-styled presentations, students will be taught various laboratory techniques, research-based data collection as well as effective presentation of scientific data. At the end of this course, students should be able to conduct physiology based laboratory experiments, carry out scientific literature searches and experimentation for an animal behaviour topic, and give an effective scientific presentation with effective presentation skills.

Learning Outcomes

Upon completion of this course, students are able to:

1) Recognize and understand some basic concepts of physiology and animal behaviour.
2) Understand how to perform practical and using the laboratory equipment to obtain data on several aspects of animal physiology.
3) Gain experience running a project on animal behaviour.
4) Demonstrate skills for data analysis and interpretation.
5) Demonstrate skills of scientific presentations.

BZT401/8 Project in Animal Biology

A final year research project that aims to expose students to research methods for solving various scientific questions related to Animal Biology field. At the end of this course, students are able to carry out scientific research in animal biology and present their research work in written thesis and scientific oral presentations.

Learning Outcomes
Upon completion of this course, students are able to:
1) Understand a research topic on Animal Biology.
2) Understand methods and protocols of doing laboratory analysis and handling equipment in the field and laboratory to obtain data related to Animal Biology Project.
3) Carry out scientific research in Animal Biology field and present their research work in written thesis and oral presentation.
4) Perform data analysis and interpretation.
5) Convey/present scientific ideas clearly and effectively.

BZT402/3 Biology of Vertebrate Pest Animals

This course will discuss on numerous factors which allow classes of vertebrates to live as pest populations and various steps taken to control them, namely physical, chemical, mechanical and biological controlling methods as well as reduction of their source of food and regulatory control measures. Within the context of chemical control, aspects of action, toxicity, physiology and pesticide technology as well as its effect on environment and magnification will be discussed. Combinations of two or more methods of control to manage vertebrate pests, and the best possible approach and its effects on the ecological, environmental and economical aspects will also be discussed.

Learning Outcomes
Upon completion of this course, students are able to:
1) Identify the factors that allow a diverse group of vertebrates to evolve as pests
2) Explain the importance of vertebrates pest in urban areas, agriculture and secondary growth areas
3) Differentiate between various approaches or methods in the control of vertebrates pest
4) Understand effective scientific framework for the control of vertebrate pests

BZT403/3 Plant Animal Interaction

This course will focus on the basic principles of plant-animal interactions. The students are exposed to a deeper understanding and discussion on the level of interaction. Some of the types of interactions that are discussed are symbiosis, mutualism, predation, granivory. This course re-examines all of these interactions from both the perspective of animals and plants. This course also 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) Describe the interaction between plants and animals (for example, mutualism andantagonism).
2) Understand the effects of interaction in terms of evolution and ecology
3) Understand and practise scientific method (through laboratory and field work)

BZT404/3 : Animal Conservation Genetic

This course emphasizes the application of population genetics and molecular analyses to answering biological questions in animal conservation. This course will cover topics on basic concepts and fundamentals of conservation genetics of animals including values of biodiversity and could be categorized into three parts, i.e. loss of biodiversity, principles and analyses of conservation genetics, and genetics and conservation.

Learning Outcomes

Upon completion of this course, students are able to:

1) Identify the main sources of genetic variation in animals and describes the relationship between genetic diversity and population viability of wild animals.
2) Describe summary of theory, the basic approach of laboratory and analytical techniques to study the genetic markers such as microsatellites, single nucleotide polymorphisms and DNA sequence
3) Explain the concept and calculation / statistical parameter variability in a population, such as polymorphism, Heterozygosity, allelic diversity, effective population size and Hardy-Weinberg equilibrium equation
4) Describe how genetic principles and techniques that can be used in the management and conservation of wild animals in captive breeding, solving taxonomic ambiguity, detect hybridization, defines the management, and forensic investigations.

BOE400/2 Special Topics in Biology

Each student will be assigned a topic and supervised by a lecturer at the beginning of semester 1 or semester 2 (4^{th} year of study). The students will be introduced to written research assignments related to the project proposed by the supervisor. The students will also be trained to make a literature survey. At the end of the semester, each student is required to write an essay and present their written research assignment. The evaluation of this course will be based on the essay, oral presentation and evaluation by supervisor based on student's effort (discussion and log book) in completing tasks given.

Learning Outcomes

Upon completion of this course, students are able to:

1) Understand the best method for collecting information based on scholarly journals and texts that can be used in conducting their scientific research.
2) Logically and analytically analyze the findings published in scholarly journals.
3) Communicate scientifically to deliver effective oral and written reports.

BOA301 /1 Industrial Training

Industrial tranning will be carried out for 8 weeks in semester 2 during the 3^{rd} year. Students will be assigned in the industry, government and private agencies/ institutions. From industrial tranning, students will be exposed to working environment. The final assessment of students after completing this course is only pass or fail.

Learning Outcomes
Upon completion of this course, students are able to:
1) Apply knowledge learned in lectures into real working environment.
2) Practice knowledge, skill and capability.

BOE201/3 Biological Instrumentation

This course is divided into two parts, namely theory and practical, with emphasis being given to the practical aspects. Among the principles/techniques that will be dicussed are assay principles, extraction and purification and analysis such as Kjeldahl, spectrophotometry, electrophoresis and chromatography. Emphasis will be given to the use of extractor equipment (Kjeldahl, atomic spectrophotometer, UV/Vis, flame photometer and pH, CO_2, & O_2 meters). This course is geared for students who are interested in courses that involve the study and efficient use of laboratory equipment in research.

Learning Outcomes
Upon completion of this course, students are able to:
1) Understand the theoretical principles of laboratory equipments such as centrifuge, spectrophotometer, electrophoresis, freeze dryer, atomic absorption spectrophotometer (AAS), gas chromatrography, flame photometer and other analysis equipments.
2) Understand the techniques and use of laboratory equipments.

BOT205/3 Microscopy and Histological Techniques
Applications of light, colour and electromagnetic wave in microscopy; basic principles of bright-field, dark-field, phase contrast, fluorescence, confocal and electron microscopes will be taught. Concepts such as magnification, resolution, contrast, image formation, numerical aperture, illumination, and depth of field will be elaborated. Basic histopathology of animals and plants dealing with the structures of cells, tissues and organs in relation to their functions will be taught and discussed. Students will be given extensive laboratory demonstrations on the different techniques of microscopy and also perform techniques in fixation and preservation of specimens, staining and sectioning, construction and use of the microtome and the preparation of histological slides.

