Faculty of Science
Student Handbook
2018/2019

University of Peradeniya

STUDENT HANDBOOK
2018/2019

Faculty of Science
University of Peradeniya

Content

MESSAGE FROM THE VICE CHANCELLOR

It is with great pleasure that I welcome the new entrants of the Faculty of Science to the University of Peradeniya, a comprehensive higher educational institute in the country having nine faculties covering all academic disciplines. Those who gain admission to the University of Peradeniya are undoubtedly a privileged group who will soon experience the excellent academic setting in a salubrious environment overlooking the Hanthana mountain range. It is your prime duty to take the advantage of the rare opportunity gained by you through hard work of many years to fulfill your higher educational objectives, and become a balanced and a valuable citizen using the resources and unique and countless opportunities of the University of Peradeniya to the maximum. The University offers an environment conducive for intellectual pursuits of diverse nature.

I take this opportunity to wish all of you a very pleasant and a memorable stay at the university and every success in your future academic activities.

Professor Upul B. Dissanayake
Vice-Chancellor
University of Peradeniya

(05th December 2018)

MESSAGE FROM THE DEAN

On behalf of the Faculty of Science, University of Peradeniya, I welcome you to the Faculty which offers an academically sound, technologically advanced and socially conducive learning environment with a wealth of resources to the study of science. Citizens of our country have made a great investment for your education, and therefore, it is your duty to make use of the opportunity being selected to the Faculty, to contribute to the advancement of the country. The undergraduate programmes offered by the Faculty of Science lead to the B.Sc. degree of either three or four year duration, which are designed to provide knowledge on both basic and applied sciences, together with comprehensive skills development components. Students admitted to the Faculty are privileged to acquire knowledge from academic staff members, who are globally, regionally and nationally renowned, highly accomplished scientists with international collaborations. Additionally, industrial training component included in most of the four year degree programmes provide hands-on experience in industrial setting, enhancing job opportunities. On the other hand, the Faculty is equipped with research laboratories with "state of the art" instruments for its students to obtain excellent research experience. At the end of the programme, you will not only be a science graduate with knowledge, but also possess necessary attitudes to be a kind, caring and compassionate human being. Consequently, the graduates of the Faculty easily find employment after the B.Sc. degree or take the route of pursuing education towards advanced degrees. Your predecessors, by their commitment and hard work, have brought fame and pride to this Faculty locally as well as globally. I hope you too would work towards achieving similar or even better standards and keep the flag of the University of Peradeniya flying high. I am certain that you enjoy your stay in the Faculty.

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INTRODUCTION

The Faculty of Science, comprising the Departments of Botany, Chemistry, Mathematics, Physics and Zoology were initially located in Colombo along with other Faculties of the University of Ceylon. It had been decided to have the permanent home of the University in Peradeniya and accordingly, the Faculty of Arts, Oriental Studies, Law, Agriculture, Veterinary and Dental Sciences were established at Peradeniya by the early part of the 1951-60 decade.

The admission of the first batch of students took place in the 1961 –62 academic year. In order to accommodate the increasing demand for science education in the country the Faculty of Science in Colombo was allowed to form a second Faculty in Peradeniya and a part of the staff from the Colombo Faculty moved to Peradeniya Faculty at the early stages, while the latter gradually built up the staff by direct recruitment. Both branches of the Faculty functioned under common administration at each of the levels of department and faculty, with common curricula and examinations. In 1967 those segments of the University of Ceylon which were situated in Colombo were constituted as a separate and independent University. Thus, the second Faculty of Science at Peradeniya comes into being on its own, as the Faulty of Science, University of Ceylon, Peradeniya.

Presently the Faculty consists of eight academic departments and two units namely, Department of Botany, Chemistry, Geology, Mathematics, Molecular Biology & Biotechnology, physics, Statistics & Computer Science, Zoology and Computer Unit and Science Education Unit. At present, 530 students are admitted annually student enrolment stands at about 1700 undergraduate and 200 postgraduate research students. There are 110 academic and 120 non – Academic members of staff in the Faculty. The Faculty of Science offers course of study leading to General and Honors Bachelor of Science (B.Sc.) Degrees. From the academic year 2001/2002 the courses are offered on a semester based course unit system. This has significantly increased the course combinations available to students allowing far more flexibility of selection of subject areas. With the introduction of the Course Unit System, the medium of instruction for all course of study offered by the Faculty was confined to English.

The general degree programme has been broad-based and restructured to allow increased flexibility, with options to offer minor subjects outside the main disciplines. The major subjects offered are: Applied Mathematics, Biostatistics, Botany, Chemistry, Computer Science, Geology, Higher Mathematics, Molecular Biology & Biotechnology, Physics, Pure Mathematics and Statistics. The minor subjects are Basic Computing, Basic Electronics, Earth Science, Economics, Environmental Science, Foods Science, Management and Science Education. The Faculty at present offers Honors degree programmes in Botany, Chemistry, Computer Science, Environmental Science, Geology, Mathematics, Molecular Biology & Biotechnology, Physics, Statistics and Zoology.

General degree students may at the end of 3rd year be selected based on performance and given the option of following courses for an additional year with special emphasis on industry-related courses leading to a B.Sc. degree in Applied Sciences in place of a General Degree.

The Faculty also conducts four year B.Sc. degree programmes in Computation and Managements (jointly with the Faculty of Arts) and in Statistics and Operations Research for students admitted from a separate window.

OFFICERS OF THE FACULTY OF SCIENCE

Dean/ Faculty of Science
Prof. S.R. Kodituwakku

Head/ Department of Botany
Prof. D.M.D. Yakandawala

Head/ Department of Chemistry
Dr. W.M.A.T. Bandara

Head/ Department of Geology
Prof. R.L.R. Chandrajith

Head/ Department of Mathematics
Prof. A.A.I. Perera

Head/ Department of Molecular Biology and Biotechnology
Prof. S.D.S.S. Sooriyapathirana

Head/ Department of Physics
Dr. V.A. Seneviratne

Head/ Department of Statistics and Computer Science
Dr. U.A.J. Pinidiyaarachchi

Head/ Department of Zoology
Dr. S.K. Yatigammana

Director/ Science Education Unit
Prof. S. Rajapakse

Assistant Registrar
Ms. W.M.S.N. Wijerathna

Assistant Bursar
Ms. S.A.W. Chathurani

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DEPARTMENT OF MATHEMATICS

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Ms. J.H.T.A. Jayaweera: *B.Sc.* (*Perad.*)

Ms. C.S. Munasinghe; *B.Sc.* (*Perad*.)

Mr. D.R.G.W.B. Ellepola; *B.Sc., M.Phil.* (*Perad.*)

Ms. S.D. Tennakoon; *B.Sc.* (*Perad*.)

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Ph.D. (*Hokkaido, Japan*) **(Director of the Unit)**

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Mr. A.M.R.S. Bandara; *B.Sc. (Perad.)*

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COURSE UNIT SYSTEM AT THE FACULTY OF SCIENCE

The Faculty of Science conducts courses under a semester based course unit system and the details are given below:

1. THE MEANING OF SOME OF THE FREQUENTLY USED TERMS

Semester: An academic year is divided into two semesters, identified as the first semester and the second semester of a particular year such that each semester is of 15 weeks duration.

Course Unit: This is a complete course taught within a semester with one or more contact hours per week. A contact hour is defined as an hour of lectures, practical, tutorials etc.

Levels: Undergraduate courses will be conducted at 4 levels, namely 100, 200, 300 and 400. The subject matters in courses get progressively advanced as the levels go higher. However, a student may register for any course unit at a lower level, subject to the recommendation of the Head of the Department.

Credit: The abstract value assigned to a course unit on the basis of contact hours per week is called a credit. Usually, one credit is equivalent to 15 hours of lectures/tutorials or 30 - 45 hours of laboratory work, field classes etc. Course units of one credit, two credits and three credits are available. The contents of a three credit course unit, for example, are approximately three times that of a course unit of one credit.

Grade Point: The range of marks is partitioned into a sequence of suitable sub-ranges (as decided by the Faculty) and the sub-ranges are designated by the symbols **A^+, A, A^-, B^+, B, B^-, C^+, C, C^-, D^+, D** and **E.** These are called grades and grade points are assigned as follows:

$A^+ = 4.0$	**$B^+ = 3.3$**	**$C^+ = 2.3$**	**$D^+ = 1.3$**
A = 4.0	**B = 3.0**	**C = 2.0**	**D = 1.0**
$A^- = 3.7$	**$B^- = 2.7$**	**$C^- = 1.7$**	**E = 0**

(Note: **A^+** and **A** have the same grade points.)

Grade Point Average (GPA): The grade point average for each level is the credit weighted mean of grade points obtained by a student for the course units he/she has offered at that level. It is calculated to the second decimal place and is an indicator of the academic performance of the student. The final GPA is computed using these level GPAs' by giving percentage weights for different levels as described under item 6.

Prerequisites: The subject matter in a course unit at a lower level is sometimes essential to follow a course unit at a higher level. The course unit at the lower level so needed is called a prerequisite of the course unit at higher level. A student is required to obtain at least **D** grade for each of the prescribed prerequisite course units (if any) before offering the higher level course unless this requirement is waived by the department offering the higher level course. At the beginning of the

academic year, each department will announce the courses offered and their prerequisites (if any).

2. ORGANIZATIONAL DETAILS

I. The Faculty conducts courses on a semester basis. The medium of instruction shall be English. Students can seek the assistance of the academic counselor and academic advisors who will help them to select appropriate subject combinations. Students are responsible for planning their programmes, but they will be guided by the academic counselor and the advisors to select course units required for the Degree Programme.

II. Each department will use a two-letter prefix together with a three-digit number to identify the course units offered by that department. The first two letters will indicate the department/subject while the three digit number will indicate the level.
For example, a 100 level course unit offered by the Department of Methametics may be named as MT 101.

III. The Head of the relevant department will advise the students on the mode of selection of the appropriate course combinations for a Special Degree Programme.

IV. There will be a minimum and a maximum number of students that could be accommodated in a given course. The department shall decide on these numbers, having taken into consideration the nature of the course unit and the available facilities of the department.

3. TYPES OF COURSE UNITS AND SUBJECTS

Course units are derived from the following categories:

I. Foundation Courses
II. Principal Subject Area
III. Supplementary Courses
IV. Applied Sciences Subject Area
V. Statistics and Operations Research Subject Area
VI. Computation and Management Subject Area
VII. Inter-Faculty Courses

I. Foundation Courses (available only at 100 level)

Foundation courses are compulsory for all students. They comprise of courses on English Language (EN 100) and Computer Applications (CS 100), each carrying 2 credits and a course on basic Biology (BL 100)/Mathematics (MT 100/ MT 120)/Law and Ethics (FND 114). The grade earned in EN 100 will not be counted in the computation of the GPA. Students who have entered to different Degree Programmes through different A/L subject streams should follow foundation courses as depicted in the table below:

Degree Programmes / Foundation Courses	General/Special/Applied Sciences Degree Programmes		Statistics and Operations Research Degree Programme (SOR)	Computation and Management Degree Programme (CM)	
	Biological Science stream	Physical Science stream		Arts, Commerce or Biology stream at G.C.E (A/L)	Physical Science stream at G.C.E. (A/L)
EN 100 Basic English	√	√	√	√	√
CS 100 Computer Applications	√	√	√	√	√
MT 100 Mathematics for Biological Sciences	√				
BL 100 Basic Life Sciences		√	√		
MT 120 Foundation Course in Mathematics				√	
FND114 Law and Ethics					√

II. Principal Subject Area

100 level courses

Course units in the following subjects will be available at the 100 level:

Biology*	Computer Science	Geology
Biology**	Mathematics*	Physics
Chemistry	Mathematics**	Statistics

200/300/400 level courses

Course units in the following subjects will be available:

Biology	Physics
Botany	Mathematics
Chemistry	Molecular Biology & Biotechnology
Computer Science	Statistics
Enviornmental Science	Zoology
Geology	

III. Supplementary Courses

- MG 201 Management Studies I (2 credits)
- MG 301 Management Studies II (2 credits)
- EC 201 Introductory Economic Theory (3 credits)

- EC 301 Sri Lankan Economy (2 credits)
- SE 201 Foundations in Science Education (2 credits)
- SE 202 Educational Philosophy and Educational Management (2 credits)
- SE 301 Methodology in Teaching Science (2 credits)
- SE 302 Teaching Practice (2 credits)
- SE 303 Assessing Students in the Learning Process (2 credits)

Supplementary courses are not compulsory. A student cannot be offered more than 12 credits from the above supplementary courses for a General/Special/Applied Sciences Degree Programme.

IV. Applied Sciences Subject Area (available only at 400 level)

Industry related course units, which are generally available only to students extending their General Degree Course by a fourth year and offering the Applied Sciences Degree Programme.

V. Statistics and Operations Research (SOR) Subject Area

Course units which are available to students admitted for the Statistics and Operations Research degree programme from a separate window by the University Grants Commission (UGC).

VI. Computation and Management (CM) Subject Area

Course units which are being offered jointly by the Faculties of Science, Arts and Management to students admitted for the Computation and Management degree programme from a separate window by the UGC.

VII. Inter-Faculty Courses

Course units offered by another Faculty of this university may also be selected by the students provided these courses are approved by the Faculty Board of Science as suitable for the course offered by the student.

4. TYPES OF UNDERGRADUATE DEGREES AWARDED

The Faculty conducts Bachelor of Science (B.Sc.) Degree Programmes and Bachelor of Science honors (B.Sc.Hons) Degree Programmes. Initially, a student registers for a B.Sc. Degree Programme, and at the end of the second year, he/she may continue to follow the B.Sc. Degree Programme or register for a Honors Degree Programme. The second option is possible only if the student fulfills certain criteria as stipulated in the section "Criteria for Selection to a Honors Degree Programme". The duration of a B.Sc. Degree Programme is three academic years, while that of a Honors Degree Programme is four academic years. At the end of 3rd year, based on performance, B.Sc. Degree students may be selected to follow a B.Sc. Hons. Degree Programme in Applied Sciences in place of a three-year B.Sc. Degree.

The Faculty also conducts four-year B.Sc. Honors Degree Programmes in Computation and Management (jointly with the Faculties of Arts and Management) and in Statistics and Operations Research for students admitted through separate windows.

5. SELECTION OF COURSE UNITS

The course units offered by each department will be available at the beginning of each semester, and the students are required to register on or before a date specified by the Faculty using the online registration system (http://scisis.fos.pdn.ac.lk/). Late registrations may be accepted under exceptional circumstances at the discretion of the Faculty on payment of a prescribed fine. In each academic year, a student must register for not less than 27 and not more than 33 credits, excluding repeated course units. Academic advisors will help students to select course units judiciously. Once the course units are selected, students shall register for each course unit thus selected at the beginning of the semester and he/she can offer only these course units to earn credits.

During the first year, students other than those who have been admitted through a separate window shall be selected for a combination of three subjects from the principal subject area and select the course units coming under these subjects (subject combinations offered are listed end of this section). Students should follow all the components of the selected subjects, i.e. theory, practicals, field work etc. During the second year of the Degree Programme, students should select at least two subjects from the principal subject area at 200 level (refer to the "Requirements to Pass the B.Sc. Degree"). The remaining credits required, if any, shall be selected from the other subjects in the principal subject area/supplementary courses. During the third year of the B.Sc. Degree Programme, the students shall select the respective course units at 300 level as in the second year.

B.Sc. Degree students at the end of 300 level are selected to the fourth year of the programme leading to the B.Sc. Hons Degree in Applied Sciences. These students should select at least 30 credits at the 400 level from the Applied Sciences subject area including a 8-credit course unit in industrial training.

During the third and fourth years of the Honors Degree Programme, the students shall select course units from the subject of specialization at 300 and 400 levels, so that their credits will add up to at least 24 per academic year. The relevant department may specify the remaining course units that should be offered. Further, the Honors Degree students will do a research project, which will carry a minimum of 6 credits. Students following the Statistics and Operations Research or the Computation and Management Degree Programmes should select course units specified for these programmes.

Following subject combinations will be offered under Physical and Biological Science streams (There should be a minimum number of 10 student enrollments to offer a combination).