Learning Outcomes
Upon completion of this course, students are able to:
1) Explain the basic principles on the main functions of microscope (magnigication, resolution and contrast) and to identify, compare and distinguish microscopy images by different techniques.
2) Explain the basic principle on different histological techniques through slide preparation and staining of samples from animals and plants.
3) Manage bright field microscopy; perform general staining and basic histological techniques with confidence.
4) Critically evaluate new applications in microscopy and histological techniques with the use of basic principles simultaneously with latest developments.

Index

SCHOOL OF CHEMICAL SCIENCES

SCHOOL OF CHEMICAL SCIENCES
(https://chem.usm.my)

VISION

To realise the aspiration of Universiti Sains Malaysia in Transforming Higher Education for a Sustainable Tomorrow.

MISSION

- To produce chemistry graduates who are knowledgeable, highly skilled, well-mannered and possess excellent work ethics suited for the requirements of the public and industrial sectors.
- To provide chemistry students with quality education.
- To instill awareness among chemistry students towards the welfare of the society.
- To provide modern facilities for chemistry teaching and research.
- To attract excellent students from Malaysia and overseas to study chemistry.

OBJECTIVES

- To provide a broad, balanced and in depth education in chemistry and related areas at the undergraduate level.
- To develop students into graduates with theoretical and practical knowledge and the ability to apply the knowledge for employment to further studies in chemistry or other related post graduate programmes.
- To develop students with various skills including practical, social, communicative, leadership and entrepreneurial skills.
- To develop students with the ability to assess and solve problems critically, logically and creatively.

INTRODUCTION

The School of Chemical Sciences (SCS), established in 1969, is one of the pioneering Schools of USM. With an academic staff of more than 38 and over 44 supporting staff, the School has been entrusted to provide professional training in chemistry to meet the demands of the industries and society.

The programme is designed not only to produce graduates with a solid knowledge of chemistry but also to equip them with attributes so that they can adapt readily to a dynamic and rapidly developing working environment. The academic programmes, Bachelor of Science with Honours, B.Sc. (Hons.) and Bachelor of Applied Science B.App.Sc. (Hons.) from the School of Chemical Sciences, USM are planned to produce graduates who are knowledgeable, highly skilled, well-mannered and possess excellent work ethics suited for the requirements of the industrial and public sectors.

In line with this aspiration, the School of Chemical Sciences has designed courses which can be modified and adjusted from time to time to suit the requirements of an unpredictable future. The School practice a system which is liberal and multi-disciplinary in nature.

Our programmes are recognised nationally by the Malaysian Institute of Chemistry (Institut Kimia Malaysia), and internationally by the Royal Society of Chemistry starting from the Academic Session of 2015/2016 to 2020/2021.

PROGRAMMES OFFERED

The School offers two undergraduate programmes leading to:

- Bachelor of Science (B.Sc.) with Honours degree.
- Bachelor of Applied Science (B.App.Sc.) with Honours degree, majoring either in Analytical Chemistry or Industrial Chemistry.

These programmes include 8 weeks of industrial training with industrial partners, commercial and research laboratories. Students are also encouraged to register for the final year research project (which covers 2 semesters) during their final year.

The postgraduate programmes offer the research mode leading to M.Sc. and Ph.D. or the mixed-mode M.Sc. (Chemical Instrumentation) which have managed to attract fellow Malaysians and many foreign nationals.

PROGRAM AIMS

PURE CHEMISTRY

To nurture dynamic, respected and referred chemists who are socially responsible in supporting national and global aspirations in science, technology and innovations for a sustainable tomorrow.

ANALYTICAL CHEMISTRY

To nurture dynamic, respected and referred analytical chemists who are socially responsible in supporting national and global aspirations in science, technology and innovations for a sustainable tomorrow.

INDUSTRIAL CHEMISTRY

To nurture ethical, referred and respected industrial chemists who contribute to the current industrial needs and development of the country in supporting the social, economic and environmental well- being of the nation.

SPECIALISATION

The School has been given priority in creating a healthy research environment with a total of over 88 postgraduate students engaging in various areas of research including natural products, organic synthesis, nanoscience, electrochemistry, liquid crystals, organometallics, environmental chemistry, materials chemistry and chemical education. Many of our academic staff has been well endowed with research grants and funding from government bodies and industries to support these research activities.

MAIN ADMINISTRATIVE STAFF

DEAN

Prof. Dr. Rohana Adnan

DEPUTY DEANS

Assoc. Prof. Dr. Melati Khairuddean
(Academic, Career & International)

Assoc. Prof. Dr. Oo Chuan Wei
(Research, Innovation & Industry-Community Engagement)

PROGRAMME MANAGERS

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(Physical Chemistry)

Dr. Mohd Rizal Razali
(Organic & Inorganic Chemistry)

Dr. Faiz Bukhari Mohd. Suah
(Analytical Chemistry)

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

ASSISTANT REGISTRAR

Mr. Subramaniam Govindan
Principal Assistant Registrar
(HR & Postgraduates)

Ms. Fauziah Rastam
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MAJOR EQUIPMENTS	**LOCATION (G09/G09A)**	**TELEPHONE EXTENSION**
Analytical Services and Testing Laboratory (MUPA)	017	4057/4058/4059
Atomic Absorption Spectrometer (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 Spectrometer (FTIR)	370	3577/5032
Gas Chromatography (GC)	MUPA, 274 & K213	4059/4040/4493
Gas Chromatography-Mass Spectrometer (GC-MS)	MUPA	4059
Gel Permeation Chromatographs (GPC)	K113	4038
High Performance Liquid Chromatograph (HPLC)	K319	-
Liquid Chromatography-Mass Spectrometer (LCMS)	MUPA	4059/4058
Nuclear Magnetic Resonance Spectrometer (NMR 400 & 500 MHz)	032	3589
Polarised Optical Microscope (POM)	366	-
Porosimeter	166	-
Thermogravimetric Analysers (TGA)	K013	4059
Total Organic Carbon Analyser (TOC)	364	-
Ultraviolet-Visible Spectrophotometers (UV-VIS)	175, 367 & 244	-

GENERAL INFORMATION

Careers

The School of Chemical Sciences was established in 1969 and has produced quality graduates who possess experience and skills in line with the programmes offered. The School is staffed with experienced lecturers and equipped with modern instruments in both teaching and research laboratories. As such, the graduates can pursue careers in public agencies such as the Malaysian Palm Oil Board (MPOB), Malaysian Agricultural Research and Development Institute (MARDI), Rubber Research Institute of Malaysia (RRI), Forestry Research Institute Malaysia (FRIM) and Jabatan Kimia Malaysia (JKM). Graduates can also work in scientific instrument companies such as Perkin Elmer. In addition, there are opportunities for graduates to serve as chemists and engineers in the electronics industry, such as Intel, Infineon, Osram and Silterra. Graduates can also venture into other fields or pursue postgraduate degrees at the School of Chemical Sciences.