Principal Subject Combination	**Combination No.**	***Special Degrees Available***
Biology**, Chemistry	1 – BBC	Biology, Botany, Chemistry, Enviromental Sc., Mol. Biol. & Biotech., Zoology
Biology*, Chemistry, Statistics	2 – BCS	Biology, Botany, Chemistry, Enviornmental Sc., Mol. Biol. & Biotech., Zoology, Statistics
Biology*, Chemistry, Computer Science	3 – BCC	Biology, Botany, Chemistry, Enviornmental Sc., Computer Sc., Mol. Biol. & Biotech., Zoology

Biology*, Chemistry, Physics	4 – BCP	Biology, Botany, Physics, Chemistry, Enviornmental Sc., Mol. Biol. & Biotech., Zoology
Biology*, Chemistry, Geology	8 – BCG	Biology, Botany, Enviornmental Sc., Geology, Chemistry, Mol. Biol. & Biotech., Zoology
Chemistry, Geology, Physics	15 – CGP	Chemistry, Enviornmental Sc., Geology, Physics
Chemistry, Mathematics**	18 – CMM	Chemistry, Enviornmental Sc., Mathematics
Chemistry, Mathematics*, Physics	19 – CMP	Chemistry, Enviornmental Sc., Physics
Chemistry, Computer Science, Statistics	21 – CCS	Chemistry, Enviornmental Sc., Computer Sc., Statistics
Chemistry, Mathematics*, Statistics	22 – CMS	Chemistry, Enviornmental Sc., Statistics
Mathematics*, Computer Science, Statistics	26 – MCS	Computer Sc., Statistics
Physics, Mathematics**	27 – PMM	Physics, Mathematics
Physics, Computer Science, Geology	28 – PCG	Physics, Computer Sc., Geology
Physics, Mathematics*, Computer Science	31 – PMC	Physics, Computer Sc.
Physics, Mathematics*, Statistics	32 – PMS	Physics, Statistics

6. ASSIGNMENT OF GRADES, GRADE POINTS AND GPA

The grades submitted by the instructor will be reviewed by a three member committee comprising of the Head of the Department, instructor and another faculty member. The Head of the Department will submit the grades obtained by the students for all the course units under his purview to the Dean's Office. The GPA of each student for each level is calculated using the formula $GPA = \Sigma c_i g_i / \Sigma c_i$, where c_i and g_i are the number of credits and the grade point for the i^{th} course unit respectively, offered at that level. Following percentage weights will be given for different levels in the computation of the final GPA:

	Percentage weights for B.Sc. Degree	Percentage weights for Honors Degrees
100 level	20 %	20 %
200 level	40 %	20 %
300 level	40 %	30 %
400 level		30 %

Other types of grades

Grade W: Withdrawal from a course unit within the first two weeks of registration is allowed, provided that the minimum credit requirement is not violated. Withdrawals after this period cannot be accepted, except on medical grounds or other valid reasons. These courses will be assigned a grade W.

Grade I: A grade "I" should be given for a student who has sufficiently covered the course but not sat for the end semester examination. If a reason, acceptable to the Faculty Board of Science is not given, the grade will be computed with the available marks and that grade will be assigned replacing the grade "I". If an acceptable reason is given for being absent, the student will be allowed to sit for an end semester examination as a proper candidate and a new grade will be assigned replacing "I". This may be the next available attempt or a make-up examination as decided by the Dean in consultation with the Head/Coordinator on a case-by-case basis.

7. EVALUATION PROCEDURE

In consultation with the Head of the Department, the instructor shall announce, at the commencement of the course, how it will be evaluated. A course unit may be evaluated by means of continuous assessments (assignments, quizzes and mid-semester examination) and end-semester examination, etc. Mid-semester examination is optional. Following weightages will be given at the calculation of the final mark.

Continuous assessments (with or without mid-semester examination)	: 20 - 40 %
End semester examination (comprehensive)	: 60 - 80 %

To earn credits for a course unit, the student should obtain at least a D grade for that course unit.

8. ATTENDANCE AND REPETITION OF A COURSE UNIT

University regulations require 80% attendance for all components of a course. Absence on medical grounds or any other valid reasons must be approved by the Faculty Board. The instructor should report to the Head of the Department, the names of students who are excessively absent. The department will decide whether the missed work/examination could be made up. When absence from classes of a course is not approved, the course will be graded **E**.

A student who obtains grades of **C-**, **D+, D** or **E** for a course unit may repeat that course unit by sitting the final examination, in order to improve his/her grade. The maximum grade given shall be a grade **C**. However, repeat candidates will not be allowed to attend practical classes. They may be allowed to sit a repeat practical examination.

9. CRITERIA TO PROCEED TO THE 200 LEVEL OF THE DEGREE PROGRAMME

A student should obtain a minimum *GPA* of 1.70 at the 100 level to enter the 200 level. The maximum period a student is allowed to stay at 100 level is four years.

10. CRITERIA FOR SELECTION TO THE APPLIED SCIENCES DEGREE PROGRAMME

The Applied Sciences Degree Programme will be offered to a limited number of students as decided by the Faculty. Selection of students for this four year Degree Programme shall be made at the end of the third academic year among the students admitted to the B.Sc. Degree Programme. The minimum requirements necessary to apply for selection to the Applied Sciences Degree Programme are as follows:

I. Satisfy requirements 1, 2 and 3 given under the section titled "Requirements to Pass the B.Sc. Degree" and,
II. *GPA* of at least 2.50

11. REMOVAL/WITHDRAWAL FROM THE APPLIED SCIENCES DEGREE PROGRAMME

In the event a student wants to opt out from the Applied Sciences Degree Programme, he/she may inform the Coordinator/Applied Science of his/her decision before the beginning of the second semester of the 4th year. Performance of such students will be considered for the award of a B.Sc. Degree under the section titled "Requirement to Pass the B.Sc. Degree**"** at the next meeting of the Board of Examiners.

12. CRITERIA FOR SELECTION TO A B.Sc. Hons. DEGREE PROGRAMME

Selection of students for Honors Degree Programmes shall be made at the end of the second academic year. The students may apply to follow a Honors Degree Programme in any one of the following principal subjects: Biology, Botany, Chemistry, Computer Science, Environmental Science, Geology, Mathematics, Molecular Biology and Biotechnology, Physics, Statistics and Zoology.

The minimum requirements necessary to apply for selection to the Honors Degree Programme are:

- At least a *GPA* of 2.50 from the 100 and 200 level course units that are considered for the degree in the selected subject of specialization.
- At least 16 credits for course units (32 credits for Mathematics) from the subject of specialization of which at least 8 credits (16 credits for Mathematics) should be at the 200 level.
- At least grade **C** for each of the foundation courses offered.

Any deviation from the above minimum requirements should be done in consultation with the Dean of the Faculty.

Course units from either Biology* or Biology** can be counted as 100 level course units under Botany or Zoology. Specified course units from Botany, Molecular Biology & Biotechnology, and Zoology can be counted as 200 level course units for selection to the Special Degree in Biology.

13. WITHDRAWAL FROM THE B.Sc. Hons. DEGREE PROGRAMME

In the event a student wants to opt out from a Honors Degree Programme, he/she should inform the relevant Head of the Department within the first four weeks after the selection for the Honors Degree programme and revert to a general degree programme.

14. REQUIREMENTS TO PASS THE B.Sc. DEGREE

The Board of Examiners will meet to consider the performance of the candidates. To pass the B.Sc. Degree, candidates have to fulfill the following requirements:

I. Obtain at least grade **C** for the three foundation courses

II. At least 90 credits (excluding EN 100) with the following minimum credit requirements:

    24 credits from each principal subject should be earned by selecting courses subject to a minimum of eight credits each at 100, 200 and 300 level. The remaining requirements can be met by following courses in different subject/subjects. Not more than 12 credits are allowed from the supplementary courses.

III. **E** grades should not appear within the minimum number of credits required.

IV. Obtain a *GPA* of at least 2.00

Note: (i) Students who fulfill all the above requirements may apply for the award of the B.Sc. Degree.

(ii) A student who has not fulfilled any of the above requirements may repeat the course units in order to fulfill the requirements.

15. AWARD OF CLASSES FOR THE B.Sc. DEGREE PROGRAMME

A student who has fulfilled all the conditions stipulated in "The requirements to pass the B.Sc. degree" shall be awarded classes, if he/she fulfills the following additional requirements:

First Class	(i) *GPA* of 3.70 and over (ii) At least grade **C** for all the course units whose credits will add up to at least 84 (iii) Completion of the Degree Programme within three years
Second Class (Upper Division)	(i) *GPA* of 3.30 – 3.69 (ii) At least grade **C** for all the course units whose credits will add up to at least 76 (iii) Completion of the Degree Programme within three years
Second Class (Lower Division)	(i) *GPA* of 3.00 - 3.29 (ii) At least grade **C** for all the course units whose credits will add up to at least 76 (iii) Completion of the Degree Programme within three years

Award of classes will be decided by the Board of Examiners using the above criteria as guidelines.

16. REQUIREMENTS TO PASS THE APPLIED SCIENCES DEGREE

The Board of Examiners will meet to consider the performance of the candidates. To pass the Applied Sciences Degree, candidates have to fulfill the following requirements:

I. Obtain at least grade **C** for the three foundation courses.

II. At least 90 credits (excluding EN 100) from the 100, 200 and 300 levels together with the compulsory courses as specified in Section 14 (Requirements to Pass the B.Sc. Degree Examination).

III. At least 30 credits at 400 level from the course units in the Applied Sciences subject area including the compulsory courses and the industrial training component.

IV. Obtain at least grade **C** for course units whose credits will add up to at least 106 (excluding EN 100).

V. Obtain at least grade **C** for the industrial training component.

VI. **E** grades should not appear within the minimum number of credits required.

VII. Obtain a *GPA* of at least 2.00

Note: (i) Grades obtained by a student except EN 100 and the industrial training component subject to the requirements stipulated in II and III above shall be considered in the computation of the final GPA.

(ii). Students who fulfill all the above requirements may apply for the award of the B.Sc. Hons. (Applied Sciences).

(iii). A student who has not fulfilled the requirements at 400 level will be considered for the B.Sc. Degree (General Degree) using the criteria in Section 14.

17. AWARD OF CLASSES FOR THE APPLIED SCIENCES DEGREE PROGRAMME

A student who has fulfilled all the conditions stipulated in "The requirements to pass the Applied Sciences Degree" shall be awarded classes, if he/she fulfills the following additional requirements:

First Class	(i) *GPA* of 3.70 and over (ii) At least grade **C** for all the course units whose credits will add up to at least 114 (iii) Completion of the Degree Programme within four years
Second Class (Upper Division)	(i) *GPA* of 3.30 – 3.69 (ii) At least grade **C** for all the course units whose credits will add up to at least 106 (iii) Completion of the Degree Programme within four years

Second Class	(i)	*GPA* of 3.00 - 3.29
(Lower Division)	(ii)	At least grade **C** for all the course units whose credits will add up to at least 106
	(iii)	Completion of the Degree Programme within four years

Award of classes will be decided by the Board of Examiners using the above criteria as guidelines

18. REQUIREMENTS TO PASS THE B.Sc. Hons. DEGREE

The Board of Examiners will meet to consider the performance of the candidates. To pass the Honors Degree, the candidates have to fulfill the following requirements:

I. Obtain at least grade **C** for the three foundation courses.

II. At least 120 credits (excluding EN 100) with the following minimum credit requirements:

105 credits from the principal subject area with at least 72 credits from the subject of specialization including courses in other subject areas specified by the department of study. Minimum of 48 credits should be from course units at 300 and 400 levels. Not more than 12 credits are allowed from supplementary courses.

III. Obtain at least grade **C** for course units whose credits will add up to 106 (excluding EN 100)

IV. Obtain at least grade **D** in the compulsory course units specified for the B.Sc. Degree for the Principal subjects offered at 100 and 200 levels and the compulsory course units specified for the Special Degree in the subject of specialization.

V. Obtain at least grade **C** for the research project.

VI. **E** grades should not appear within the minimum number of credits required.

VII. Obtain a *GPA* of at least 2. 00

Note: (i) Students who fulfill all the above requirements may apply for the award of the B.Sc. Hons.

(ii) A student who has not fulfilled any of the above requirements may repeat the course units in order to fulfill the requirements.

19. AWARD OF CLASSES ON COMPLETION OF THE B.Sc. Hons. DEGREE PROGRAMME

A student who has fulfilled all the conditions stipulated in "The requirements to pass the B.Sc. Hons. Degree" shall be awarded classes, if he/she fulfills the following additional requirements:

First Class	(i) *GPA* of 3.70 and over (ii) **A** or higher grades for at least 50% of the credits in 300 and 400 levels and at least grade **C** for the remaining 300 and 400 level course units (iii) Completion of the Degree Programme within four years
Second Class (Upper Division)	(i) *GPA* of 3.30 - 3.69 (ii) Grade **B** or above for at least 50% of the credits in 300 and 400 levels and at least grade **D** for the remaining 300 and 400 level course units subject to a maximum of 3 credits with grade D/D+ (iii) Completion of the Degree Programme within four years
Second Class (Lower Division)	(i) *GPA* of 3.00 - 3.29 (ii) At least grade **B** for at least 50% of the credits in 300 and 400 levels, and at least grade **D** for the remaining 300 and 400 level course units subject to a maximum of 6 credits with grade D/D+ obtained from a maximum of 3 courses (iii) Completion of the Degree Programme within four years

Award of classes will be decided by the Board of Examiners using the above criteria as guidelines.

20. REQUIREMENTS TO PASS THE B.Sc. Hons. IN STATISTICS AND OPERATIONS RESEARCH AND THE B.Sc. Hons. IN COMPUTATION AND MANAGEMENT

The Board of Examiners will meet to consider the performance of the candidates. To pass the Degree, the candidates have to fulfill the following requirements:

I. Obtain at least grade **C** for the three foundation courses.

II. At least 120 credits (excluding EN 100) among those course units specified for the relevant Degree Programme.

III. Obtain at least grade **C** for course units whose credits will add up to 106 (excluding EN 100).

IV. Obtain at least grade **D** in the compulsory course units specified for the course.

V. Obtain at least grade **C** for the project (if any).

VI. **E** grades should not appear within the minimum number of credits required.

VII. Obtain a *GPA* of at least 2.00.

Note: (i) Students who fulfill all the above requirements may apply for the award of the relevant Bachelor of Science Degree.

(ii) A student who has not fulfilled any of the above requirements may repeat the course units in order to fulfill the requirements.

21. AWARD OF CLASSES ON COMPLETION OF B.Sc. Hons. IN STATISTICS AND OPERATIONS RESEARCH AND B.Sc. Hons. IN COMPUTATION AND MANAGEMENT PROGRAMMES

A student who has fulfilled all the conditions stipulated in "Requirements to pass the B.Sc. Hons. in Statistics and Operations Research and the B.Sc. Hons. in Computation and Management" shall be awarded classes, if he/she fulfills the following additional requirements:

First Class	(i) *GPA* of 3.70 and over (ii) At least grade **C** for all the course units whose credits will add up to at least 114 (iii) Completion of the Degree Programme within four years
Second Class (Upper Division)	(i) *GPA* of 3.30 - 3.69 (ii) At least grade **C** for all the course units whose credits will add up to at least 106 (iii) Completion of the Degree Programme within four years
Second Class (Lower Division)	(i) *GPA* of 3.00 - 3.29 (ii) At least grade **C** for all the course units whose credits will add up to at least 106 (iii) Completion of the Degree Programme within four years

Award of classes will be decided by the Board of Examiners using the above criteria as guidelines.

22. COMPLETION OF DEGREE

Students should complete all three year Degree Programmes in six academic years from the date of admission to the Faculty. In the case of students offering a four year Degree, this period will be eight academic years.
Students who have completed all requirements of a Degree should claim for the Degree using the course selection form prepared for each student by the Faculty.

23. ENTRIES IN THE TRANSCRIPT

Course units with the corresponding credits together with the grades earned will appear in the transcript. E grades which have been upgraded will not appear but the credit earned of the repeated course unit will appear under the particular semester when the unit was completed with a label (R) to indicate that the course was repeated. E grades which have not been upgraded will appear in the transcript. The final *GPA* and the Class (if any) will also appear in the transcript. Courses of which the grades are not taken for the calculation of the final GPA (except for EN 100) will not appear in the final academic transcript. The transcript will be issued upon application and the payment of a prescribed fee.

Note: Changes to these rules and regulations may be made by the Faculty Board with the approval of the Senate of the University of Peradeniya.

SCHOLARSHIPS, PRIZES AND MEDALS

Nimal and Savithri Gunatilleke Gold Medal for excellence in Biology
This Medal awarded to the students who shows the greatest performance at all 100, 200, 300 and 400 level Honours Degree programme examinations in Biology. A minimum of B+ or its equivalent at the first available attempt has to be earned for these courses and student should pass all the course units at the first available attempt in the relevant examinations conducted by the Faculty of Science. A minimum of a second Class (Upper Division) pass or its equivalent Cumulative or Final GPA should be obtained to be eligible for the award.

Prof. M.D. Dassanayake Gold Medal for Botany
This gold medal is awarded to the student who shows the greatest competence in Botany at the Honours Degree Examination in Botany.

Prof. M.D. Dassanayake Prize for Botany
This Prize is awarded to the student who shows the greatest competence in Botany at the 200 level.

Savitri and Nimal Gunatilleke Scholarship for Excellence in Ecology
This Scholarship is awarded annually to a 400 level student who has recorded the best performance in the subjects of BT 201 – Plant Diversity I, BT 202- Plant Diversity II, BT 203 – Vegetation Dynamics and Measurements, BT 309 – Biodiversity Conservation and Management, BT 310 – Ecosystems of Sri Lanka, their Ecology and Conservation, and also passed all the courses at the first available attempt to the satisfaction of the Faculty Board of Science.

S.A. Kulasooriya Gold Medal for Excellence in Microbiology
This gold medal is awarded annually to the student who has recorded the best performance at the 100, 200, 300 and 400 level examinations in the area of Microbiology (i.e., BL 107- Basic Microbiology, BT 201 –Plant Diversity I, BT 302 – Advanced Microbiology and BT 412 – Applied Microbiology).

Sultanbawa Prize in Organic Chemistry
This prize is awarded to the student who shows the greatest competence in Organic Chemistry with a minimum GPA of 3.9 for 300 and 400 level Organic Chemistry course unites (or papers) at the honours degree examination in Chemistry.

Bhikaji Framji Khan Gold Medal for Chemistry
This medal is awarded to the student who shows the greatest competence in Chemistry at Honours Degree Examination in Science.

P.W. Vitanage Memorial Scholarship
This scholarship is awarded to the student who shows the best performance by obtaining the highest GPA for 100 and 200 level courses offered by the Department of Geology.

Dr. C.A. Hewawitharana Memorial Prize for Physics:
This prize is awarded to the student with best overall performance in the Honours Degree Programme in Physics.

Prof. V. Appapillai Memorial Scholarship in Physics:
This scholarship is awarded to the student with the best performance in 100 and 200 Level Physics courses and was selected and registered to follow the Honours Degree Programme in Physics.

Prof. A.W. Wolfendale Prize for Physics:
This prize is awarded to the student with the best performance during the first year of the Honours Degree Programme in Physics.

George Dissanaike Memorial Gold Medal for Physics:
This gold model awarded to the student with the best performance at the examinations of the 300 and 400 Level compulsory courses in Physics.

Felix Prashantha Amarasinghe Memorial Gold Medal for Excellence in Zoology
This gold medal is awarded to the student who obtained the highest final GPA at the B.Sc. Zoology Honours Degree on the basis of the criteria determined by the Faculty of Science and all the courses required for the B.Sc. Honours Degree of the Zoology at the first available attempta. A. minimum of 3.5 final GPA should be obtained to be eligible for the award.

Coomaraswamy Prize for Science
Three prizes are awarded to the students who show the greatest competence at the B.Sc. Degree Examination in Science of which one is for the student who secures over 60 % in Biological Science and the other two for the students who secure 1st and 2nd places in Physical Science in order of merit.

Chemical Industries (Colombo) Ltd. Prize
Two awards are given each year on the basis of the performance at the 200 level examination (B.Sc. / B.Sc. Honours Degree programmes)

Prof. Lakshman Dissanayke Gold Medal for Excellence in Physics
The gold medal awarded to the Physics honours student who has recorded the highest GPA of not less than 3.70 for the compulsory Physics courses at 100, 200, 300 and 400 levels based on the criteria as determined by the Faculty.

Alumni Prize for excellence in Computer Science
The prize awarded to the Computer Science Honours Degree student who has recorded the highest Cumulative GPA (CGPA) for all the courses recommended by the Department of Statistics & Computer Science at 100, 200, 300 and 400 levels based on the criteria as determined by the Faculty

Alumni Prize for excellence in Statistics
The prize awarded to the Statistics Honours Degree student who has recorded the highest Cumulative GPA (CGPA) for all the courses recommended by the Department of Statistics & Computer Science at 100, 200, 300 and 400 levels based on the criteria as determined by the Faculty

G.P Wannigama Gold medal for Excellence in Chemistry
The award shall be given annually to the student who has recorded the highest cumulative GPA for all the Chemistry courses with "CH" course code at 100, 200, 300 and 400 levels required for the B.Sc (Special) degree Examination in Science.

REGULATIONS RELATING TO EXAMINATION PROCEDURE, OFFENCES & PUNISHMENTS FOR EXAMINATION CONDUCTED UNDER THE SEMESTER BASED COURSE UNIT SYSTEM

Regulations made by the Senate of the University of Peradeniya and approved by the Council under Section 136 read with Sections 29, 45 and 46 of the Universities Act No. 16 of 1978 as amended by the Universities (Amendment) Act No.7 of 1985.
Examination of a course/course unit may consist of several assessment components (quizzes, within semester and end-semester examinations, term papers, assignments, etc.)

1. Regulations

These Regulations may be cited as the Examination Procedure, Offences & Punishment Regulation No.1 of 2008.

1.1. Part I - Examination Procedure

1. A candidate is expected to be outside the examination hall at least 15 minutes before the commencement of each paper, but shall not enter the hall until he/she is requested to do so by the supervisor.

2. On admission to the hall a candidate shall occupy the seat allotted to him/her and shall not change it except on the specific instruction of the Supervisor.

3. For examinations which have duration of one or more hours, a candidate shall not be admitted to the examination hall after the expiry of half an hour from the commencement of the examination. A candidate shall not be allowed to leave the hall until half an hour has elapsed from the commencement of the examination or during the last 15 minutes of the paper.

4. However, under exceptional circumstances or in cases where examinations have duration of less than one hour, the supervisor in consultation with the Dean of the Faculty concerned may use his discretion in the enforcement of Rule 3.
5. A candidate shall have his/her student record book/student identity card/admission card with him/her in the examination hall on every occasion he/she presents himself/herself for a paper. His/Her candidature is liable to be cancelled if he/she does not produce the student record book/student identity card/admission card when requested to do so. If he/she fails to bring his/her student record book/student identity card /admission card, he/she shall sign a declaration in respect of the paper for which he/ she had not produced the student record book/student identity card/admission card in the form provided for it, and produce the student record book/student identity card/admission card to the Registrar or the relevant Senior Assistant Registrar/Assistant Registrar within the next three working days. If a candidate loses his/her student record book/student identity card/admission card during the examination period, he/she shall obtain a duplicate of student record book/student identity

card/admission card as the case may be from the Registrar or relevant Senior Assistant Registrar/Assistant Registrar for production at the examination hall.

6. A candidate shall not have on his/her person or in his/her clothes or on the admission card, time-table, student record book/student identity card, any notes, signs or formulae etc., except those items that are permitted. All unauthorized items which a candidate has brought with him/her should be kept at a place indicated by the Supervisor/Invigilator.

7. A candidate may be required by the supervisor to declare any item in his/her possession or person.

8. No candidate shall copy or attempt to copy from any book or paper or notes or similar material or from the scripts of another candidate. A candidate shall neither help another candidate nor obtain help from another candidate or any other person. A candidate shall not conduct himself/herself so negligently that an opportunity is given to any other candidate to read anything written by him/her or to watch any practical examination performed by him/her. No candidate shall use any other unfair means or obtain or render improper assistance at the examination.

9. If any candidate was found to have copied from another candidate by an examiner at the time of marking, he/she would be treated as having committed a punishable offence.

10. No candidate shall submit a practical book or field book or dissertation/thesis or project study or answer script or assignment which has been prepared wholly or partly by anyone other than the candidate himself/herself.

11. A candidate shall bring his/her own pens, ink, mathematical instruments, erasers, pencils or any other approved equipment or stationery which he/she has been instructed to bring. The use of a calculator will be permitted only for papers that contain a rubric to that effect.

12. Examination stationery (i.e. writing paper, graph paper, drawing paper, ledger paper, precise paper etc.) will be supplied at the examination hall as and when necessary. No sheet of paper or answer book supplied to a candidate may be torn, crumbled, folded or otherwise mutilated. No papers other than those supplied to him/her by the Supervisor/Invigilator shall be used by candidates. All material supplied, whether used or unused, shall be left behind on the desk and not removed from the examination hall.

13. Every candidate shall enter his/her Index Number/Registration Number on each answer book and on every continuation paper. He/She shall also enter all necessary particulars as required. A candidate who inserts on script an Index Number/Registration Number other than his/her own is liable to be considered as having attempted to cheat.

    A script that bears no Index Number/Registration Number, or has an Index Number/Registration Number which cannot be identified, is liable to be

rejected. No candidate shall write his/her name or any other identifying mark on the answer script unless otherwise authorized.

14. All calculations and rough work shall be done only on paper supplied for the examination, and shall be cancelled and attached to the answer script. Such work should not be done on any other material. Any candidate who disregards these instructions runs the risk of being considered as having written notes or outline of answers with the intention of copying.

15. Any answer or part of an answer, which is not to be considered for the purpose of assessment, shall be neatly crossed out. If the same question has been attempted in more than one place the answer or answers that are not to be considered shall be neatly crossed out.

16. Candidates are under the authority of the supervisor and shall assist him/her by carrying out his/her instructions and those of the Invigilator during the examination and immediately before and after it.

17. Every candidate shall conduct himself/herself in the examination hall and its precincts as not to cause disturbance or inconvenience to the supervisor or his staff or to other candidates. In entering and leaving the hall, he/she shall conduct himself/herself as quietly as possible. A candidate is liable to be excluded from the examination hall for disorderly conduct.

18. Candidates shall stop work promptly when ordered by the Supervisor/Invigilator to do so.

19. Absolute silence shall be maintained in the examination hall and its precincts. A candidate is not permitted for any reason whatsoever to communicate or to have any dealings with any person other than the Supervisor/Invigilator. The attention of the Supervisor/Invigilator shall be drawn by the candidate by raising his/her hand from where he/she is seated.

20. During the course of answering a question paper no candidate shall be permitted to leave the examination hall temporarily. In case of an emergency, the Supervisor/Invigilator may grant him/her permission to do so but the candidate will be under his/her surveillance.

21. No person shall impersonate a candidate at the examination, nor shall any candidate allow himself/herself to be impersonated by another person.

22. Any candidate receiving unauthorized assistance from any person shall be deemed to have committed an examination offence.

23. If circumstances arise which in the opinion of the supervisor render the cancellation or postponement of the examination necessary, he/she shall stop the examination, collect the scripts already written and then report the matter as soon as possible to the Dean of the relevant faculty.

24. The Supervisor/Invigilator is empowered to require any candidate to make a statement in writing on any matter which may have arisen during the course of

the examination and such statement shall be signed by the candidate. No candidate shall refuse to make such a statement or to sign it. If such a candidate refuses to make such a statement or refuses to sign it, the Supervisor/Invigilator shall make his own statement and report the matter to the Dean of the relevant faculty.

25. No candidate shall contact any person other than the Vice-Chancellor, Dean, Head of the Department, the Registrar or the relevant Senior Assistant Registrar regarding any matter concerning the examination.

26. Every candidate shall hand over the answer script personally to the Supervisor/Invigilator or remain in his/her seat until it is collected. On no account shall a candidate hand over his/her answer script to an attendant a minor employee, or another candidate.

27. Every candidate who registers for a course/course unit shall be deemed to have sat the examination of that course/course unit unless he/she withdraws from the course/course unit within the prescribed period for dropping courses/course units. He/She should submit a medical certificate in support of his/her absence, prior to the commencement of the examination. If such a document cannot be submitted before the commencement of the examination. a candidate shall inform of his/her inability to attend the examination to the Dean of the Faculty within a week after the commencement of the examination. The medical certificate shall conform to the Senate Regulations. (See Appendix I.)

28. When a candidate is unable to present himself/herself for any part/section of an examination of a course/course unit, he/she shall notify or cause to be notified this fact to the Dean of the Faculty and relevant Senior Assistant Registrar or Assistant Registrar immediately. This should be confirmed in writing with supporting documents by registered post within two weeks.

29. A student will be eligible for honours if all requirements for the award of honours are met within the prescribed period for the Degree. However, candidates found guilty of an examination offence shall not be eligible for honours.

30. No student shall sit an examination of a course/course unit, if he/she has exhausted the number of attempts that he/she is allowed to sit that particular examination, unless he/she has been granted special permission to do so by the Dean of the relevant faculty.

2. Part II – Examination Offences and Punishments

2.1. Offences

1 Any candidate who violates Examination Rule 6 shall be deemed guilty of the offence of possession of unauthorized documents/items and his/her candidature for the examinations of that semester shall be cancelled and he/she shall be prohibited from sitting any examination of this university for a period varying from 1 - 5 semesters.

2 Any candidate who violates Examination Rule 8 or 9 shall be deemed guilty of the offence of copying and therefore his/her candidature shall be cancelled from the examinations of that semester and he/she, shall be prohibited from sitting any examination of this university for a period of five semesters.

3 Any candidate who violates Examination Rule 10 shall be deemed guilty of the offence of having cheated at the examination and his/her candidature for the examinations of that semester shall be cancelled and he/she shall be prohibited from sitting any examination of this university for period varying from 1 - 9 semesters.

4 Any candidate who is detected removing examination stationery and other material provided for the examination (Rule 12) shall deemed guilty of an examination offence and his/her candidature for the examinations of that semester shall cancelled and he/she shall be liable to be prohibited from sitting any examination of university for a period of three semesters.

5 Any candidate who violates any one or more of the rules in 7, 16, 17, 18, 19 and 20 shall be deemed guilty of the offence of disorderly conduct and his/her candidature shall cancelled from the examinations of that semester and he/she shall be prohibited from sitting any examination of this university for a period of three semesters.

6 Any candidate who violates Examination Rule 21 shall be guilty of the offence of impersonation and his/her candidature for the examinations of that semester shall be cancelled and he/she shall be prohibited from sitting any examination of this university. Impersonator/s may also be liable to any punishment under the Penal Code/Criminal Law. In the event the impersonator is found to be a graduate of this university, his/her Degree shall be withdrawn.

7 Any candidate who violates Examination Rule 22 shall be guilty of an examination offence and his/her candidature for from the examinations of that semester shall be cancelled and he/she shall be prohibited from sitting any examination of this university for a period of 1 - 5 semesters.

8 Any candidate found aiding and abetting in the commission of any of the above examination offences shall be deemed to have committed that offence and shall be punished in respect of the offence in accordance with the provisions of the relevant section.

9 Any other offence which is not covered in the above sections alleged to have been committed by a candidate and reported to the relevant authority by a supervisor or Examiner shall be inquired into and appropriate action taken.

3. Part III - Procedure Regarding Examination Offences Committed by Candidates

1. There shall be an Examination Disciplinary Committee of not less than 3 members of whom at least one member is from outside the Faculty, appointed for each case by the Dean of the relevant faculty to inquire into and make recommendations (including punishments) on examination offences referred to it. Member(s) outside the Faculty shall be selected from a panel of members appointed for this purpose by the Vice Chancellor.

2. **Classification of Offences**

Examination offences may be broadly classified as follows:

2.1 Possession of unauthorized documents/items
2.2 Copying
2.3 Cheating
2.4 Removal of stationery
2.5 Disorderly conduct
2.6 Impersonation
2.7 Unauthorized assistance
2.8 Aiding and abetting in the commission of above offences
2.9 Other offences.

3. **Punishments**
(As specified in Part II -1.1 -1.9)

4. **Procedure**

4.1 In all cases of violation of examination rules detected, the supervisor shall take action as outlined below and forward his/her report to the relevant Dean/Senior Assistant Registrar or Assistant Registrar

4.2 In cases of disorderly conduct the supervisor shall in the first instance warn the candidate to be of good behaviour. Disorderly conduct shall be considered grave, only if such conduct in the opinion of the supervisor is considered as causing a disturbance in the conduct of the examination. Where the candidate persists in unruly or disorderly conduct the supervisor may exclude the candidate from the examination hall and issue him a letter with a copy to the relevant Dean/Senior Assistant Registrar/Assistant Registrar, cancelling his/her candidature from the examination.

4.3 In all cases of examination offences detected, the supervisor shall send a report to the relevant Dean along with any material taken into custody. Material taken into custody should be authenticated by placing the signatures of the candidate and the Supervisor/Invigilator and the date, time and place of detection. A supervisor should give particulars of any incriminating material of which he/she cannot take possession. The Supervisor's report should be countersigned by one of the Invigilators.

4.4 The Dean after preliminary inquiry shall place all reports of examination offences submitted by supervisors for action of the relevant Examination Disciplinary Committee for further action.

4.5 Supervisor, Examiner, Head of Department or any other official of the University who detects an examination offence shall report the matter in writing to the relevant Dean, who shall after preliminary inquiry submit his findings to the relevant Examination Disciplinary Committee for further action.

4.6 Any allegations regarding the commission of examination offences from whomsoever received shall be submitted by the Dean after preliminary inquiry to the relevant Examination Disciplinary Committee for further action.

5. **The Decision**

5.1 The punishment recommended by the Examination Disciplinary Committee shall be submitted to the relevant Faculty Board for a decision and the decision will be reported to the Senate.

Senior Assistant Registrar/Assistant Registrar of the relevant Faculty shall be the Convener/Secretary of the inquiring committee on examination offences.

6. **Appeals Board**

6.1 There shall be an Appeals Board, consisting of three members, appointed by the Vice Chancellor to consider appeals regarding the decision referred to in 5.1 above. Any student on whom a punishment has been imposed may, within a period of two weeks from the date of communication to him/her of such punishment, appeal against such punishment to the Vice Chancellor.

7. **Postgraduate Institutes**

7.1 In the case of Postgraduate Institutes the functions of the Dean and the Faculty Board with regard to these regulations shall be performed respectively by the Director and the Coordinating Committee of the relevant Institute.

4. Appendix I - Procedure Approved by the University of Peradeniya for the Acceptance of Medical Certificates Submitted by Students for Work and Examinations

1. Students are requested to support the absence from course work or examination due to illness by a valid medical certificate conforming to the format of a medical certificate issued by a government hospital. Such medical certificate should be obtained from the following persons:

   University Medical Officer (UMO)
   District Medical Officer
   Consultant Specialist in the particular field
   Head of a Government Base Hospita1
   Medical Superintendent of a Provincial Ayurvedic Government Hospital
   Ayurvedic Physician registered in the Council

   Under exceptional circumstances, medical certificates issued by private hospitals or registered private practitioners could be considered by the University Medical Board.

2. Students who fall ill during sessions or examination time should contact the University Medical Officer at the University Health Centre immediately.

If a student falls sick at home or elsewhere during sessions or examination time he/she or his/her guardian should inform the Dean of the respective Faculty within seven (7) days by telegram/fax/e-mail followed by a letter indicating the nature of the illness and the name of the attending doctor etc. A medical certificate supporting the illness of the student also should be sent to the Dean.

Under exceptional circumstances if a student was not able to meet the deadline mentioned above, he/she could send his/her appeal to the relevant Faculty Board.