Alumni of the School of Chemical Sciences

All graduates of the School of Chemical Sciences are automatically members of the Chemistry Alumni. It is hoped that participation in activities organised by the Chemistry Alumni Association of the School of Chemical Sciences will foster better relationship and cooperation among members and the School for the benefits of all. It is hoped that nostalgia and love towards the alma mater can be brought back through the Chemistry Alumni.

All graduates of the School of Chemical Sciences can update their information or register as members using the on-line form via http://chem.usm.my/.

AWARDS AND DEAN'S CERTIFICATE

(a) **Royal Education Award by the Malaysian Rulers' Council**
For the best final year students in all fields.

(b) **Tuanku Chancellor Gold Medal Award**
For the best final year student in all fields.

(c) **USM Gold Medal Award (awarded by Woman's Association USM)**
For the best female final year student in all fields.

(d) **USM Gold Medal Award (awarded by Tun Dato' Seri Dr. Lim Chong Eu)**
For the best final year student in the Bachelor of Science.

(e) **USM Gold Medal Award (awarded by Chemical Company of Malaysia Bhd. - CCM)**

For the best final year student in the field of Chemistry.

(f) **USM Book Award (awarded by Hoechst Malaysia Sdn. Bhd.)**

For the best final year student in the field of Industrial Chemistry.

(g) **Dean's Certificate** will be awarded to any student in the School of Chemical Sciences who 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

1. Mr. Amir Hamzah Bin Yasak
   ESPEK Sdn. Bhd.
2. Mdm. Syazrin Syima Sharifuddin
   National Hydraulic Research Institute of Malaysia (NAHRIM)
3. Mr. Lye Poh Huat
   Penchem Technologies Sdn. Bhd.

POSTGRADUATE STUDIES

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

(a) Full-time or part-time programme leading to degrees in Master of Science and Doctor of Philosophy by research.

(b) Full-time or part-time mixed-mode programme (a combination of course work and research) leading to a Master of Science degree.

Further information can be obtained from the Institute of Postgraduate Studies, USM.

FACILITIES

The School is equipped with teaching and research laboratories. Existing analytical and characterisation instruments include the NMR (500 MHz for liquid state analysis), ICP-MS, ICP-OES, GCMS, LCMS (TOF), DSC/TGA, TOC, GPC, CHN Analyser, HPLC, GC, FTIR with Microscope, UV-Vis, FTIR, AAS and Fluorescence spectrophotometers, Electrochemical systems and Surface Area Analyser, Guoy-Balance, POM and other supporting equipments. The School is also equipped with Electronics and Glass-Blowing Workshops.

The expertise and facilities available in the School of Chemical Sciences are always tapped by the industries and government agencies in solving their problems. In line with the desire to improve the consultation services, the School of Chemical Sciences has taken a proactive step by setting up an Analytical Services and Testing Laboratory (MUPA) in the year 2000, which offers effective services for the industrial sectors.

COURSE STRUCTURE

(i) Structure of Study Programme

Course Component	Credit Requirement B.Sc. (Hons.)
Core **(T)**	70
Elective **(E)** or Minor **(M)**	32
University **(U)**	18
Total	**120**

(ii) Industrial Training

Students are encouraged to apply for Industrial Training (KIE361/4) after the 6th semester.

(iii) Final Year Project

Students are encouraged to register for Chemistry Project (KUE409/6) during their final year of studies. This involves conducting research work for 2 semesters and submitting a Final Year Project report.

Students who do not wish to register for the Chemistry Project (KUE409/6) may fulfill the 6 credits requirement by registering other theory courses offered by the School.

(iv) Assessment

Course assessment will be based on:

a) Examination
b) Course Work

The assessment will cover the knowledge, applications, analytical and writing skills. Skills will be assessed through the course work in the form of assignments,quizzes, tests, presentations or laboratory report.

LIST OF COURSES OFFERED

B.Sc. (Hons.) (Chemistry)		
(i) Core Courses (T) - 70 Credits		
Selection of 3 or 4 credits		**Pre-requisites**
ZCT103/3	Physics III (Vibrations, Waves and Optics)	
BOM114/4	Fundamental Genetics	
Compulsory - 61 Credits		**Pre-requisites**
MAA101/4	Calculus for Science Students 1	
MAA102/4	Calculus for Science Students 2	
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)
KFT233/4	Physical Chemistry I	KTT112 (s) or KOT122 (s)
KAT245/4	Analytical Chemistry I	KTT112 (s) or KOT122 (s)
KUT304/2	Physical Chemistry Practical	KUT102 (s), KFT332 (c)
KUT305/2	Analytical Chemistry Practical I	KUT101 (s), KAT349 (c)
KTT313/3	Inorganic Chemistry III	KTT212 (s)
KFT332/3	Physical Chemistry II	KFT233 (s), KUT304 (c)
KAT349/3	Analytical Chemistry II	KAT245 (s), KUT305 (c)
KUT407/2	Inorganic and Analytical Chemistry Practical	KUT203 (s), KUT305 (s)
KUT408/2	Physical and Organic Chemistry Practical	KUT206 (s), KUT304 (s)
KOT423/3	Organic Chemistry III	KOT222 (s)
KFT431/3	Physical Chemistry III	KFT332 (s)
Selection of 6 credits		
KUE409/6 or 6 credits	Chemistry Project Or Other theory courses from Analytical Chemistry, Industrial Chemistry and Pure Chemistry.	

(ii) Elective Courses (E) - 32 credits		
(a) Selection of 5 credits or more		
ZCT104/3	Physics IV (Modern Physics)	
BOM111/4	Biodiversity	
BOM112/4	Basic Ecology	
KUE306/2	Research Methodology in Chemistry - *(Compulsory)*	
(b) Selection of 9 credits		**Prerequisites**
KOE322/3	Natural Products*	KOT222 (s)
KTE411/3	Selected Topics in Inorganic Chemistry	KTT212 (s)
KOE423/3	Selected Topics in Organic Chemistry*	KOT222 (s), KUT408 (s)
KFE432/3	Special Topics in Physical Chemistry	KFT332 (s)
(c) Selection of 18 credits or more		
KIE361/4	Industrial Training	
Additional of **14** or **18 credits** to fulfill the elective component must be taken from Analytical Chemistry, Industrial Chemistry and other courses from the School of Physics, Mathematical Sciences, Biological Sciences, Industrial Technology or Centre for Global Archaeological Research.		