The Dean on receipt of such medical certificate/s should follow the following procedure:

i. In case of Western Medical Certificates submitted by students to cover absence from course work or examination:

   a. The medical certificate should be referred to the Chief Medical Officer (CMO) of the university for his/her observations and recommendations.
   b. The CMO in turn examines the certificate and if he/she wishes could summon the student for examination and thereafter send his/her observations, recommendations to the Dean.
   c. In cases where the CMO wishes to convene the Western Medical Board he/she may make arrangements to convene the Western Medical Board and refer the recommendations of the Board to the Dean.
   d. The Dean on receipt of such recommendations from the CMO or Western Medical Board should send it to the Faculty Board for ratification.

ii. In the case of Ayurvedic Medical Certificates submitted by students to cover absence from course work or examinations the following procedure should be followed:

   a. Ayurvedic medical certificates submitted by student in respect of absence from examinations or course work should be circulated among the members of the Ayurvedic Medical Board for their observations by the Senior Assistant Registrar/Assistant Registrar in charge of student registration of each Faculty in consultation with the Deans of the respective Faculties.
   b. Each member of the Ayurvedic Medical Boardmay send his/her observations and recommendations on the face of the medical certificate to the Dean of the respective Faculty through the Senior Assistant Registrar/ Assistant Registrar of the Faculty;
   c. In case where the opinion of the members of the Ayurvedic Medical Board vary the Senior Assistant Registrar Assistant Registrar of the Faculty in consultation with the Dean of the Faculty may take steps to convene a meeting of the Ayurvedic Medical Board.

d. If the members of the Ayurvedic Medical Board think that the medical certificates should be examined at a meeting of the Board, the Dean of the Faculty should be informed accordingly.

e. If the members wish to examine students concerned, they could be summoned before the Medical Board through the Senior Assistant Registrar/ Assistant Registrar of the Faculty.

f. The recommendation of the Ayurvedic Medical Board should be sent to the Faculty Board through the Dean of the Faculty for ratification.

g. The original copies of the Ayurvedic Medical Certificate submitted by students should be kept in the files of the students concerned and copies of such certificates should be sent to the Chief Medical Officer for purposes of record.

3. There shall be two Medical Boards in the University, viz. Western Medical Board and Ayurvedic Medical Board.

i. Western Medical Board

Terms of Reference

a. The Western Medical Board shall consider cases where the Chief Medical Officer of the University has doubt about the validity of the grounds (including medical certificate) upon which the request of students to be excused for absence from course work of examinations.

b. The Chief Medical Officer of the University shall convene the Western Medical Board if and when necessary.

c. The Board has the right to call students before the Board when necessary for purposes of interview, examination and investigations.

d. Recommendations of the Medical Board should be sent to the Faculty Board through the Dean of the respective Faculty.

e. The Western Medical Board should consist of the Heads of the Departments of Medicine, Surgery and Psychiatry of the Faculty of Medicine or their nominees and the CMO of the University.

ii. Ayurvedic Medical Board

Composition

The Ayurvedic Medical Board shall consist of three (3) persons appointed by the senate of the University.

Terms of Reference

a. The Ayurvedic Medical Board shall consider Ayurvedic Medical Certificates submitted by students requesting exemption from examinations or course work and make recommendations to the Senate through the Deans of the respective Faculties.

b. The Board shall meet at least once within a semester. The Senior Assistant Registrar/ Assistant Registrar in charge of student registration in consultation with the Dean of the respective Faculty shall convene meetings of the Ayurvedic Medical Board whenever

necessary and co-ordinate the work between the Faculty and the Ayurvedic Medical Board.

c. The board has the right to call students before the Board when necessary for purposes of interviews, examination and investigations. Such requests should be sent to the students through the Senior Assistant Registrar/Assistant Registrar in charge of student registration of each Faculty.

Guidelines for the Functioning of the Ayurvedic Medical Board

a. When accepting Ayurvedic Medical Certificates, caution is to be exercised by accepting from only those who are registered in the Ayurvedic Medical Council.

b. General or Special registered Ayurvedic Medical Practitioners could recommend on anyone occasion leave up to 14 days at a stretch. Those with more than the above amount should get an endorsement from the Medical Officer in charge of the closest Government Ayurvedic Hospital or Government Ayurvedic Dispensary.

c. The decision on leave stipulated in Medical Certificates from Ayurvedic Hospitals. Government Dispensaries or Local Government Ayurvedic Dispensaries rests with the Board.

d. This Board possesses the right to question the validity of any Ayurvedic Medical Certificate.

e. The Board possesses the right to summon before them any student submitting an Ayurvedic Medical Certificate, if necessary.

4. When students request exemption from examinations of course work upon the basis of illness, the ultimate decision on question of exemption, repetition of course and of eligibility for honours, shall be the functions of the relevant Faculty Board upon the recommendation of the Medical Board or the Chief Medical Officer.

STUDENT LIFE

The University of Peradeniya was built with the goal of providing an environment suitable for the intellectual, emotional and personal development of students. The unique setting and infrastructure of the university together with the diverse student population creates a opportunity for a fulfilling lifestyle.
Students of the Faculty of Science are afforded all of the services and opportunities of the University of Peradeniya. More information on university facilities and resources can be found through the official university website at: https://www.pdn.ac.lk/student/student.php

Welfare Services

I. Residence

The University provides accommodation to the students in the Halls of Residence situated within the University premises. The basis on which the students are allocated to Halls of Residence may change from time to time, depending on the number of vacancies available in the Halls of Residence.

II. Sports and Recreation

For recreation, facilities such as playgrounds, tennis courts and a cinder running track are located within the University premises. Students can participate in a variety of team and individual sports including cricket, rugby, soccer, hockey, tennis volley-ball, athletics etc. A modern gymnasium is situated about 500 meters away from the faculty equipped for badminton, basketball, netball, volleyball, table-tennis, trampolining, weight lifting, etc.

Department of Physical Education/Gymnasium

Phone intercom 2164 (Director)
intercom 2162 (office)
intercom 2163 (swimming pool)
opening hours 7.00 a.m. to 8.00 p.m.

The Faculty of Arts Theatre often screens cinematic films of international renown, which are usually free for students. The Sarathchandra open-air amphitheatre is a land mark of the university, where most dramas performed in the university are staged.

III. Medical Centre

The University Health Centre is open to all students during week days in two sessions (morning and afternoon) per day. During the weekends and public holidays, only emergency cases are treated. University Medical Officers are on call to attend to emergencies.
Contact information

Chief Medical Officer Dr. P.M.A. Samarakkody
081-238-8152 (direct)
2024 (intercom)
Office/Lab 2028
Female wards/ Pharmacy 2022, 2026

IV. Computer and Internet Access

The Faculty Computer Centre is located at the ground floor of the administrative building. The centre is open to all science faculty students where computers with most current software and broadband internet facilities are available.

V. Student Counseling

The faculty of Science maintains a student counseling service to assist and guide students who have problems pertaining to academic, social and personal matters. These services are offered by senior members of the academic staff.

VI. Banking Facilities

The People's Bank and the Bank of Ceylon have their sub-branches in the University premises in addition to the main branches at Peradeniya. Mahapola scholarships to students are paid through the Bank of Ceylon, campus branch, which is located in the students centre.

VII. Canteen

The University maintains a canteens in each of the Halls of Residence. In addition, the Science Faculty has its own canteen at ground floor of the Science Education Building. The Students' Centre which is situated near the Gymnasium also houses a canteen for students.

VIII. Post Office and Telephone Exchange

A Sub Post Office and the University Telephone Exchange are located on the hill opposite the New Arts Theatre.

IX. Barber saloon, Laundry and Tailoring Shop

These are available in the Students' Centre and at the Peradeniya town.

X. Police and Security Service

The closest police station is situated on the Kandy-Colombo road near the Peradeniya Teaching Hospital.

Any incidents regarding the security of University property or any incident of breach of law may be reported to the security personnel in the security posts at the faculties and the senate building. The main Security Office is located near the New Arts Theatre.

Marshels division
Contact information

Office	081-239-2423
	2423 (intercom)
Chief Marshal	077-599-6290

Security office

Office	081-238-9182
Chief security officer	2134 (intercom)

XI. Book Shops and Grocery Shops

The faculty book shop is situated at ground floor of the Science Education Unit building, next to the faculty canteen. The main book shop of the university is situated in the University Students' Centre. University publications can be purchased from the sales Outlet at the Senate building. Groceries are available in the cooperative store at the North End (known as USO), and at Peradeniya town.

XII. Places of Worship

A Buddhist Temple, a Hindu Temple, a Mosque, a Christian church and a Catholic Church are located in the premises of the University.

STUDENT SOCIETIES

Students are encouraged to join the societies in the Faculty and in the University for the purpose of furthering academic and social objectives. There are a number of societies and associations registered in the University. Some of them are listed below.

Societies of the University and Faculty of Science

1. Applied Sciences Society
2. Art Circle of Faculty of Science
3. Botanical Society
4. Buddhist Brotherhood
5. Chemical Society
6. Computer Society
7. English Drama Society
8. Gandarwa Sabhawa
9. Hantana Conservation Society
10. Helahanda Students' Society
11. Hindu Students Society
12. Mathematical Society
13. Muslim Majlis
14. Music Society
15. Newman Society
16. Photographic Society
17. Physical Society
18. Rotaract Club
19. Sinhala Natya Mandalaya
20. Sinhala Sangamaya
21. Soba Sansadaya
22. Socialist Students' Union
23. Statistical Circle
24. Student Christian Movement
25. Tamil Sangeetha Natya Sangam
26. University Botanical Society
27. University Explorers' Club
28. University Geological Society
29. Zoologists' Association of University of Peradeniya

SUMMARY OF COURSES OFFERED

- **FOUNDATION COURSES**

Foundation courses which are conducted only at the 100 level are compulsory for all students. The grades of the EN 100 will not be counted when the final GPA is calculated.

Course Number	Course Title	No. of credits	Compulsory for				
			B.Sc. Degree	B.Sc. Hons. Degree	Applied Sciences	SOR	CM
EN 100	Basic English	2	√	√	√	√	√
CS 100	Computer Applications	2	√	√	√	√	√
BL 100*	Basic Life Sciences	2	√	√	√	√	
MT 100†	Mathematics for Biological Sciences	2	√	√	√		
MT120†	Foundation Course in Mathematics	2					√
FND114‡	Law and Ethics	3					√

* Compulsory for those who have not offered Biology at the G.C.E. (A/L) Examination

† Compulsory for those who have not offered Combined Mathematics or Mathematics at the G.C.E. (A/L) Examination

‡ Compulsory for those who have offered Combined Mathematics or Mathematics at the G.C.E. (A/L) Examination

- **PRINCIPAL SUBJECT AREA**

BIOLOGY

At the 100 Level, Biology is offered as principal subject areas, Biology* (8 credits) and Biology** (16 credits) jointly by the Departments of Botany, Molecular Biology & Biotechnology and Zoology. Both Biological and Physical Science students can offer these subjects.

100 LEVEL - BIOLOGY				
Course Number	Course Title	No. of credits	Compulsory for	
			Biology*	Biology**
BL 101	Basic Biology	2	√	√
BL 102	Plant & Animal Form & Function	2	√	√
BL 103	Basic Ecology	2	√	√
BL 107	Basic Microbiology	2	√	√
BL 115	Biomolecules	2		√
BL 116	Introductory Environmental Biology	2		√
BL 117	Biotic Interactions	2		√
BL 118	Introductory Evolutionary Biology	2		√
BL 120*	Introduction to Biotechnology and its Applications	2		
	Total		8	16

*optional course

Selection for the Special Degree in Biology

The Special Degree Program in Biology will be offered jointly by the Departments of Botany, Molecular Biology & Biotechnology and Zoology to undergraduates in the Biological Science stream who have successfully completed Biology* or Biology** program at 100 level and the stipulated course units from Botany, Molecular Biology & Biotechnology and Zoology at 200 level.

200 LEVEL – BIOLOGY				
Course Number	Course Title	No. of credits	Prerequisites	Compulsory for Special Degree
BT 201	Plant Diversity 1	2		√
BT 202	Plant Diversity II	2		√
BT 203	Vegetation Dynamics & Measurements	2		
BT 205	Angiosperm Morphology & Anatomy	2		
BT 206	Plant Physiology	2		
BT 207	Plant Biochemistry	2		
MB 201	Biological Chemistry	3	BL 101,CH 101, CH 102	√
MB 206	Principles of Genetics	3	BL 101	√
MB 226	Molecular Genetics	3	BL 101, CH 101,CH 102	√
ZL 201	Animal Embryology	2		
ZL 206	Invertebrate Diversity	3		√
ZL 215	Zoogeography & Sri Lankan Fauna	2		
ZL 216	Vertebrate Diversity	3		√
ST 202 / BT 209 †	Applied Statistics / Biostatistics †	2		√
	Total	**33**		**21**

† BT 209 is equivalent to ST 202.

The students for Biology Special Degree will be selected from among those who have successfully completed 100 and 200 level courses**.**

Selection of Course Units for the Special Degree in Biology

For students who are selected for the Special Degree in Biology, specified course units from Botany, Molecular Biology & Biotechnology and Zoology at 300/400 levels, given in the table will be considered as one principal subject area - **Biology**.

300 AND 400 LEVEL BIOLOGY				
Course Number	Course Title	No. of credits	Prerequisites	Compulsory for Special Degree
BT 301	Analytical Methods	2		
BT 302	Advanced Microbiology	2		√
BT 303	Soil fertility & Management	2		
BT 308	Plant Systematics	2		√
BT309	Biodiversity Conservation & Management	2		√
BT 310	Ecosystems of Sri Lanka: Ecology & Conservation	2		√
BT 311	Plant Reproductive Biology & Plant Breeding	2	BT 307	
MB 306	Recombinant DNA Technology	3	MB 201, MB 226	√
MB 311	Molecular Cell Biology	3	MB 201	
MB 322	Molecular Biotechnology	2	MB 226, MB 306	√
MB 326	Bioinformatics	3	MB 226	√
MB 333	Molecular Phylogenetics	2	MB 206, MB 226	
ZL 301	Functional Histology	2		√
ZL 302	Comparative Anatomy & Animal Physiology	2		
ZL 303	General Entomology	2		
ZL 304	Biology of Parasites	2		
ZL 307	Fish Biology	2		√
ZL 314	Evolutionary Biology and Systematics	2		
ZL 318	Amphibian & Reptilian Biology	2		√
ZL 319	Avian & Mammalian Biology	2		√
HR 301	Human Resource Management	2		
	Total	**43**		**24**
BT 407	Advanced Plant Systematics	2	BT 308	
BT 409	Dynamic Plant Ecology	3	BT 309, BT 310	
BT 412	Applied Microbiology	2	BT 302	
MB 412	Biotechnology Industry	2	MB 322	
ZL 401	Taxonomy, Field sampling, Biostatistics	2		√
ZL 403	Applied Entomology	3		
ZL 404	Applied Parasitology	3	ZL 304	
ZL 406	Environmental Biology	3		

ZL 412	Biodiversity & Conservation Biology	3		
ZL 421	Scientific writing and presentations	2		√
BL 401	Evolutionary Biology	2		
BL 403 † / ZL 431	Independent Study / Seminar	1 2		√
SI 401	Industrial Training	2		
BL 404	Research Project	6-8		√
	Total	**40-42**		**11**

† Equivalent to BT 414

When Biology is selected as the subject of specialization (Requirements to pass the Special Degree – item 17 of page 07 of the Faculty Handbook), a minimum total of 77 credits may be earned over a period of four years. The balance credit requirement to make up a minimum total of 105 credits from the Principal Subject Areas may be selected from any Principal Subject Area subject to the approval of the respective Department of Study.

BOTANY

At the 100 Level two principal subject areas, Biology* and Biology**, having 8 and 16 credits respectively are offered jointly by the Departments of Botany and Zoology. Both Biological and Physical Science students could offer these subjects.

From the 200 Level onwards Botany is offered as a principal subject area. The students who have followed Biology* as a principal subject area at the 100 level are permitted to take Botany as a principal subject at 200 and 300 Levels. Other students who wish to follow selected course units in Botany would also be accommodated subject to availability of places. Those students who have completed Botany as a principal subject at the 200 Level shall be eligible for selection to a Special Degree in Botany at the end of the second year subjected to their fulfillment of compulsory requirements for the botany special course. The Special Degree students spend an extra two (02) years learning courses in a range of areas in Botany and carrying out a research project. The department also conducts three course units for the fourth year students in the Applied Sciences Degree Programme. The General Degree students after successful completion of three years with required GPA are permitted to register for the Applied Sciences Degree.

The laboratory work of all course units offered by the Department of Botany shall be evaluated on a continuous assessment basis as well as an end semester examination.

100 LEVEL - BIOLOGY offered jointly by the Departments of Botany, and Zoology.						
Course Number	Course Title	No. of Credits	Biology*	Biology**	Compulsory for	
					General Degree	Special Degree
BL 101	Basic Biology	2	√	√		√
BL 102	Plant & Animal Form & Function	2	√	√		√
BL 103	Basic Ecology	2	√	√		√
BL 107	Basic Microbiology	2	√	√		√

BL 115	Biomolecules	2		√		
BL 116	Introductory Environmental Biology	2		√		
BL 117	Biotic Interactions	2		√		
BL 118	Introductory Evolutionary Biology	2		√		
BL 120*	Introduction to Biotechnology and its Application	2				
	Total		**8**	**16**		**8**

* optional subject

200 LEVEL – BOTANY					
Course Number	Course Title	No.of Credits	Pre-requisites	Compulsory	
				General Degree	Special Degree
BT 201	Plant Diversity I	2		√	√
BT 202	Plant Diversity II	2		√	√
BT 203	Vegetation Dynamics & Measurements	2			
BT 204 †	Enzymology	2			
BT 205	Angiosperm Morphology & Anatomy	2			
BT 206	Plant Physiology	2			√
BT 207	Plant Biochemistry I	2			
BT 209 ††	Biostatistics	2			√
FS 202	Food Science I	2			
	Total	**18**		**4**	**8**

† Equivalent to MB 221 offered by the Department of Molecular Biology & Biotechnology.