(s) = sequential (course must be taken earlier)
(c) = concurrent (course can be taken concurrently)
* = offer in alternate year

(iii) Minor (M) & Elective (E) Programme – 32 credits		
Elective (E) Components		
(a) Selection of 12 credits		**Prerequisite**
ZCT104/3	Physics IV (Modern Physics)	
BOM111/4	Biodiversity	
BOM112/4	Basic Ecology	
KIT257/3	Materials Chemistry	
KUE306/2	Research Methodology in Chemistry – *(Compulsory)*	
KOE322/3	Natural Products*	KOT222 (s)
KAT345/4	Spectroscopic Methods	KAT245 (s)
KIT358/3	Polymer Chemistry	KOT122 (s)
KIE361/4	Industrial Training	
KTE411/3	Selected Topics in Inorganic Chemistry	KTT212 (s)
KOE423/3	Selected Topics in Organic Chemistry*	KOT222 (s), KUT408 (s)
KFE432/3	Selected Topics in Physical Chemistry	KFT332 (c)
KAE445/3	Bioanalysis	KAT344 (s) or KAT349 (s)
KIE456/3	Food and Palm Oil Chemistry	
KIE458/3	Current Topics in Industrial Chemistry	
KIT458/3	Chemical Processing	KTT112 (s), KOT122 (s)
Minor (M) Components		
(c) Selection of 20 credits		
Select from any minor programme. Please refer to the book of Minor Programme Guideline.		
All Minor Programmes offered by other Schools can be taken by the Chemistry Students subject to the requirements imposed by the School which offers the Minor Programmes such as Management, Computer, Communication, Psychology, English or other Sciences.		

All the courses offered are subjected to changes when the need arises.
(s) = sequential (Course must be taken earlier)
(c) = concurrent (Course can be taken concurrently)
* = offer in alternate year

Proposed Schedule by Semester

B.Sc. (Hons.) (Chemistry)

YEAR 1					
COMPONENT	**SEMESTER 1**		**SEMESTER 2**		**CREDIT**
	CODE	**CREDIT HOURS**	**CODE**	**CREDIT HOURS**	
University Courses (U)	Refer to page 31-43	3	Refer to page 31-43	3	
	WUS101	2	HTU223	2	
Core Courses (T)	KTT112	4	KOT122	4	
	KUT101	2	KUT102	2	
	MAA101	4	MAA102	4	
TOTAL CREDIT HOURS		**15**		**15**	**30**

YEAR 2					
COMPONENT	**SEMESTER 3**		**SEMESTER 4**		**CREDIT**
	CODE	**CREDIT HOURS**	**CODE**	**CREDIT HOURS**	
University Courses (U)	SHE101	2	LSP300	2	
Core Courses (T)	KOT222	3	KTT212	3	
	KAT245	4	KFT233	4	
	KUT203	2	KUT206	2	
	ZCT103 (option)	3	BOM114 (option)	4	
Elective (E) or Minor (M) Courses	Elective / Minor	3	Elective / Minor	4	
TOTAL CREDIT HOURS		**14/17**		**15/19**	**32/33**
YEAR 3					

COMPONENT	SEMESTER 5		SEMESTER 6		CREDIT
	CODE	CREDIT HOURS	CODE	CREDIT HOURS	
University Courses (U)	LKM400	2	LSP402	2	
Core Courses (T)	KTT313	3	KFT332	3	
	KAT349	3	KUT304	2	
	KUT305	2			
Elective (E) or Minor (M) Courses	KUE306	2	Elective / Minor	9	
	BOM111 / BOM112 (option)	4	ZCT104 (option)	3	
TOTAL CREDIT HOURS		**12/16**		**16/19**	**31/32**

YEAR 4					
COMPONENT	SEMESTER 7		SEMESTER 8		CREDIT
	CODE	CREDIT HOURS	CODE	CREDIT HOURS	
University Courses (U)					
Core Courses (T)	KUE409	3	KUE409	3	
	KFT431	3	KOT423	3	
	KUT408 / KUT407	2	KUT407 / KUT408	2	
Elective (E) or Minor (M) Courses	Elective / Minor	3	Elective / Minor	4	
	KIE361 / Elective / Minor	4			
TOTAL CREDIT HOURS		**15**		**12**	**27**
GRAND TOTAL CREDIT HOURS					**120/122**

Program Learning Outcomes: Upon completion of this programme, students will be able to:

PO1	**Knowledge (of the discipline)**	• Apply fundamental knowledge of chemistry to chemistry related practices.
PO2	**Practical Skills (of the discipline)**	• Perform safe handling of chemicals and proficient manipulation of laboratory apparatus and analytical instruments.
PO3	**Social Skills and Responsibilities**	• Demonstrate social skills and responsibility for the well-being of society.
PO4	**Values, Attitudes and Professionalism**	• Balance and uphold positive values, ethics and accountability in societal and professional engagement.
PO5	**Communication, Leadership and Teamwork Skills**	• Lead and collaborate with diverse team members and demonstrate effective communication.
PO6	**Problem Solving and Scientific Skills**	• Provide practical solutions to chemistry related issues by employing appropriate and relevant chemistry knowledge and skills.
PO7	**Information Management and Life-long Learning Skills**	• Manage information and seek new knowledge and skills independently.
PO8	**Managerial & Entrepreneurial Skills**	• Display relevant and appropriate managerial and entrepreneurial skills.

SYNOPSIS OF COURSES

KUT101/2 General Chemistry Practical I

General chemistry practical on theory involving inorganic and analysis chemistry. Separation of the Components of a Mixture. Chemical Formulas. Chemical Reactions of Copper and Percent Yield. Titration of Acids and Bases. Analysis of Water for Dissolved Oxygen. Preparation of Sodium Bicarbonate and Sodim Carbonate. Gravimetric Determination of Phosphorus in Plant Food. Titration Curves of Polyprotic Acids. Determination of the Solubility-Product Constant for a Sparingly Soluble Salt. Preparation and Reactions of Coordination Compounds: Oxalate Complexes. Oxidation - Reduction Titration II: Analysis of Bleach. Microscale Chemistry Experiments Titration of Acid and Bases

Learning Outcomes

Upon completion of this course, students are able to:

1. Demonstrate competency in appropriate basic laboratory techniques in analytical and inorganic chemistry.
2. Interpret data from laboratory observations and measurements with appropriate use of chemical equations and calculations.
3. Display safe laboratory practices.
4. Write reports clearly, concisely and appropriately.

KUT102/2 General Chemistry Practical II

The General Chemistry Practical II contains two parts which are the organic part and the physical part. This subject applies theoretical knowledge in practice to understand the methods of measuring and recording the experiment data in a clear, concise, and appropriate manner, from laboratory observations and measurements as follows;

1. Stereochemistry
2. Extraction & Crystallization using Acid Base Properties
3. Paper Chromatography - Separation of Cation & Dyes
4. Determination of the Dissociation Constant of a Weak Acid
5. Preparation of Aspirin and Oil of Wintergreen
6. Analysis of Aspirin
7. Behaviour of Gases: Molar mass of Vapor
8. Determination of R: The Gas Law Constant
9. Colorimetric Determination of an Equilibrium Constant in Aqueous Solution
10. Heat of Neutralization
11. Rate of Chemical Reaction I: A Clock Reaction
12. Rate of Chemical Reaction I: Rate and Order of H_2O_2

Learning Outcomes

Upon completion of this course, students are able to:
1. Demonstrate competency in appropriate basic laboratory techniques in organic and physical chemistry.
2. Interpret data from laboratory observations and measurements with appropriate use of chemical equations and calculations.
3. Display safe laboratory practices.
4. Write reports clearly, concisely and appropriately.

KTT112/4 Inorganic Chemistry I

This course will introduce topics in basic chemistry such as stoichiometry, atomic structure, nuclear chemistry, periodic table, chemical bonding and properties of matter.

Learning Outcomes

Upon completion of this course, students are able to:
1. Apply the knowledge of stoichiometry to discuss and solve problems on stoichiometric problems.
2. Apply the knowledge of the atoms in the periodic table to discuss the relationship between the elements in the group and in a particular period.
3. Apply the Bohr Theory and wave mechanics to understand the electronic configuration and bonding theory in chemical bond formation.
4. Apply the knowledge of nuclear chemistry to explain radioactive decay and to understand the safe and unsafe uses of radioactive elements.
5. Apply the knowledge of structures, properties of solids to explain the various types of materials.

KOT122/4 Organic Chemistry I

Electronic structure and bonding. Acids and bases. An introduction to organic compounds: functional groups, nomenclature and representation of 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 the organic chemistry principles in order to explain the stereochemistry of the organic reactions.

KUT203/2 Inorganic Chemistry Practical KUT101 (s)

Basic techniques of preparation and characterisation of the inorganic compounds. This course includes the following list of experiments. Students need to carry out the experiments selected from the list by referring to the Practical Manual KUT203:

1. Studies on a metal complex, potassium trioxalatoaluminate(II) trihydrate, $K_3[Al(ox)_3].3H_2O$.
2. Preparation and conductivities of complex compounds $[Co(NH_3)_4CO_3]NO_3$ and $[Co(NH_3)_5Cl]Cl_2$.
3. Synthesis of bis (triphenylphosphine) copper(II) borohydride, $(Ph_3P)_2CuBH_4$.
4. Complex ion composition using Job's method.
5. The chemistry of vanadium.
6. Electronic spectra of coordination compounds.
7. Preparation and resolution of tri (ethylenediamine) cobalt (III) ion into its optical antipodes.
8. Characterisation of the linkage isomers: nitropentaaminecobalt (III) chloride, $[Co(NH_3)_5NO_2]Cl_2$ and nitritopentaaminecobalt(III) chloride, $[Co(NH_3)_5ONO]Cl_2$.
9. The electronic spectra of some copper(II) complexes.

Learning Outcomes

Upon completion of this course, students are able to:
1. Demonstrate the common techniques on the synthesis of inorganic compounds and methods of characterisation.
2. Interprete data associated with the synthesis and the products obtained at laboratory scale.
3. Use the data obtained to illustrate the inorganic chemistry principles.
4. Demonstrate safety practices in inorganic laboratory.
5. Write reports following the appropriate format.

KUT206/2 Organic Chemistry Practical KUT102 (s), KOT122 (s)

Basic organic techniques in chromatography (thin-layer, column and gas-liquid), fractional distillation, extraction and isolation techniques, spectroscopy (NMR, IR, UV & MS) and classical qualitative analysis are introduced through a series of compulsory experiments. This is followed by several experiments which expose the students to a selection of techniques in physical organic chemistry (such as the investigation of resonance energy related to unsaturated α, β carbonyl system) and preparative organic

chemistry involving some distinct reactions, e.g. the Diels-Alder, pinacol-pinacolone rearrangement and the Michael conjugate addition.

Learning Outcomes

Upon completion of this course, students are able to:
1. Demonstrate competency when conducting and applying various separation techniques
2. Deduce the structures of simple organic compounds from their chemical and physical characteristics using the IR and NMR spectra.
3. Perform various multi-step small scale syntheses including purification of the end products.
4. Write reports clearly and appropriately for all the experimental reactions conducted.
5. Display safe laboratory practices.

KTT212/3 Inorganic Chemistry II **KTT112 (s)**

Introduction on transition metal complexes and coordination chemistry. Structure, isomerism and nomenclature, formation constant for transition metal complexes, preparation of coordination compounds and spectroscopy, bonding theory in the formation of transition metal complexes, introduction on the reaction mechanism, transition metal complexes in organometallic and basic concept on group theory.

Learning Outcomes

Upon completion of this course, students are able to:
1. Describe all the fundamental properties and characteristics related to the transition metals and their complexes.
2. Apply the knowledge of coordination compounds to explain the formation of metal-ligand complexes.
3. Apply various chemical bond theories to explain the compounds containing metal-ligand and metal-metal bonding.
4. Apply the knowledge of coordination chemistry in reaction mechanisms, organometallics and group theory.

KOT222/3 Organic Chemistry II **KOT122 (s)**

Identification of organic compounds: mass spectrometry, infrared spectroscopy, ultraviolet/visible spectroscopy and NMR spectroscopy. Oxidation, reduction and radical reactions. Aromatic compounds: aromaticity, reactions of benzene and substituted benzenes. Introduction to carboxylic acids: nomenclature, structure, preparation and reactions and acidity. Introduction to carbonyl chemistry: organometallic reagents, nucleophilic acyl substitution and the use of protecting groups.