†† Equivalent to ST 202 offered by the Department of Statistics & Computer Science and ZL 205 offered by the Department of Zoology.

300 LEVEL – BOTANY (Students intending to select Botany as a principal subject area at 300 level must have offered Botany as a principal subject at the 200 level).					
Course Number	Course Title	No. of Credits	Pre-requisites	Compulsory	
				General Degree	Special Degree
BT 301	Analytical Methods	2			
BT 302	Advanced Microbiology	2			√
BT 303	Soil Fertility & Management	2			
BT 304	Plant Pathology	2			√
BT 305	Developmental Physiology & Postharvest Technology	2	BT 207		√
BT 307	General & Molecular Genetics †	2			
BT 308	Plant Systematics	2			√
BT 309	Biodiversity Conservation & Management	2	BT 209		√
BT 310	Ecosystems of Sri Lanka:	2			√

	Their Ecology & Conservation				
BT 311	Plant Reproductive Biology & Plant Breeding	2	BT 307/MB 206		√
BT 312	Economic Botany	2			
BT 313	Independent Study	1			√
FS 302	Food Science II	2			
HR 301	Human Resource Management	2			
	Total	**27**			**15**

† offers only for students who have not followed MB 206

400 LEVEL – BOTANY					
Course Number	Course Title	No. of Credits	Pre-requisites	Compulsory	
				General Degree	Special Degree
BT 401	Nitrogen Fixation	3			
BT 402	Rhizobiology	3	BT 302		
BT 403	Plant Toxicology	2	BT 207		
BT 404	Advanced Plant Pathology	2	BT 304		
BT 405	Plant Biochemistry II	3	BT 207		
BT 406	Plant Molecular Genetics & Biotechnology	3	BT 307		
BT 407	Advanced Plant Systematics	2	BT 308		
BT 408	Advanced Plant Physiology	2	BT 206, BT 207		
BT 409	Dynamic Plant Ecology	3	BT 309, BT310		
BT 410	Forestry	2			
BT 411	Herbarium	1			√
BT 412	Applied Microbiology	2	BT 302		
BT 413	Advanced Plant Developmental Physiology	2	BT 305		
BT 414	Independent Study	1			√
BT 415	Research Project	6-8	BT 209		√
BT 416	Seed Biology and Technology	2			
BT 417	Phytogeography	2	BT 308		
BT 418	Evolution and Diversity of Cryptogamic Plants	2			
BT 419	Physiology and Management of Ornamental Plants	2			
BT 420	Biological Nitrogen Fixation	2	BT 302		
SI 401	Industrial Training	2			
	Total	**45-47**			**10**

CHEMISTRY

100 LEVEL - CHEMISTRY					
Course Number	Course Title	No. of Credits	Pre-requisites	Compulsory	
				General Degree	Special Degree
CH 101	Principles of Chemistry I	3		√	√
CH 102	Principles of Chemistry II	3	CH 101	√	√
CH 108	Elementary Chemistry Laboratory I	1		√	√
CH 109	Elementary Chemistry Laboratory II	1	CH 108	√	√
	Total	**8**		**8**	**8**

200 LEVEL – CHEMISTRY					
Course Number	Course Title	No. of Credits	Pre-requisites	Compulsory	
				General Degree	Special Degree
CH 211	Inorganic Chemistry I	2	CH 101, CH 102	√	√
CH 212	Inorganic Chemistry II	1	CH 211		√
CH 218	Inorganic Chemistry Laboratory I	1	CH108, CH211	√	√
CH 221	Organic Chemistry I	2	CH 101, CH 102	√	√
CH 222	Introductory Organic Synthesis	1	CH 221		√
CH 228	Organic Chemistry Laboratory I	1	CH 109, CH 221	√	√
CH 231	Physical Chemistry I	2	CH 101, CH 102	√	√
CH 232	Molecular Properties, Molecular spectroscopy and Spectroscopic Instrumentation	1	CH 231		√
CH 238	Physical Chemistry Laboratory I	1	CH 231	√	√
	Total	**12**		**9**	**12**

300 LEVEL – CHEMISTRY					
Course Number	Course Title	No. of Credits	Pre-requisites	Compulsory	
				General Degree	Special Degree
CH 316	Special Topics in Inorganic Chemistry	2	CH 211		
CH 317	Advanced Inorganic Chemistry	3	CH 211		√
CH 319	Advanced Inorganic Chemistry Laboratory	2	CH 218		√

CH 321	Chemistry of Biomolecules	1	CH 221		√
CH 324	Organic Chemistry II	2	CH 221, CH 222		√
CH 326	Advanced Organic Chemistry I	2	CH 221		
CH 328	Organic Chemistry Laboratory II	1	CH 228	√	
CH 329	Advanced Organic Chemistry Laboratory	2	CH 228		√
CH 330	Advanced Physical Chemistry I	3	CH 232, CH 331		√
CH 331	Physical Chemistry II	2	CH 231	√	√
CH 332	Physical Chemistry III	1	CH 231		√
CH 338	Physical Chemistry Laboratory II	1	CH 238	√	
CH 339	Advanced Physical Chemistry Laboratory II	2	CH 238		√
CH 341	Analytical Chemistry	3	CH 231		√
CH 342	Computer Applications and Instrumentation	2	CH 231		√
CH 348	Analytical and Inorganic Chemistry Laboratory	1	CH 218	√	
CH 351	Biological Chemistry I	2	CH 321		√
CH 361	Environmental Chemistry	3	CH 211, CH 221		
CH 369	Industrial Training	1			√
CH 371	Industrial Chemistry	3	CH 221, CH 231		
MB 331	Fermentation Technology	2			
HR 301	Human Resource Management	2			
	Total	**43**		**5**	**26**

400 LEVEL – CHEMISTRY					
Course Number	Course Title	No. of Credits	Pre-requisites	Compulsory	
				General Degree	Special Degree
CH 411	Advanced Radio Chemistry	1	CH 211, CH 212		
CH 414	Bioinorganic Chemistry	1	CH 211		
CH 416	Advanced Inorganic Chemistry II	2	CH 317		√
CH 417	Topics in Solid State Chemistry	2	CH 211		√
CH 424	Special topics in Organic Chemistry	1	CH 221, CH 326		
CH 425	Advanced Organic Chemistry II	3	CH 324, CH 326		√
CH 426	Natural Product Chemistry	3	CH 324		√

CH 435	Advanced Physical Chemistry II	2	CH 331		√
CH 436	Advanced Physical Chemistry III	2	CH 331		√
CH 437	Modern Topics in Physical Chemistry	2	CH 330 CH342		
CH 438	States of Matter	2	CH 317, CH 330		
CH 443	Advanced Analytical Chemistry	3	CH341		√
CH 448	Analytical /Instrumental Chemistry Laboratory	1	CH 443		√
CH 455	Biological Chemistry II	2	CH 351		√
CH 456	Proteins	1	CH 321		
CH 458	Biological Chemistry Laboratory	1	CH351		
MB 416	Environmental Biotechnology	2			
CH 491	Seminar	1			√
CH 492	General Aspects and Recent Developments in Chemistry	1			√
CH 499	Research Project	6-8			√
SI 401	Industrial Training	2			
	Total	**43-45**			**28**

COMPUTER SCIENCE

100 LEVEL - COMPUTER SCIENCE

Course Number	Title	No. of Credits	Pre-requisites	Compulsory for	
				General Degree	Special Degree
CS 101	Introduction to Computer Science	3		√	√
CS 102	Programming Techniques	3		√	√
CS 104	Structured oriented Programming practical	1	CS 101, CS 102	√	√
CS 105	Object oriented Programming practical	1	CS 101, CS 102	√	√
	Total	**8**		**10**	**10**

200 LEVEL - COMPUTER SCIENCE

Course Number	Title	No. of Credits	Pre-requisites	Compulsory for	
				General Degree	Special Degree
CS 201	Data Structures	2	CS 101, CS 102	√	√
CS 202	Data Structures Practicals	1	CS 104, CS 105, CS 201	√	√

CS 203	Database Management Systems	2	CS 101, CS 102	√	√
CS 204	Programming using Database Management Systems	1	CS 104, CS 105, CS 202, CS 203	√	√
CS 205	Computer Architecture	3	CS 101, CS 102		√
CS 206	Computer Device Interfacing	2	CS 205		√
CS 209	Concurrent Programming	1	CS 105, CS 201		
BC 201	Basic Computing I	2	CS 100		
BC 202	Micro Computer Applications I	1	BC 201		
	Total	**15**		**6**	**11**

300 LEVEL - COMPUTER SCIENCE

Course Number	Title	No. of Credits	Pre-requisites	Compulsory for	
				General Degree	Special Degree
CS 303	Operating Systems Concepts	3	CS 201	√	√
CS 304	Project in Computer Science I	3	CS 311, CS 315, CS 303		√
CS 305	Communication Networks	2	CS 303	√	√
CS 306	Compiler Construction	3	CS 315, CS 303		
CS 307	Computer Graphics	3	CS 315		√
CS 308	Computer Graphics Programming	2	CS 307		√
CS 309	Object Oriented Analysis and Design	3	CS 102, CS 201		√
CS 310	Server Side Web Programming	3	CS 104, CS 105, CS 203, CS 204		√
CS 311	Software Engineering	2	CS 201	√	√
CS 312	Human Computer Interaction Design	2	CS 201, CS 315		
CS 313	Digital Image Processing	2	CS 315		
CS 314	Image Processing practical	1	CS 313		
CS 315	Design and Analysis of Algorithms	2	CS 201, CS 202		
BC 301	Basic Computing II	2	BC 201, BC 202		
BC 302	Micro Computer Applications II	1	BC 301		
HR 301	Human Resource Management	2			
	Total	**36**		**7**	**21**

400 LEVEL - COMPUTER SCIENCE					
Course Number	Title	No. of Credits	Pre-requisites	Compulsory for	
				General Degree	Special Degree
CS 401	Artificial Intelligence and Expert Systems	3	CS 311, CS 315		
CS 402	Intelligent Systems in CIM	2	CS 409		
CS 404	Parallel Processing	3	CS 206, CS 303, CS 306		
CS 406	Foundations of Distributed Computing	3	CS 102, CS 305		
CS 408	Computer Vision	2	CS 313, CS 314		
CS 409	Neural Networks and Fuzzy Logics	3	CS 401		
CS 410	Internet and Multimedia Systems	2	CS 305		
CS 411	Multimedia practical	1	CS 410		
CS 412	Mobile and Pervasive Computing	2	CS 305, CS 406		
CS 413	Information and Network Security	2	CS 305		
CS 414	Software Project Management	2	CS 311		
CS 415	Industrial Training	3			
CS 421	Project in Computer Science II- Individual Project Work	6-8	CS 311		√
CS 423	Seminar	1			√
ST 402	Data Mining Techniques	3	CS 409		
ST 403	Statistics for Bioinformatics	2			
	Total	**40-42**			**9**

Note: Students opting to follow the Special Degree course in Computer Science are required to select courses from the following course units in addition to fulfill their credit requirements.

ST102 (3 credits) Introduction to Probability Theory
ST201 (3 credits) Probability Theory
ST203 (3 credits) Theory of Statistics
MT308 (2 credits) Combinatories
MT209 (2 credits) Graph Theory
MT311(3 credits) Linear Programming
MT407 (3 credits) Optimization Theory
GL316(2 credits) Remote Sensing and GIS

ENVIORNMENTAL SCIENCE

Those students who have completed Chemistry as a principal subject at the 200 Level shall be eligible for selection to a Special Degree in Environmental Science at the end of the second year subjected to their fulfillment of compulsory requirements to be selected for the Environmental Science Special Degree Programme.

300 LEVEL – ENVIORNMENTAL SCIENCE				
Course Number	**Title**	**No. of Credits**	**Pre-requisites**	**Compulsory for special degree**
ES 301	Concepts in Environmental Science	3		√
ES 302[1]	Biological Indicators in Environmental Management	2		
ES 303	Water and Soil Pollution	3		√
ES 304	Environmental Law and EIA	2		√
ES 305[2]	Remote Sensing and GIS	3		√
ES 306[3]	Ecosystems of Sri Lanka: Their Ecology and Conservation	2		
ES 307	Wetlands and their Exploitation	2	ZL 206	
ES 308	Marine Resources and Marine Pollution	2	ZL 206	
ES 309[4]	Analytical Chemistry	3	CH 231	√
ES 310[5]	Hydrology	2		
ES 311	Mining and the Environment	2		
ES 312[6]	Biodiversity, Conservation and Management	2		
ES 313	Energy, Climate and Environment	3		√
ES 314	Geological Environment and Earth Resources	2		
ES 315[7]	Advanced Microbiology	2		
ES 316	Mathematics for Environmental Modeling	3		
HR 301	Human Resource Management	2		
	Total	**40**		**17**

400 LEVEL – ENVIORNMENTAL SCIENCE				
Course Number	**Title**	**No. of Credits**	**Pre-requisites**	**Compulsory for special degree**
ES 401	Geologic and Hydrologic Hazards	2		√
ES 402[8]	Cleaner Production for Industry	2		
ES 403	Environmental Management and Sustainable Development	2		√
ES 404	Air and noise Pollution	3		√
ES 405	Waste and Waste Management	3		√
ES 406	Environmental Analysis Laboratory	2	ES 309, CH 238	√
ES 407[9]	Ecotourism and Nature Conservation	3	ZL 216, ZL 332	
ES 408[10]	Biodiversity and Conservation Biology	3	ZL 216, ZL 332	
ES 409[11]	Oceanography and Coastal Geomorphology	2		
ES 410[12]	Environmental Biotechnology	2		
ES 411	Medical Geology and Environmental Toxicology	2		
ES 412	Nanotechnology and the Environment	2		
ES 413	Environmental Economics	2		
ES 414[13]	Applied Microbiology	2	BT 302	
ES 415[14]	Research Methodology & Scientific Writing	2		√
ES 416	Seminar	1		√
ES 417	Research Project	6-8		√
	Total	**41-43**		**21-23**

[1]Equivalent to ZL 306
[2]Equivalent to GL 327
[3]Equivalent to BT 310
[4]Equivalent to CH 341
[5]Equivalent to GL 321
[6]Equivalent to BT 309
[7]Equivalent to BT 302
[8]Equivalent to AS 432
[9]Equivalent to ZL 405
[10]Equivalent to ZL 412
[11]Equivalent to GL 439
[12]Equivalent to MB 416
[13]Equivalent to BT 412
[14]Equivalent to AS 402

GEOLOGY

100 LEVEL - GEOLOGY					
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Compulsory for**	
				General Degree	**Honours degree**
GL 111	Earth Processes	3		√	√
GL 112	Earth Processes Practical	1	GL 111	√	√
GL 113	Earth Materials	3		√	√
GL 114	Earth Materials Practical	1	GL 113	√	√
	Total	**08**		**08**	**08**

200 LEVEL - GEOLOGY					
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Compulsory for**	
				General Degree	**Honours degree**
GL 211	Optical Mineralogy	3	GL 111, GL 112, GL 113, GL 114	√	√
GL 212	Introductory Petrology	3	GL 111, GL 112, GL 113, GL 114	√	√
GL 213	Geochemistry	2	GL 111, GL 112, GL 113, GL 114		
GL 214	Geophysics	2	GL 111, GL 112, GL 113, GL 114		
GL 215	Economic Geology	3	GL 111, GL 112, GL 113, GL 114	√	√
GL 216	Geomorphology	1	GL 111, GL 112, GL 113, GL 114		
GL 217	Soil and Rock Mechanics	2	GL 111, GL 112, GL 113, GL 114		
GL 218	Photo-geology	2	GL 111, GL 112, GL 113, GL 114		
GL 219	Introductory Structural and Field Geology	2	GL 111, GL 112, GL 113, GL 114	√	√
	Total	**20**		**11**	**11**

300 LEVEL - GEOLOGY					
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Compulsory for**	
				General Degree	**Honours degree**
GL 321	Hydrology	2			
GL 322	Geology of Sri Lanka	2		√	√
GL 323	Metamorphic petrology	3	GL 211, GL 212	√	√
GL 324	Igneous petrology	3	GL 211, GL 212		√
GL 325	Sedimentary Petrology	3	GL 211, GL 212		√
GL 326	Applied Geophysics	2	GL 214		

GL 327	Remote Sensing, GIS and GPS	3			
GL 328	Structural Geology and Tectonics	3	GL 211 GL 212	√	√
GL 329	Analytical Techniques in Geology	3			
GL 330	Hydrogeology	2			
GL 331	Environmental Geology	2			
GL 332	Engineering Geology	3	GL 217		
GL 333	Economic Geology and Gemmology	2	GL 211, GL 212 GL 215		
GL 334	Field Geology	2	GL 211, GL 212 GL 219	√	√
	Total	**35**		**10**	**16**

400 LEVEL - GEOLOGY					
Course Code	**Course Title**	**No. of Credits**	**Pre-requisites**	**Compulsory for**	
				General Degree	**Honours degree**
GL 431	Applied Hydrogeology	2	GL 330		
GL 432	Isotope Geology	2			
GL 433	Surveying and Leveling	2			
GL 434	Scientific Writing and Communication	1			√
GL 435	Seminar on Special Topics in Geology	1			√
GL 436	Field Geology Assessment	2	GL 334		√
GL 437	Seismology	2			
GL 438	Quaternary Geology	1	GL 325		
GL 439	Oceanography	2			
GL 440	Exploration and Mining Geology	2			
GL 441	Petroleum Geology	2	GL 325		
GL 442	Advanced Metamorphic Petrology	3	GL 323		†
GL 443	Advanced Igneous Petrology	3	GL 324		†
GL 444	Advanced Sedimentary Petrology	3	GL 325		†
GL 445	Advanced Engineering Geology	2	GL 332		
GL 446	Research Project	8			√
GL 447	Industrial Training	4			√
	Total	**42**			**19**

† Only One of these course units is compulsory

MATHEMATICS

100 LEVEL – MATHEMATICS						
Course Number	Course Title	No. of credits	Prerequisites	Compulsory for		
				General Degree		Special Degree
				*	* *	
MT101	Vector Methods	2			√	√
MT102	Introduction to Probability Theory	3			√	√
MT103	Differential Equations	2			√	√
MT104	Abstract Algebra I	3		√	√	√
MT105	Real Analysis I	3		√	√	√
MT106	Classical Mechanics I	3	MT 105		√	√
	Total	**16**		**6**	**16**	**16**

200 LEVEL – MATHEMATICS						
Course Number	Course Title	No. of Credits	Pre-requisites	Compulsory for		
				General Degree		Special Degree
				*	**	
MT 201	Groups, Rings and Fields	3	MT 104	√	√	√
MT 202	Real Analysis II	3	MT 105	√	√	√
MT 203	Ordinary Differential Equations	3	MT 103			
MT 204	Mathematical Methods	3	MT 101		√	√
MT 205	Classical Mechanics II	2	MT 106			
MT 206	Mathematical Modelling	3			√	√
MT 207	Numerical Analysis I	2			√	√
MT 208	Set Theory	1				
MT 209	Graph Theory	2				
	Total	**22**		**6**	**14**	**14**
300 LEVEL – MATHEMATICS						
Course Number	Course Title	No. of Credits	Pre-requisites	Compulsory for		
				General Degree		Special Degree
				*	**	
MT 301	Linear Algebra	3	MT 201	√	√	√
MT 302	Real Analysis III	3	MT 202	√	√	√
MT 303	Differential Geometry	2				
MT 304	Partial Differential Equations	2	MT 103			
MT 305	Group Theory	3	MT 201			√
MT 306	Topology I	3	MT 105			√
MT 307	Complex Analysis I	2	MT 202			√
MT 308	Combinatorics	2	MT 209			
MT 309	Number Theory	3	MT 201			√

MT 310	Fluid Mechanics I	3	MT 202, MT 204		√	√
MT 311	Linear Programming	3				
MT 312	Numerical Analysis II	3	MT 207		√	√
HR 301	Human Resource Management	2				
	Total	**34**		**6**	**12**	**23**

* Mathematics as a single subject

** Mathematics as two subjects

400 LEVEL – MATHEMATICS				
Course Number	Course Title	No. of Credits	Pre-requisites	Compulsory for Special Degree
MT 401	Galois Theory	3	MT 301, MT 305	√
MT 402	Measure Theory	3	MT 302	√
MT 403	Topology II	3	MT 306	√
MT 404	Complex Analysis II	3	MT 306, MT 307	
MT 405	Functional Analysis	3	MT 301, MT 306, MT 402	√
MT 406	Fluid Mechanics II	3	MT 310	
MT 407	Optimization Theory	3	MT 311	√
MT 408	Independent Study /Project Work	6-8		√
MT 416	Nonlinear Dynamics	3	MT 204, MT 304	
SE 401	Industrial Training	2		
	Total	**32-34**		**21**

MOLECULAR BIOLOGY AND BIOTECHNOLOGY

100 LEVEL - MOLECULAR BIOLOGY AND BIOTECHNOLOGY					
Course Number	Course Title	No. of credits	Pre-requisites	Compulsory for	
				General Degree	Special Degree
BL 101	Basic Biology	2		√	√
CH 101	Principles of Chemistry I	3		√	√
CH 102	Principles of Chemistry II	3	CH 101	√	√
CH 108	Elementary Chemistry Laboratory I	1		√	√
CH 109	Elementary Chemistry Laboratory II	1	CH 108	√	√
BL 120*	Introduction to Biotechnology and its Applications	2			
	Total	**12**		**10**	**10**

* Optional course

200 LEVEL - MOLECULAR BIOLOGY AND BIOTECHNOLOGY					
Course Number	Course Title	No. of credits	Pre-requisites	Compulsory for	
				General Degree	Special Degree
MB 201	Biological Chemistry	3	BL 101, CH 101, CH 102	√	√
MB 206	Principles of Genetics	3	BL 101		√
MB 211	Cell and Tissue Culture	2	BL 101		
MB 216 †	General Microbiology	1	BL 101	√	√
MB 221	Enzymology	2	BL 101, CH 101, CH 102	√	√
MB 226	Molecular Genetics	3	BL 101, CH 101, CH 102	√	√
BT 201	Plant Diversity I	2			
BT 206	Plant Physiology	2			
CH 221	Organic Chemistry I	2	CH 101, CH 102		
CH 231	Physical Chemistry I	2	CH 101, CH 102		√
CH 232	Molecular Properties, Molecular Spectroscopy and Spectroscopic Instrumentation	1	CH 231		
PH 261	Medical Physics	2			
ST 202	Applied Statistics	2			
ZL 201	Animal Embryology	2			
	Total	**29**		**9**	**14**

300 LEVEL - MOLECULAR BIOLOGY AND BIOTECHNOLOGY					
Course Number	Course Title	No. of credits	Pre-requisites	Compulsory for	
				General Degree	Special Degree
MB 301	Biochemistry and Molecular Biology Laboratory	2	MB 201, MB 226	√	√
MB 306	Recombinant DNA Technology	3	MB 201, MB 226	√	√
MB 311	Molecular Cell Biology	3	MB 201		√
MB 316	Molecular Immunology	2	BL 101		√
MB 322	Molecular Biotechnology	2	MB 226, MB 306	√	√
MB 326	Bioinformatics	3	MB 226		√
MB 331	Fermentation Technology	2	CH 101, CH 102		
MB 333	Molecular Phylogenetics	2	MB 206, MB 226		√
MB 335	Molecular Virology	3	MB 226		√

MB 337	DNA and Forensic Medicine Laboratory	2	MB226		√
BT 302	Advanced Microbiology	2			
BT 304	Plant Pathology	2			
BT 309	Biodiversity and Conservation Management	2			
BT 311	Plant Reproductive Biology and Plant Breeding	2	BT307		
CH 341	Analytical Chemistry	3	CH 231		√
CH 361	Environmental Chemistry	3	CH 211, CH 221		
ZL 302	Comparative Anatomy & Animal Physiology	2			
ZL 303	General Entomology	2			
ZL 312	Developmental Biology	2	ZL 201		
HR 301	Human Resource Management	2			
	Total	**46**		**7**	**27**

400 LEVEL - MOLECULAR BIOLOGY AND BIOTECHNOLOGY					
Course Number	Course Title	No. of credits	Pre-requisites	Compulsory for	
				General Degree	Special Degree
MB 401	Molecular Biology of Plant and Animal Diseases	2	MB 201, MB 226		√
MB 412	Biotechnology Industry	2	MB 322		√
MB 416	Environmental Biotechnology	2	MB 226, MB 322		√
MB 441	Special Topics in Cell and Molecular Biology	3	MB 311		√
MB 472	Scientific Writing and Research Methodology	3			√
MB 488	Biosafety Issues in Biotechnology	2	MB 322		
MB 489	Quantitative Genomics and Molecular Breeding	3			
MB 490	Independent Study	1			
MB 491	Molecular Developmental Biology	3			√
MB 492	Applications of Nanobiotechnology	3	MB 322		
MB 495	Seminar	1			√
MB 499	Research Project	6-8			√
SI 401	Industrial Training	2			
	Total	**33-35**			**24**

†Available to students who have not offered biology in GCE (A/L).

PHYSICS

100 LEVEL – PHYSICS					
Course Number	Course Title	No. of credits	Pre-requisites	Compulsory for	
				General Degree	Special Degree
PH 101	General Physics I	3		√	√
PH 102	General Physics II	3		√	√
PH 103	Elementary Physics Laboratory I	1		√	√
PH 104	Elementary Physics Laboratory II	1		√	√
	Total	**8**		**8**	**8**
200 LEVEL – PHYSICS					
Course Number	Course Title	No. of credits	Pre-requisites	Compulsory for	
				General Degree	Special Degree
PH 200	Mechanics and Fluid Dynamics	2		√	√
PH 205	Thermal and Statistical Physics	2		√	√
PH 211	Vibrations and AC Theory	2			√
PH 230	Quantum Mechanics and Atomic Physics	2		√	√
PH 240	Introductory Solid State Physics	2		√	√
PH 245	Electronics Theory I	2			√
PH 261	Medical Physics	2			
PH 262	Energy, Weather and Environment	2			
PH 263	Introductory Astronomy	2			
PH 280	General Physics Laboratory I	1	PH 103, PH 104	√	√
PH 281	General Physics Laboratory II	1	PH 103, PH 104		√
PH 285	Electronics Laboratory I	1	PH 245	*	√
	Total	**21**		**9**	**15**
300 LEVEL – PHYSICS					
Course Number	Course Title	No. of credits	Pre-requisites	Compulsory for	
				General Degree	Special Degree
PH 304	Relativity	2			√
PH 313	Physical Optics and Optical instruments	2		√	√
PH 323	EM Waves and Communication	2		√	√
PH 333	Introductory Nuclear Physics	2			√
PH 341	Semiconductor Physics and Devices	2			
PH 345	Electronics Theory II	2	PH 245, PH 285		
PH 350	Microstructure and Properties of Materials	2	PH 240		
PH 361	Biophysics	2			
PH 363	Astrophysics	2	PH 263		

PH 365	Modern Particle Physics	2			
PH 366	Physics of Atmosphere, Weather and Climate	2			
PH 370	Mathematical Methods in Physics	2			√
PH 373	Computational Physics	2			
PH 374	Experimental Techniques and Material Characterization	2			
PH 375	Nanoscience	2	CH 231 / PH 230		
PH 380	General Physics Laboratory III	1	PH 103, PH 104	√	√
PH 381	General Physics Laboratory IV	1	PH 103, PH 104	*	√
PH 383	Advanced Physics Laboratory I	2	PH 280, PH 281		√
PH 384	Advanced Physics Laboratory II	2	PH 383		√
PH 385	Electronics Laboratory II	1	PH 245, PH 285		
PH 392	Seminar	1			√
PH 395	Industrial Training	1			
HR 301	Human Resource Management	2			
	Total	**39**		**6**	**17**

* Only one of these course units is compulsory

400 LEVEL – PHYSICS				
Course Number	Course Title	No. of credits	Pre-requisites	Compulsory for Special Degree
PH 403	Classical Mechanics	2	PH 200	√
PH 406	Statistical Physics	2	PH 205	√
PH 414	Lasers	1		
PH 422	Magnetic Materials	2	PH 240	
PH 423	Electromagnetic Theory	2	PH 323	√
PH 430	Quantum Mechanics I	3	PH 230	√
PH 431	Quantum Mechanics II	2	PH 430	
PH 433	Nuclear and Reactor Physics	3	PH 230, PH 333	
PH 436	Radiation Detection and Measurement	2	PH 333	
PH 440	Solid State Theory	3	PH 240	
PH 445	Electronics Theory III	2	PH 345	
PH 454	Solid State Ionics & Devices	2		
PH 455	Polymer physics	2		
PH 456	Nuclear Magnetic Resonance (NMR)	2		
PH 457	Advanced Nanoscience	2	PH 375	
PH 458	General relativity	2	PH 370	
PH 481	Advanced Physics Laboratory III	4	PH 381, PH 382	√

PH 486	Nuclear Physics Laboratory	2	PH 436	
PH 487	Investigation Laboratory	1		√
PH 491	Research Project	6-8		√
PH 493	Independent Study	1		
PH 496	Laboratory Teaching course	1		
SI 401	Industrial Training	2		
	Total	**51-53**		**22**

STATISTICS

100 LEVEL – STATISTICS					
Course Number	Course Title	No: of credits	Pre-requisites	Compulsory for	
				General degree	Special degree
ST 101	Introduction to Statistics	3		√	√
ST 102	Introduction to Probability Theory	3		√	√
ST 103	Statistics Applications I	1	ST 101	√	√
ST 104	Statistics Applications II	1	ST 101	√	√
MT105	Real Analysis I	3			
ST 105**	Mathematics for Statistics	3			
	Total	**14**		**8**	**8**

** Equivalent to MT 107 offered by the Department of Mathematics

200 LEVEL – STATISTICS					
Course Number	Course Title	No: of credits	Pre-requisites	Compulsory for	
				General degree	Special degree
ST 201	Probability Theory	3	ST 102	√	√
ST 202††	Applied Statistics	3			
ST 203	Theory of Statistics	3	ST 201	√	√
ST 204	Sampling Techniques	2	ST 203	√	√
ST 205	Statistical Simulation	2	ST 203		
MT 202	Real Analysis II	3	MT 105		
MT 204	Mathematical Methods	3			
MT 207	Numerical Analysis I	2			
MT 209	Graph Theory	2			
	Total	**22**		**8**	**8**

†† For students who do not offer Statistics as a major subject. Equivalent to BT 209 offered by the Department of Botany and ZL 205 offered by the Department of Zoology

300 LEVEL – STATISTICS					
Course Number	Course Title	No: of credits	Pre-requisites	Compulsory for	
				General degree	Special degree
ST 301	Regression Analysis	3	ST 203	√	√
ST 302	Statistical Quality Control	2	ST 203		√

ST 303	Design and Analysis of Experiments	3	ST 203	√	√
ST 305	Multivariative Methods I	2	ST 105, ST 203		√
ST 306	Data analysis & Preparation of Reports	1	ST 301, ST 302		√
ST 307	Time Series Analysis	2	ST 203, ST 301		√
ST 308	Bayesian Statistics I	2	ST 203		
ST 309	Non-parametrics & Categorical Data Analysis	3	ST 203	√	√
ST 325	Seminar	1	ST 306, ST 307		√
MT 302	Real Analysis III	3	MT 202		
MT 304	Partial differential Equations	2	ST 105		
MT 308	Combinatorics	2	MT 209		
HR 301	Human Resource Management	2			
	Total	**28**		**9**	**17**

Students opting to follow the Special Degree Programme in Statistics are required to follow BC201, BC202, BC301 and BC302 if they did not follow Computer Science as a major subject.

400 LEVEL – STATISTICS					
Course Number	Course Title	No: of credits	Pre-requisites	Compulsory for	
				General	Special
ST 401	Actuarial Statistics	2	ST 203		
ST 402	Data Mining Techniques	3	CS 409		
ST 403	Statistics for Bioinformatics	2			
ST 404	Stochastic Processes	2	ST 201, ST 203		
ST 405	Multivariate Methods II	2	ST 305		
ST 406	Bayesian Statistics II	2	ST 308		
ST 407	Linear Models	3	ST 105, ST 203		
ST 408	Reliability Theory and survival analysis	3	ST 203		
CS 401	Artificial Intelligence and Expert Systems	3	CS 311		
CS 409	Neural Networks and Fuzzy Logics	3	CS 401		
ST 425	Project work/Industrial Training	3			
ST 426	Research project	6-8			√
	Total	**34-36**			**17**

Note: Students opting to follow the Special Degree course in Statistics are required to select courses
from the following course units in addition to fulfill their credit requirements.
GL316(2 credits) Remote Sensing and GIS
MT311(3 credits) Linear Programming
MT407 (3 credits) Optimization Theory
MT412 (3 Credits) Financial Mathematics

ZOOLOGY

The Department of Zoology offers Biology* and Biology** jointly with the Department of Botany at the 100 level. The Department offers Zoology as a principal subject area from 200 level onwards.

From the 200 Level onwards Zoology is offered as a principal subject area. The students who have followed Biology* or Biology** as a principal subject area at the 100 level are permitted to take Zoology as a principal subject at 200 and 300 Levels. Those students who have completed Zoology as a principal subject at the 200 Level shall be eligible for selection to a Special Degree in Zoology at the end of the second year. The Special Degree students spend an extra two (02) years learning courses in a range of areas in Zoology and carrying out a research project.