Learning Outcomes

Upon completion of this course, students are able to:
1. Describe and name the carbonyl and aromatic compounds and propose the synthesis of these compounds.
2. Predict the products and propose appropriate mechanisms for the reactions of the above compounds.
3. Identify and determine the structure of an unknown compound with different spectroscopic techniques.
4. Discuss the concept of resonance to account for the stabilities of conjugated dienes, allylic radicals and cations.
5. Predict the products and propose the appropriate mechanisms for oxidation, reduction and radical reactions.

KFT233/4 Physical Chemistry I **KTT112 (s) or KOT122 (s)**

Properties of gases: gas laws, van der Waals equation, kinetic theory of gases, principle of the corresponding states, Maxwell-Boltzmann distribution, collision theory, effusion, diffusion, viscosity and thermal conductivity.
Chemical kinetics: rate laws, temperature effect, experimental methods, complex reactions. First law of thermodynamics: work, heat, energy, enthalpy change, heat capacity, adiabatic and isothermal processes, reversible and irreversible processes. Thermochemistry.

Learning Outcomes

Upon completion of this course, students are able to:
1. Apply the van der Waals and other equation of states to distinguish between ideal and real gases.
2. Apply the knowledge of kinetic theory of gases to explain various molecular collisions, speeds and transport properties of gases.
3. Demonstrate how kinetic and thermodynamic principles can be used to determine the reaction rates and various thermodynamic parameters of the reversible and irreversible processes, respectively.
4. Demonstrate the ability to apply equations, to discuss and solve problems on gas properties, chemical kinetics and thermodynamics.

KAT245/4 Analytical Chemistry I **KTT122 (s) or KOT122 (s)**

Stoichiometry calculations, statistical data treatment, good laboratory practices, concepts of equilibrium, gravimetric analysis, acid-base equilibria, acid-base titrations, complexometric titrations, precipitation reactions and titrations, electrochemical cells and redox titrations.

Learning Outcomes

Upon completion of this course, students are able to:
1. Apply knowledge on basic concepts to calculate various concentrations.
2. Apply knowledge of statistical concepts in analytical chemistry to make calculation and to make correct conclusions.
3. Apply knowledge of various chemical equilibria including acid-base, complexometry, gravimetry and redox to explain various titration methods.
4. Demonstrate the ability to apply appropriate equations to solve problems in chemical equilibrium using systematic methods.

KIT257/3 Materials Chemistry

Introduction: Classification of materials; Relation between structure, processing and properties.
Atomic Structure and Chemical Bonding: Atomic structure; Types of chemical bonding; Properties from bonding; Unit cell; Crystal structure of solids; Crystallographic directions and planes; Determination of crystal structure.
Imperfection in Solids: Types of imperfections/defects; Defects in ceramic structures; Defects in alloys; Characterization of defects.
Diffusion in Solids: Types of diffusion; Diffusion mechanisms; Factors that influence diffusion; Effects of diffusion to the structure and properties of materials.
Ceramics: Basic categories of ceramics; General properties of ceramic materials, structure of ceramics, silicates and glasses; New and modern ceramics; Biodegradable and bioactive ceramics; Applications of ceramic materials.
Polymers: Polymer molecules; Types of polymers; Structure of polymer; Molecular weight, degree of polymerisation and degree of crystallisation, polymer crystals; Synthesis of polymer; Phase transition of polymer.
Metals and Alloys: Classification of metals and alloys; Bonding in metals; Metallic structure; Phase diagram of metal (iron).
Composites: General requirements for composite; Types of composites; Form of matrices and reinforcement phases; Concrete and hybrid composites; Benefits and application of composite materials.
Phase Diagrams: Basic concept of phase equilibrium; Classification of phase diagrams; Interpretation of phase diagram; Lever Rule; Development of microstructure; Phase transformations; Factors that influence the phase transformation.
Properties of Materials: Mechanical properties: Stress, strain, elastic and plastic behavior, strength, hardness, ductility and toughness. Electrical properties: Conductivity, electron energy bands, electron mobility, semiconductors and dielectric materials. Magnetic properties: Magnetic force, magnetic field, classification of magnetic materials and its magnetic properties. Thermal Properties: Heat capacity, thermal conductivity, thermal expansion and thermal stress/shock. Optical Properties: Reflection, refraction, absorption and transmission, color and fiber optic.

Corrosion and Degradation of Materials: Corrosion of metals: Corrosion reaction and corrosion rate, factors that influence the corrosion, forms of corrosion, corrosion protections. Degradation of Polymer: Swelling, dissolution, bond rupture and weathering.

Learning Outcomes

Upon completion of this course, students are able to:
1. Describe the types of bonds and planes within a unit cell and to distinguish between single crystals and polycrystalline materials.
2. Comprehend the mechanism and factors that influence diffusion on the structure and properties of materials.
3. Explain the types of bonding and structures in ceramics, polymers, metals, alloys and composites.
4. Analyse the mechanical, electrical, magnetic, thermal and optical properties of materials.
5. Analyse the corrosion reaction, the factors that influence the corrosion and methods of corrosion prevention.

KUT304/2 Physical Chemistry Practical I **KUT102 (s), KFT332 (c)**

This course contains the following set of experiments: Primary salt effect. Determination of the vapour pressure and molar enthalpy of vapourisation of 2-propanol. Determination of the rate constant of a second order reaction using electrical conductance. Simultaneous determination of chloride-iodide mixture: Evaluation of K_{sp} for AgCl and AgI. Determination of heat and entropy of solution of potassium hydrogen tartrate ($C_4H_5O_6K$) at 35 ºC. Determination of the dissociation constant of an indicator. Thermodynamics of electrochemical cells. Fractional distillation. Heterogeneous equilibrium: The three component liquid system with incomplete miscibility. Determination of the molecular weight of high polymer by viscosity method. Hydrogen bonding between phenol molecules. Electrochemistry of solution. Adsorption photometry - simultaneous analysis of a two-component mixture of Cr^{3+} and Co^{2+} spectrophotometrically. Kinetics of the persulphate-iodide reaction. Only 12 out of 14 experiments will be selected for each semester.

Learning Outcomes

Upon completion of this course, students are able to:
1. Apply the principles of thermodynamics and kinetics in illustrative experiments.
2. Demonstrate competence in a variety of physico-chemical measurement techniques.
3. Analyse and interprete the experimental data obtained.
4. Demonstrate the ability of scientific communications through written reports.
5. Display safe laboratory practices.

KUT305/2 Analytical Chemistry Practical I **KUT101 (s), KAT349 (c)**

Experiments involving ultraviolet-visible and infrared spectroscopy, ion exchange resin, fluoride selective electrode, flame emission and atomic absorption spectroscopy, high performance liquid chromatography, gas chromatography and electrogravimetry.

Learning Outcomes

Upon completion of this course, students are able to:
1. Demonstrate competency in instrumental analysis based on spectroscopic methods such as UV/Visible spectrophotometry, infrared spectrometry, atomic absorption and flame emission spectroscopy.
2. Apply methods of instrumental analysis based on electrochemical techniques.
3. Apply methods of instrumental analysis based on separation methods such as gas chromatography and high performance liquid chromatography.
4. Display safe laboratory practices.
5. Write reports on the basis of experimental results and to draw correct conclusions.

KUE306/2 Research Methodology in Chemistry

The student will conduct a comphrehensive study on a particular issue or topic related to chemistry. Students will conduct literature search, write a research proposal and make an oral presentation.

Learning Outcomes

Upon completion of this course, students are able to:
1. Identify problems and show problem-solving skills.
2. Demonstrate the ability to use a variety of methods to obtain information.
3. Analyse and interprete information, write reports and discuss orally.
4. Demonstrate the ability to manage time for a particular task.

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

The first part of this course will expose students on the concept of bioinorganic chemistry. The role of metal ions in the 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 on 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.

KOE322/3 Natural Products Chemistry **KOT222 (s)**

The introduction of natural products which include the phytochemical screening and the extraction methods. The chemistry and properties of the secondary metabolites which includes the major groups of terpenes, alkaloids, phenolic compounds, fatty acids and polyketides. The biosynthesis of the main groups – fatty acids and polyketides (acetate pathway), terpenes (mevalonate pathway), alkaloids (Shikimic pathway) and phenolic compounds (Mannich reaction).
Other compounds being described include prostaglandins, insect pheromones, antibiotics and current topics of interest. The chemistry of natural product molecules shows pharmaceutical or agricultural importance with the practical skills in the natural product isolation and structure elucidation.

Learning Outcomes

Part A: Theory

Upon completion of this course, students are able to:
1. Identify the types of natural products and methods of extraction, isolation and characterisation.
2. Use appropriate reagents in the synthesis of natural product analogues.
3. Relate the reactions such as alkylation, phenolic oxidative coupling, redox reaction, oxidative cleavage of the aromatic ring in the construction of natural products compounds.
4. Demonstrate the acetate, shikimate and mevalonate pathways in the biosynthesis of fatty acid, alkaloids and terpenes.

Part B: Practical

Upon completion of this course, students are able to:
1. Apply the methods of phytochemical screening, methods of extraction, isolation and characterisation in secondary metabolites identification.
2. Analyse and interprete the experimental data obtained and write reports clearly and appropriately.
3. Display safe laboratory practices.

KFT332/3 Physical Chemistry II **KFT233 (s), KUT304 (c)**

First, second and third laws of thermodynamics, work, heat and energy, enthalpy change, heat capacity, adiabatic process, Gibbs and Helmholtz free energies, chemical potential, fugacity and composition change.

Changes of State: physical transformation of pure substances and mixture. Phase diagram, stability of phases, Clapeyron equation, partial molar quantities, thermodynamics of mixing, properties of solution, activity, phase diagram for systems with two and three components.
Electrochemistry: Debye Hückel theory, electrochemical cell, electrode potential and thermodynamics of cells.

Learning Outcomes

Upon completion of this course, students are able to:
1. Apply the first, second and third laws of thermodynamics to solve problems in physical chemistry.
2. Describe the partial molar quantities of a mixture.
3. Use appropriate equations to calculate the chemical potential.
4. Use the Debye-Hückel equation to calculate the thermodynamic equilibrium constant.
5. Relate the thermodynamic principles to electrochemical cells including the derivation of the Nernst equation.

KAT345/4 Spectroscopic Methods KAT245 (s)

Basic principles, instrumentation and the applications in qualitative and quantitative analyses of the following techniques: Molecular ultraviolet and visible absorption spectrometry, infrared absorption spectrometry, fluorescence spectrometry, atomic absorption spectrometry (flame and non-flame methods), atomic emission spectrometry, X-ray fluorescence, atomic mass spectrometry, X-ray photoelectron spectroscopy and Auger electron spectroscopy.

Experiments based on the following methods: infrared spectrophotometry, ultraviolet-visible spectrophotometry, spectroflurometry, flame photometry, atomic absorption spectrometry.

Learning Outcomes

Upon completion of this course, students are able to:
1. Demonstrate an understanding of the basic principles of spectroscopic methods such as ultraviolet-visible spectrometry, infrared spectrometry, fluorescence, atomic absorption spectrometry (flame and non-flame method), flame emission spectrometry, atomic emission spectrometry with plasma and electrical discharge sources, mass spectrometry, X-ray fluorescence and Auger electron spectroscopy.
2. Identify main components of instrumentation used in spectroscopic methods.
3. Select the appropriate spectroscopic technique for a particular analysis.
4. Write reports clearly, concisely and appropriately. Display safe laboratory practices.

KAT349/3 Analytical Chemistry II **KAT245 (s), KUT305 (c)**

Basic principles, instrumentation and applications in qualitative and quantitative analyses of the following techniques: electroanalytical, spectroscopic and chromatographic.

Learning Outcomes

Upon completion of this course, students are able to:
1. Demonstrate the understanding of basic principles of atomic and molecular spectroscopic, separation and electrochemical methods.
2. Describe and discuss the instrumentation and techniques of various analytical methods.
3. Discuss the applications of the various methods for the analyses of samples.

KIT358/3 Polymer Chemistry **KOT122 (s)**

Introduction to polymer: Polymerisation processes; Step-reaction polymerisation; Ionic polymerisation: Cross-linking and network formation; Molecular weight of polymer; Physical and mechanical behaviours of polymer; Characterisation and analysis of polymer.

Learning Outcomes

Upon completion of this course, students are able to:
1. Comprehend the importance, classification, properties of polymers.
2. Construct kinetic equations for radical chain polymerisation and chain transfer reactions.
3. Write polymerisation reaction mechanism and crosslinking reaction mechanism involved in ionic polymerisation.
4. Identify the methods used to determine the structure, physical and mechanical properties of polymers.