100 LEVEL - BIOLOGY offered jointly by the Departments of Botany and Zoology.						
Course Number	Course Title	No. of credits	Biology*	Biology**	Compulsory for	
					General degree	Special degree
BL 101	Basic Biology	2	√	√		
BL 102	Plant & Animal Form & Function	2	√	√		
BL 103	Basic Ecology	2	√	√		
BL 107	Basic Microbiology	2	√	√		
BL 115	Biomolecules	2		√		
BL 116	Introductory Environmental Biology	2		√		
BL 117	Biotic Interactions	2		√		
BL 118	Introductory Evolutionary Biology	2		√		
BL 120#	Introduction to Biotechnology and its Applications	2				
	Total	**18**	**8**	**16**		

#optional course

200 LEVEL –ZOOLOGY					
Course Number	Course Title	No: of credits	Pre-requisites	Compulsory for	
				General degree	Special degree
ZL 201	Animal Embryology	2		√	√
ZL 205 †	Biostatistics	2			
ZL 206	Invertebrate Diversity	3		√	√
ZL 215	Zoogeography & Sri Lankan Fauna	2			
ZL 216	Vertebrate Diversity	3		√	√
ZL 217	Coastal Ecosystems and Coral Reefs	2			
ZL 218	Histological and Museum Techniques	1			√
MB 226	Molecular Genetics	3			
	Total	**18**		**8**	**9**

† Equivalent to ST 202 and BT 209

300 LEVEL –ZOOLOGY					
Course Number	Course Title	No: of credits	Pre-requisites	Compulsory for	
				General degree	Special degree
ZL 302	Comparative Anatomy & Animal Physiology	2		√	√
ZL 307	Fish Biology	2			
ZL 314	Evolutionary Biology & Systematics	2		√	√
ZL 322	Insect Pest Management	2	ZL 206		
ZL 323	Vector Borne Diseases	2	ZL 206		
ZL 324	Inland Fisheries and Aquaculture	2	ZL 307		
ZL 326	Animal Behaviour	2		√	√
ZL 327	Animal Genetics and Molecular Biological Techniques *	2		√	√
ZL 328	Herpetology	3	ZL 216		√
ZL 329	Avian and Mammalian Biology	3	ZL 216		√
ZL 330	Ecotourism and Nature Conservation	2			
ZL 331	Limnology and Wetland Ecology	2			
ZL 332	Quantitative Ecology	2			√
HR 301	Human Resource Management	2			
	Total	**30**		8	**16**

***** Equivalent to MB 226/ BT 307

400 LEVEL –ZOOLOGY					
Course Number	Course Title	No: of credits	Pre-requisites	Compulsory for	
				General degree	Special degree
ZL 404	Applied Parasitology	3	ZL 304		
ZL 406	Environmental Biology	3			
ZL 407	Immunobiology	3			
ZL 410	Marine Biology & Fisheries	3			
ZL 411	Wildlife Management	3			
ZL 412	Biodiversity & Conservation Biology	3			
ZL 421	Scientific Writing & Presentations	2			√
ZL 424	Research Methods and Data Analysis	2	ZL 205		√
ZL 425	Entomology	3	ZL 322		
ZL 426	Developmental Biology	2	ZL 201		
ZL 428	Independent Study & Seminar	2			√
ZL 491	Research Project	6-8			√
SI 401	Industrial Training	2			
	Total	**37-39**			**12-14**

† Equivalent to MB 431

- **SUPPLEMENTARY COURSES**

Course Number	Course Title	No. of credits	Pre-requisites
ECONOMICS			
EC 201	Introductory Economic Theory	3	
EC 301	The Sri Lankan Economy	2	EC 201
MANAGEMENT STUDIES			
MG 201	Management Studies I	2	
MG 301	Management Studies II	2	
SCIENCE EDUCATION			
SE 201	Foundations in Science Education	2	
SE 202	Educational Philosophy and Educational Management	2	SE 201
SE 301	Methodology in Teaching Science	2	SE 201
SE 302	Teaching Practice	2	SE 201
SE 303	Assessing Students in the Learning Process	2	SE 201
SE 310	Introduction to Scientific Writing	1	

- **APPLIED SCIENCES SUBJECT AREA**

Course Number	Course Title	No. of credits	Compulsory for App. Sci . Degree
AS 400	Industrial Management	2	√
AS 401	Industrial Placement	8	√
AS 402	Research Methodology & Scientific Writing	2	√
AS 403	Seminar	1	√
AS 404	Data Integrity Management& Data Analysis	2	√
AS 409	Industry and the Environment	2	√
AS 410	Applications Laboratory	2	√
Category I (Biology – based Courses)			
AS 414	Industrial Microbiology	2	
AS 415	Biodiversity Conservation and Sustainable Development	2	
AS 416	Fisheries and Aquaculture	2	
AS 417	Food and Fresh Produce Technology	2	
AS 418	Ecotourism	2	
AS 481	Enzymes in Industry	2	
AS 482	Biochemistry and Molecular Laboratory Instrumentation	1	
AS 483	Bioinformatics	2	
Category II (Chemistry - based Courses)			
AS 431	Chemical Technology	2	
AS 432	Cleaner Production for Industry	2	
AS 433	Industrial Waste Management	2	
AS 434	Industrial Organic Chemistry	2	
Category III (Geology - based Courses)			
AS 444	Industrial and Economic Minerals	2	
AS 445	Remote Sensing and Geographic Information Systems	2	
Category IV (Mathematics - based Courses)			
AS 451	Industrial Mathematics	2	
AS 452	Financial Mathematics	2	
Category V (Physics - based Courses)			
AS 461	Semiconductor Device Technology and Application	2	
AS 462	Science and Technology of Ceramic Materials	2	
AS 463	Energy; Sources, Use and Conservation	2	
AS 464	Workshop Practice	2	
AS 465	Industrial Applications (Electronics/Hardware) Laboratory	2	

Category VI (Statistics/Computer Science - based Courses)			
AS 471	Design and Development of Software Systems	2	
AS 472	Management of Computers and Computer Networks	2	
AS 473	Visualizing Statistical Concepts using Java and Software Development	2	
AS 474	Statistical Applications in Industry and Project Presentation	2	
	Total	**68**	**19**

- **COMPUTATION AND MANAGEMENT SUBJECT AREA**

Course Number	Course Title	No. of credits	Pre-requisites	Compulsory Courses			
				BS	PS	AR	CO
CS 100	Computer Applications - Foundation course	2		√	√	√	√
EN 100	Basic English	1		√	√	√	√
FND 114	Law and Ethics	3			√		
MT 120	Foundation course in Mathematics	2		√		√	√
CS 101	Introduction to Computer Science	3		√	√	√	√
CS 102	Programming Techniques	3		√	√	√	√
CS 104	Structured oriented Programming practical	1	CS 101, CS 102	√	√	√	√
CS 105	Object oriented Programming practical	1	CS 101, CS 102	√	√	√	√
MT105	Real Analysis I	3					
MT 121	Mathematics for Arts/Commerce Students I	3		√		√	√
MT 122	Mathematics for Arts/Commerce Students II	3		√		√	√
ECN 101	Introductory Microeconomics I	3		√	√	√	√
ECN 102	Introductory Macroeconomics II	3		√	√	√	√
MGT 101	Principles of management	3		√	√	√	√
MGT 103	Introduction to Business Accounting	3		√	√	√	
FNA 102	Introduction to Art History and Aesthetics	3			√		
PSC 101	Introduction to State and Government	3			*		*
SE 101	Science and Society	3			*		*
CS 201	Data Structures	2	CS 101, CS 104, CS 105	√	√	√	√
CS 202	Data Structures Practicals	1	CS 201	√	√	√	√
CS 203	Database Management Systems	2	CS 101, CS 104, CS 105	√	√	√	√
CS 204	Programming using DBMS Packages	1	CS 104, CS 105, CS 202, CS 203	√	√	√	√
MT 221	Mathematics for Management Studies I	3		√	√	√	√
ECN 201	Intermediate Microeconomics I	3		√	√	√	√

ECN 202	Intermediate Macroeconomics II	3		√	√	√	√
MGT 206	Human Recourse Management	3		√	√	√	√
MGT 207	Operations Management	3		√	√	√	√
MGT 208	Business Statistics	3		√	√	√	√
MGT 209	Project Management	3		√	√	√	√
MGT 211	Business Accounting for Decision Making	3		√	√	√	√
CS 303	Operating Systems Concepts	3	CS 203	√	√	√	√
CS 305	Communication Networks	2	CS 303	√	√	√	√
CS 309	Object Oriented Analysis and Design	3	CS 102, CS 201				
CS 310	Server side web programming	3	CS 104, CS 105, CS 203, CS 204				
CS 311	Software Engineering	2	CS 201	√	√	√	√
CS 315	Design and Analysis of Algorithms	2	CS 202, CS 301				
MT 321	Mathematics for Management Studies II	3		√	√	√	√
ECN 304	Econometrics I	3		√	√	√	√
MGT 301	Marketing	3		√	√	√	√
MGT 304	Entrepreunership	3		√	√	√	√
MGT 305	Cost & Management Accounting	3		√	√	√	√
MGT 307	Business Law	3		√	√	√	√
MGT 424	Strategic Management	3		√	√	√	√
MGT 438	Management Information Systems	3		√	√	√	√
MGT 421	Project involving internship	6-8		√	√	√	√
MGT 423	Seminar	1		√	√	√	√
	Total	**115-117**		**101**		**99**	

BS - BioScience **PS - Physical Science** ***Compulsory for Physical Science**
AR - Arts **CO- Commerce** and Commerce stream only

Note: Students opting to follow the Computation and Management Degree are required to select courses from the following course units at 400 level in addition to fulfill their credit requirements.

Semester I : 3 credits from CS 400 level courses and 2 credits from MGT 400 level courses
Semester II : 9 credits from CS 400 level or MGT 400 level of which at least 3 must be from CS 400 and 3 from MGT 400 level

- **STATISTICS & OPERATIONS RESEARCH SUBJECT AREA**

Course Number	Course Title	No: of Credits	Pre-requisites	Compulsory Courses
ST 101	Introduction to Statistics	3		√
ST 102	Introduction to Probability Theory	3		√
ST 103	Statistics Applications I	1	ST 101	√
ST 104	Statistics Applications II	1	ST 101	√
CS 101	Introduction to Computer Science	3		√
CS 102	Programming Techniques	3		√
CS 104	Structured oriented Programming practical	1	CS 101, CS 102	√
CS 105	Object oriented Programming practical	1	CS 101, CS 102	√
MT105	Real Analysis I	3		√
MT 107	Mathematics for Operations Research	3		√
MT 108	Operations Research I	2		√
MT 109	Linear Programming	3	MT 107, MT 108	√
ST 201	Probability Theory	3	ST 102	√
ST 203	Theory of Statistics	3	ST 201	√
ST 204	Sampling Techniques	2	ST 203	
ST 205	Statistical Simulation	2	CS 102, CS 104, CS 105, ST 203	√
CS 201	Data Structures	2	CS 101,CS 104, CS 105	√
CS 202	Data Structures Practicals	1	CS 104, CS 105, CS 201	√
CS 203	Database Management Systems	2	CS 101, CS 104, CS 105	√
CS 204	Programming using Database Management Systems	1	CS 104, CS 105, CS 202, CS 203	√
MT 202	Real Analysis II	3	MT 105	
MT 204	Mathematical Methods	3	MT 107	
MT 209	Graph Theory	2		
MT 210	Advanced Linear Programming	3	MT 109	√
MT 211	Integer Programming	3	MT 210	√
MT 212	Operations Research II	2	MT 109	√
ST 301	Regression Analysis	3	ST 203	√
ST 302	Statistical Quality control	2	ST 203	√
ST 303	Design and Analysis of Experiments	3	ST 203	√

ST 305	Multivariate Methods I	2	ST 203	√
ST 306	Data Analysis & Preparation of Reports	1	ST 301, ST 302	√
ST 307	Time Series Analysis	2	ST 203, ST 301	
ST 308	Bayesian Statistics I	2	ST 203	√
ST 309	Non Parametric and Categorical Data analysis	3	ST 203	√
ST325 / MT325	Seminar	1	ST 306, ST307	√
CS 315	Design and Analysis of Algorithms	2	CS 201, CS 202	√
MT 304	Partial Differential Equations	2	MT 103	
MT 313	Convex Analysis	2	MT 202	
MT 314	Network Optimization Theory	3	MT 210	√
MT 315	Operations Research III	2	MT 109, MT 314	√
MT 316	Non-Linear Programming	3	MT 210	√
ST 401	Actuarial Statistics	2	ST 203	
ST 402	Data Mining Techniques	3	CS 409	√
ST 403	Statistics for Bioinformatics	2		
ST 404	Stochastic Processes	2	ST 201, ST 203	
ST 405	Multivariate Methods II	2	ST 305	√
ST 406	Bayesian Statistics II	2	ST 308	
CS 409	Neural Networks and Fuzzy Logics	3	CS 401	
MT 409	Selected Topics in Applied Operations Research	2	MT 315, MT 316	
MT 410	Optimization for Engineering Design	3	MT 315, MT 316	√
MT 411	Optimization Modeling	2	MT 315, MT 316	√
MT 412	Financial Mathematics	3		√
ST425/ MT 425	Project work/Industrial training	6-8		√
	Total	**126-128**		**86**

SYLLABI OF COURSES OFFERED

FOUNDATION COURSES

BL 100 Basic Life Sciences (2 credits)

***Biology of Plants and Animals*:** Cell structure (molecular and organelle) and function. Cell cycle, mitosis and meiosis. Anatomical and histological organization of organ systems of plants and animals cells. Function of organsystems.

***Life and environment*:** energy and life, photosynthesis and respiration. Basic concepts in ecology. Biodiversity. Human activities and the ecosystem. Conservation.

***Human Biology*:** Human blood groups, Genetic diseases. Reproduction. Sexually transmitted diseases. Chemicals and human health.

***Current trends in human Biology*:** Recombinant DNA technology, GM foods, cancer, DNA forensics, Biological agents as weapons.

Interactive learning exercises in biology.

CS 100 Computer Applications (2 credits)

Introduction to Computer and operating Systems,

Micro Computer Applications: Use of Software Packages- Spread Sheet applications, DBMS applications, Utility programs and Word processing.

Data Protection Techniques: Data security techniques, Computer Viruses and prevention.

Data Communication: Email, Internet and Networking of Computers.

Introduction to a Programming Language: Procedures, Functions, File handling, Application of a DB management.

(This course includes both theory and practicals)

Recommended Texts:

1. C.S.French, *Computer Science*
2. D. Howard, *Programmer's Guide to Foxpro 2.0*
3. Robert Slade, *Computer viruses*

EN100 Basic English Foundation Course

This compulsory course will be conducted over two semesters of the same academic year

Interactive teaching – 90 hrs per acedemic year

Four skills in language learning will be covered

Grammar and writing – part of speech, active and passive voice structures, conditionals, conjunctions, prepositions, relative clauses, tenses, sentence structures, writing simple descriptions, process writing, recording a practical, how to organize a paragraph with main idea and supporting details using cohesive devices, sequence markers, structure vocabulary related to comparison, classification, cause and effect, spatial relations, chronological order

Reading – surveying a text book, skimming and scanning, identifying main ideas and supporting details, guessing contextual meanings of words using definition signals and reference markers, punctuations, prefixes, reading comprehension (general and subject related), reading and note taking

Listening – listen to a text or a recorded lecture and take down specific information in the form of diagrams, tables, graphs, filling in blanks, listening and note taking, answer questions based on dialogues and short conversations

Speaking – give a speech using guidelines given in a cue card, develop a story based on a picture, role play, debates, describe an incident, create stories

MT 100 Mathematics for Biological Sciences (2 credits)

Sets and inequalities, Linear equations, Quadratic equations, Functions and graphs, Trigonometric Functions,
Limits, Derivatives, Curve sketching, Maximum-minimum problems, Exponential and logarithmic functions
Techniques of integration, Areas and volumes, partial derivatives,
Introduction to vectors, Matrices and determinants.

Recommended Texts:

1. *Mathematics for Biological Sciences,* J.C. Arya and R.W. Lardner

MT 120 Foundation Course in Mathematics (2 credits)

Different types of numbers, Variables, Parameters, Computer arithmetic, Linear and Quadratic equations, Functions and graphs, Logarithmic and Exponential functions, Trigonometric functions, Cartesian coordinate system, Coordinate geometry of straight line and circle, Evaluation of limits,
Derivatives: Derivatives of standard functions , Algebra of derivatives, Chain rule, Derivatives of functions in parametric forms, Anti-derivatives and Techniques of integration.
First order Difference Equations and Discrete models.

SE 100 Introduction to Science and Society (0 credits)

Scientific Method; Milestones in Science; Science in Development; Science and the Law; Science and Ethics

FND 114 Law and Ethics (3 credits)

This course will be taught in two sections on law, ethics emphasizing the differences and interfaces.

Section I: What is Law; Branches of Law; The Legal System of Sri Lanka; The Court Structure; Services of law; The constitution: Separation of power, Sri Lankan constitution, Fundamental Rights; Law in relation to Religion, Morals, Gender, Justice and punishment, Freedom, Sovereignty and the State; International Law, Legal concepts: Emergency laws, Intellectual Property Law, Public Trust, Right /Duty, Democracy /minorities, torture.

Section II: What is Ethics; Ethics and Morality; Nature of ethical propositions; Religious ethics; Theories of Ethics: Aristotelian Ethics - Necomachean Ethics, Kantian Ethics - Categorical Imperative, , Levinasian Ethics - Responsibility to Other, Derridian Ethics- Forgiveness, Alain Budiou - Understanding of Evil; Professional Ethics, Teacher and student, Doctor and patient, Lawyer and client; Trials against Socrates, Christ, Eichmann; Bio Ethics and Animal Ethics; Selected ethical concepts: sex, adultery, marriage, divorce, abortion ,love, prostitution, plagiarism , ragging, student politics, racism.

PRINCIPAL SUBJECT AREA

BIOLOGY

BT Course Units - See under Botany
MB Course Units - See under Molecular Biology & Biotechnology
ZL Course Units – See under Zoology

BL 401 Evolutionary Biology (2 Credits)
History of evolutionary biology; Phylogenetic and ecological bases of evolution; Geography of evolution; Evolutionary processes in populations and species; Molecular evolution and Macroevolution; Human evolution.