KIE361/4 Industrial Training

This training programme is opened to students who have completed at least 6 semesters of their studies. The duration for this course is 8-10 weeks (during the semester break between 3rd and 4th year). The students are required to undergo industrial training at various industries/organizations or at Centres of Excellence in USM. At the end of the training, students must submit a report and present their work. Students who have passed the course will also be awarded with a Certificate of Completion for the Industrial Training and the result (Pass/Fail) will appear in their academic transcript.

Learning Outcomes

1. Exhibit competencies and competitiveness in their respective areas of expertise.

2. Relate work experience with knowledge learned at universty.
3. Demonstrate interacting skills and communicating effectively.
4. Obtain experience and knowledge that can be utilised to choose the right job after graduation.

KUT407/2 Inorganic and Analytical Chemistry Practical KUT203 (s), KUT305 (s)

The spectra of metal carbonyls. Electronic spectra of coordination compounds. Preparation and resolution of *tris*(ethylenediamine)cobalt(III) into optical isomers. Preparation of ferrocene and its acetyl derivative. Application of IR spectroscopy to characterise linkage isomer, nitropentaaminecobalt(III) chloride. Photometric titrations with UV-VIS spectroscopic method. Determination of aluminium with 8-hydroxyquinoline through fluorimetric method. Flame photometry. Atomic absorption spectrometry. Kinetic method for the determination of selenium.

Learning Outcomes

Upon completion of this course, students are able to:
1. Demonstrate the advanced techniques on the synthesis, isolation and characterisation of the inorganic compounds.
2. Demonstrate advanced skills in various spectroscopic and separation techniques.
3. Write clear and concise practical reports which are related to the experimental work.
4. Display safe laboratory practices.

KUT408/2 Physical and Organic Chemistry Practical KUT206 (s), KUT304 (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 concentratio ns. 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 interprete 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.

KUE409/6 Chemistry Project

Research projects on various chemistry topics.

Learning Outcomes

Upon completion of this course, students are able to:
1. Demonstrate competency in various measurement techniques.
2. Identify problems and demonstrate problem solving skills.
3. Analyse and interprete the data, write concise reports and discuss the result orally.
4. Demonstrate the ability to use various retrieval methods to obtain information.
5. Display safe laboratory practices.

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 reaction. Approach on 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. Differentiate the transition metal cluster complexes based on the structure and bonding properties.
2. Explain the importance of catalysts and their role in the reactions.
3. Explain the preparation, reactivity, properties and the processing of inorganic polymers.

KOT423/3 Organic Chemistry III **KOT222 (s), KUT408 (s)**

Structure, synthesis and reaction of amines, carboxylic acids and carboxylic acid derivatives. Condensations and α-substitution of carbonyl compounds. Carbohydrates, nucleic acids, 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 the organic synthesis.

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 in the current issues related to organic chemistry.
2. Apply 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 **KFT332 (s)**

Quantum theory: Wave-particle duality, postulates, uncertainty principle, Schroedinger equation, particle in a one-, two- and three-dimensional box, harmonic oscillator and rigid rotor.
Statistical thermodynamics: Boltzmann distribution, ensemble, partition functions, calculation of thermodynamic functions.
Kinetics: transition state theory, thermodynamics of reactions, reaction in solution, reactive species, photochemistry, oscillating reactions.

Learning Outcomes

Upon completion of this course, students are able to:
1. Apply the postulates to formulate the modern quantum theory.
2. Solve the Schroedinger equation for the particle-in-a-box problems.
3. State and calculate the thermodynamic quantities from partition functions.
4. Demonstrate competence in applying the collision and transition-state theories.
5. Apply the Michaelis-Menten mechanism to explain an enzyme-catalysed reaction.

KFE432/3 Selected Topics in Physical Chemistry **KFT332 (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 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 in the current issues related to physical chemistry.
2. Apply 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 KAT349 (s)**

Introduction to biomolecules, proteins, nucleic acids, sample preparation, application of chromatography in life and health sciences, electrophoresis methodologies for genomics and proteomics, mass spectrometry in proteomic analysis, immunochemical methods, nuclear magnetic resonance (NMR) and magnetic resonance imaging (MRI) technologies in life sciences.

Learning Outcomes

Upon completion of this course, students are able to:
1. Differentiate the class of biomolecules including chemical, physical and their functional characteristics.
2. Demonstrate understanding on the latest developments in analytical instrumentations in bioanalysis.

3. Identify suitable chemical and biological methods for the analysis of biological compounds.
4. Demonstrate understanding of the other related methods in chemical and biological molecule.

KIE456/3 Food and Palm Oil Chemistry

Carbohydrates: Classification of structures; dietary utilisation as food component, reaction-hydrolysis, dehydration and thermal degradation and browning; functions in foods. Proteins: Physicochemical properties. General properties: chemical reaction and interaction of amino acid and protein. Denaturation, functional properties of proteins. Oil and fats: Type; composition, physical and chemical properties, quality control, stability, oxidation and anti-oxidant, processing and technology edible oils. Flavours: Analysis and identification, structures and organoleptic quality, production of typical flavor substances (vanilin, saccharin etc). Food additives: Role of acids, bases, salt, chelating agents, antimicrobes and types of sweeteners. Stabilisers and texturisers. Structures and composition of palm oil. Chemical properties and non-fatty components. Physical properties of palm oil. Technology of palm oil. Research trends in chemistry and technology of palm oil. Practical experiments on quality controls of palm oil.

Learning Outcomes

Upon completion of this course, students are able to:
1. Identify the classification and structures of carbohydrates, proteins and oils and their physico-chemical properties.
2. Describe the chemical changes of the major food components during processing.
3. Discuss the roles and functions of food additives and flavours.
4. Describe the factors affecting the chemical deterioration of oils and fats during storage, transportation and frying.
5. Perform analyses of quality parameters in assessing quality of oils and fats.

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.

KIE458/3 Selected Topics in Industrial Chemistry

This course will discuss several topics or current issues in industrial chemistry.
It covers the following areas:

1. Food Chemistry.
2. Hydrogen energy.
3. Polymer based industry.
4. Unit operations and processing.
5. Catalysis and surface science.
6. Electrochemical based industry.

Learning Outcomes

Upon completion of this course, students are able to:
1. Demonstrate understanding in the current issues related to industrial chemistry.
2. Apply fundamentals of chemistry in solving current industrial chemistry problems.
3. Display the ability to discuss the current issues orally and in writing.

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