Recommended Texts:

1. Monroe W. Strickberger, *Evolution (3rd Edition)*, Jones & Bartlett Publishers (2000) ISBN 0-7637-1066-0
2. Dan Graur & Wen-Hsiung Li, *Fundamentals of Molecular Evolution (Second Edition)*, Sinauer Associates,Inc. ISBN 0-87893-266-6
3. Michael R. Rose and Laurence D. Mueller, *Evolution and Ecology of the Organism*, Prentice Hall (2005) ISBN 0-13-010404-3
4. Douglas J. Futuyma, *Evolutionary Biology (3rd Edition)*, Sinauer Associates (1998) ISBN 0-87893-189-9
5. Douglas J. Futuyma, *Evolution*, Sinauer Associates (2005) ISBN 0-87893-187-2
6. Mark Ridley, *Evolution (3rd edition)*, Blackwell (2003) ISBN 1-4051-0345-0 Scott R. Freeman and Jon C. Herron, *Evolutionary Analysis*, Prentice Hall (2003) ISBN 0-13-101859-0

BL 402 Scientific Writing & Ethics (1 credit)
Writing Scientific Papers; Organization and Content; Guidelines for writing under different headings; Plagirism in scientific writing.

BL 403 Independent Study (1 credit)
(Equivalent to BT 414)
A structured programme to encourage active student learning and develop their communication and presentation skills. The students obtain an in-depth understanding of given topics of botanical interest by literature survey and reading recommended research/scientific articles and deliver seminar/s.

BL 404 Research Project (8 credits)
A research project on a biological topic shall be carried out in the final year under the supervision of staff members. The student is expected to carry out a literature survey, write the Research Proposal and present it. On completion of the project, make an oral presentation of the work and submit a written report.

SI 401 Industrial training (2 credits)
Each student will undergo full time training in the industry for the prescribed period on projects assigned by the industry. Students are required to have a duly maintained 'Daily Diary' which should be submitted to the Head of the Department within two weeks after completion of the training. In addition, the students are expected to write a report and make a presentation on the work carried out by them.

BOTANY

100 LEVEL COURSES

BL 101 Basic Biology (2 credits)
Cell Biology - Chemical nature of life, origin of life, scientific method, prokaryotic and eukaryotic cells, cell types, structure and function of cell membranes and organelles, cell division, structure and function of genetic material.
Classification of organisms - Early and current systems of classification.
Genetics and evolution - Chromosome theory of inheritance, Mendelian genetics and deviation, linkage and recombination, mutations, Hardy-Weinburg principle, sources of variation, natural selection, origin of species. Laboratory exercises based on above topics.

Recommended Texts:

1. Campbell, N. A., Reece, J. B. and Mitchel, I. G. (1996). Biology 4th Edition. The Benjamin/Cummings Publishing Company, Inc.
2. Marder, S. S. (2001). Biology 7th edition. McGraw – Hill Book Company Inc., USA.
3. Raven, P. H. and Johnson, G.B. (1996). Biology. 4th Edition. Wm. C. Brown Publishers.
4. Tauro, P. Kapoor, K. K. and Yadav, K. S. (1986). An Introduction to Microbiology. Wiley Eastern Limited, New Delhi.
5. Winter, P. C., Hickey, G. T. and Fletcher, H. L. (2000). Genetics. 2nd Edition. Vivo Books Private Ltd., New Delhi.

BL 102 Plant and Animal Form and Function (2 credits)
Plant Form & Function: Tissue types; Internal structure of plants and organs; Photosynthesis; Transport systems; Plant nutrition. **Animal Form & Function**: Levels of body organization, body form and symmetry; Major animal groups and their basic needs for survival; How different animal groups solve problems of survival and challenges of the environment through form and function; Functional adaptations of animals under extreme environmental conditions.
Practicals based on above.

Recommended Texts:

1. *Biology.* Peter H. Raven and George B. Johnson. 6th Edition. McGraw Hill, Boston.
2. *Diversity of Organism.* Caroline M. Pond. (1999). Hodder & Stoughton.
3. *Biology.* N.A. Campbell, J. B. Reeve, I.G. Mitchel. 8th Edition. Benjamin-Cummings Publishing Company.
4. *Plant Physiology.* F.B. Salisbury and C.W. Ross. (1996). Wadsworth Publishers, London.
5. *Plant Physiology.* Taiz, L. and Zeiger, E. (1996). Benjamin-Cummings Publishing Company.

BL 103 Basic Ecology (2 Credits)
Ecological levels (individuals, populations, communities, habitats, ecosystems, biomes, biosphere); Components of the physical environment (energy, water, atmospheric gases, wind, fire, gravity, topography, geologic substratum and soil); Energy flow in

ecosystems (trophic levels, food webs, productivity); Cycles of materials (hydrological cycle, carbon cycle, biogeochemical cycles).
Practicals based on above.

Recommended Texts:

1. *Biology, Principles and Processes*. Michael Roberts, Michael Reiss, Grace Monger. (1993) Thomas Nelson & Sons, Ltd. UK.
2. *Biology.* Peter H. Raven & George B. Johnson, 6th Edition. McGraw Hill, Boston.
3. *Biology.* N.A. Campbell, J. B. Reeve, I.G. Mitchel. 8th Edition. Benjamin-Cummings Publishing Company.
4. *Elements of Ecology*. R. L. Smith and T. M. Smith (2000). Benjamin/Cummings Science Publishing.
5. *Ecology of World Vegetation.* O.W. Archibold (1995) Chapman and Hall.
6. *Tropical Rain Forest Ecology.* D. J. Mabberley, (1992) Blackie and Son Ltd.

BL 107 Basic Microbiology (2 credits)

Introduction to microorganisms, history, discovery and diversity. Classification and major groups of microorganisms - Mollicutes, Bacteria and Protozoa. Viruses, Viroids, Prions. Distribution and role of microorganisms in different environments. Microbial cell structure and function. Microorganisms in biotechnology and disease. Microbiological equipment and safety procedures. Sterile techniques - culturing, isolation, purification, characterization and identification of microorganisms.
Laboratory exercises based on the above topics.

Recommended Texts:

1. Atlas, R.M. (1995). Principles of Microbiology. Mosby.
2. Madigan, M.T., Martinko, J.M. and Parker. J. (2002). Brock Biology of Microorganisms. 10th edition. Prentice Hall.

BL 115 Biomolecules (2 Credits)

Essential classes of biomolecules - nucleic acids, proteins, fatty acids & lipids and carbohydrates; structure and function; chemistry, properties and interactions of biomolecules; applications of biomolecules in agriculture, medicine, forensics and industry.
Laboratory exercises based on above topics.

Recommended Texts:

1. Buchanan, B.B., Guissem, W. and Jones, R.L. (2000). Biochemistry & Molecular Biology of plants. American Society of Plant Physiologists.
2. Callow, J.A., Ford – Lloyd, B.V. and Newbury, H.J. (1997). Biotechnology and Plant Genetic Recourses. Conservation and use. Biotechnology in Agriculture Series, No.19.
3. Meuser, F., Manners, D.J. and Seibel, W. (1993). Plant Polymeric Carbohydrates. The Royal Society of Chemistry.
4. Nelson, D. L. and Cox, M. M. (2009). Lehninger Principles of Biochemistry (5th Edition), W.H. Freeman and Company.
5. Stryer, L. (1995). Biochemistry (4th Edition). W.H. Freeman and Company.
6. Wilson, K. and Walker, J. (2005). Principles and techniques of Biochemistry and Molecular Biology (6th Edition). Cambridge University Press.

BL 116 Introductory Environmental Biology (2 Credits)

Basic concepts in environmental biology; Hydrosphere; Lithosphere; Atmosphere; Biosphere; renewable & nonrenewable resources and cycling of energy & matter; Climate & life; human population growth & problems of overpopulation; Atmospheric pollution and global changes: impacts of atmospheric pollution on biota- plants, animals, humans, carbon footprint; World food resources & green revolution; Effect of agriculture on environment; Water resources: pollution and treatment methods; Solid and hazardous wastes; Environmental health & toxicology; Sustaining terrestrial biodiversity and urban biodiversity. Global resources and associated problems.
Practicals based on above.

Recommended Texts:

1. *Living in the Environment: Principles, Connections and Solutions*. Tyler, G. and Miller Jr. (2004).Thompson books.
2. *Biology.* Peter H. Raven & George B. Johnson, 6th Edition. McGraw Hill, Boston.

BL 117 Biotic Interactions (2 Credits)

Nutralisum verses interactions among plants, animals and microbes; kinds of biotic interactions with examples, intraspecific interactions and interspecific interactions – symbiotic relationships, protection and defense, competition & allelopathy. The role of trophic interactions in community initiation, maintenance and degradation. Biotic interactions affecting the sizes of species populations and diversity. Community consequences of biotic interactions and co-evolutionary dynamics. Biotic interactions in human dominated landscapes. Application aspects of biotic interactions. Laboratory exercises based on above topics.

Recommended Texts:

1. Begon, M., J.L. Harper, and C.R. Townsend (2000). *Ecology: Individuals, Populations and Communities***.** 3rd Edition. Sinauer Associates, Sunderland, Mass.
2. Campbell, Neil A. and Jane B. Reece (2002). *Biology*. 6th Edition. Pearson Higher Education.
3. David F.R.P. Burslem, Michelle A. Pinard and Sue E. Hartley (Eds.) (2005). *Biotic interactions in the tropics: their role in the maintenance of species diversity*. Cambridge University Press, UK.

BL 118 Introductory Evolutionary Biology (2 Credits)

Introduction; Evidence for evolution; Mechanisms of evolution; Micro and macroevolution; Speciation; Co-evolution; Adaptation; Adaptive radiation; Phylogenetics; Phenotypic plasticity; Kin selection; Parent offspring conflict; Human evolution; Health and evolution; Evolution of photosynthesis, angiosperms and crop plants. Practicals based on above.

Recommended Texts:

1. *Biology.* Neil A. Campbell; Jane B. Reece; Robert B. Jackson; Michael L. Cain; ; Steven A. Wasserman; Peter V. Minorsky, 8th Edition. Benjamin-Cummings Pub Co.
2. *An Introduction to Biological Evolution.* Kenneth V. Kardong. (2007). McGraw-Hill Science.

BL 120 Introduction to Biotechnology and its Applications (2 credits)

Introduction to Molecular Biology and Biotechnology, historical development, land mark discoveries and pioneering scientists, diverse applications of Biotechnology in medicine, food production and environmental protection. World Wide Web Resources on Biotechnology and their reliability, the fraudulent nature of bioterrorism and how to circumvent it through proper and safe use of Biotechnology. In the contexts of humanitarian and environmental catastrophes, the use of Biotechnology as a developmental tool to face the challenges in the present and future.

Recommended Texts:

1. Thieman, W.J., and Palladino, M.A. (2012) Introduction to Biotechnology, (Third Edition). Benjamin Cummings.
2. Walker, S. (2006) Biotechnology Demystified, (Fifth Edition). The McGraw-Hill Companies.
3. National Center for Biotechnology Information, U.S. National Library of Medicine, 8600 Rockville Pike, Bethesda, MD, 20894, USA. Website: http://www.ncbi.nlm.nih.gov/ .
4. International Service for the Acquisition of Agri-biotech Applications (ISAAA), Operated in USA, Kenya and Philippines. Website: http://www.isaaa.org/.
5. GMO Compass, the task of GMO Compass is to collect objective, science-based information on the use of genetic engineering in the agri-food industry and present it to the public in a way that is easy to understand and readily accessible. Maintained at Genius GmbH, Robert-Bosch-Str. 7, 64293 Darmstadt, Germany. Website: http://www.gmo-compass.org/eng/.

200 LEVEL COURSES

BT 201 Plant Diversity I (2 credits)

Basic concepts of biodiversity, levels (species, genetic, ecosystem); range of diversity in relation to size, life span, form, nutrition, reproduction, habitats, life cycles etc. Nomenclature and classification, importance of biodiversity, its conservation and sustainable utilization. Diversity among lower organisms: Monera (Prokaryota), Protista, algae, Chromista, Fungi. Basic characters, modern classification systems, range of form, reproduction and life cycles with reference to type examples. Importance of fungi in nature, biodeterioration, medicine, agriculture & industry.
Laboratory exercises based on above topics.

Recommended Texts:

1. Pandy, B. P. (1994). *A Text Book of Botany*, Fungi. S. Chand & Co. Ltd., New Delhi.
2. Mehrotra, K.R & Anjela, K.R. (1990). *An Introduction to Mycology*. Wiley Eastern Ltd., New Delhi.

BT 202 Plant Diversity II (2 credits)

Diversity of non-vascular plants (Bryophytes) and vascular plants (Tracheophytes). General characteristics of Bryophytes. Occurrence and adaptations to habitat. Diversity in the gametophytic and sporophytic structure of some selected genera of mosses, liverworts and hornworts. Evolutionary tendencies exhibited by the sporophytes of the Bryophyta. General characteristics of Tracheophytes, diversity in morphology and anatomy of the sporophyte and sporangial structure of the Pteridophyta. Eusporangiate and Leptosporangiate ferns. Homosporous and heterosporous life cycle. Evolutionary tendencies among ferns. Gymnospermae – evolution and evolutionary relationship

among gymnosperms, morphology, distribution, anatomical variations, uses, reproduction and propagation of gymnosperms. Angiosperm reproduction and life cycle.
Laboratory exercises based on above topics.

Recommended Texts:

1. Vashista, B. R. (1996). Botany for degree students - Bryophyta. S. Chand & Company Ltd. Rem Nagar, New Delhi – 110055, India
2. Vashista, P. C. (1996). Botany for degree students – Pteridophyta. S. Chand & Company Ltd. Rem Nagar, New Delhi - 110055, India
3. Vashista, P. C. (1996). Botany for degree students – Gymnosperms. S. Chand & Company Ltd. Rem Nagar, New Delhi - 110055, India
4. Biswas, C. and Johri, B. M. (1997). The Gymnosperms. Springer – Verlag and Narosa Publishing House. Berlin and New Delhi, India 494pp.

BT 203 Vegetation Dynamics and Measurement (2 credits)

Plant communities, vegetation measurements, physiognomic or structural data, floristic data, vegetation dynamics, disturbances, primary and secondary succession, pioneer and climax species.
Field and laboratory exercises based on the above.

Recommended Texts:

1. Kent, M. and Coker, P. (1992). *Vegetation description and analysis.* Wiley & Son, New York.
2. Clenn-Lewin, D.C., R.K.Peet and T.T. Veblen (1992). *Plant Succession: Theory and prediction*. Chapman & Hall, U.K., 246pp.
3. Kershaw, K.A. (1973). *Quantitative and Dynamic Plant Ecology.* 2nd Edition. Edward Arnold, U.K., 304pp.

BT 204 Enzymology (2 credits)

(Equivalent to MB 221)
Enzymes as biological catalysts, their structure, mode of action, mechanism of catalysis, classification and nomenclature. Co-factors, prosthetic groups and co-enzymes. Equilibrium constant of a reaction and free energy change, energy of activation. Mode of action of co-enzymes and principal co-enzymes. Kinetics of enzymatic reactions, effect of enzyme and substrate concentration on reaction rate, Michaelis Constant, Michaelis-Menton kinetics for single and bi-substrate reactions. Linear representations. Effect of chemical and physical agents on kinetics, temperature, pH, inhibitors, allosteric effectors. Chromatographic and electrophoretic techniques. Enzyme and substrate assay techniques. Protein-ligand binding studies, immobilized enzymes, turn-over number. Catalytic efficiency of enzymes. Reaction-related specificity, substrate-related specificity. Industrial applications. Human disease related to defective enzymes.
Laboratory exercises based on above topics.

Recommended Texts:

1. Wilson, K. and Walker, K. M. (1994). *Principles and Techniques of Practical Biochemistry* (4th edition). Cambridge University Press. UK.
2. Weil, J. H. (1990). *General Biochemistry* (6th edition). Wiley Eastern Limited, New Delhi, India.

BT 205 Angiosperm Morphology and Anatomy (2 Credits)

Stem, root and leaf morphology, reproductive morphology, seedling morphology and vegetative morphology.

Embryogenesis, apical meristems and their derivatives, growth, morphogenesis and differentiation, ground tissues, vascular tissues and dermal tissues. Structure and development of root and shoot, leaf anatomy, trichomes, secretary structures. Secondary growth, periderm and wood.
Laboratory exercises based on the above.

Recommended Texts:

1. Bell, A.D. *Plant Form. An illustrated guide to flowering plant morphology*.
2. James, G.H. and Melinda, W.H. (2001). *Plant Identification Terminology: An illustrated glossary*. 2nd Edition, Spring Lake Publication.
3. Raven, P.H., Evert, R.F. and Eichhorn, S.E. (1999). *Biology of Plants*. 6th Edition, Chapters 23-27, 555-670pp.

BT 206 Plant Physiology (2 credits)

Functions of water in plant, concept of water potential and its measurements, water balance of the plant. Overview of soil-plant-atmospheric continuum, active and passive absorption of water. Stomatal physiology, solute transport in apoplast and symplast, passive and active transport of solutes across membrane barrier, essential nutrients in plants, nutrient solutions and deficiencies. Laboratory exercises based on above topics.

Recommended Texts:

1. Taiz, L & Zeiger E (1999*). Plant Physiology*. Benjemin Cummings Publishing Company, New York.
2. Hopkins, W.G. (1999). *Introduction to Plant Physiolog*y. John Wiley and Sons, New York.
3. Salisbury, F.B. & Ross, C.W. (1996*). Plant Physiology.* Wadsworth Publishers, London.
4. Kramer, P.J. & Boyer, J.S. (1996). *Water Relations of Plants and Soils.* Academic Press, London
5. Marschner, H. (1995). *Mineral Nutrition of Higher Plants*. Academic Press, London.

BT 207 Plant Biochemistry I (2 Credits)

Photosynthesis as energy conversion, photosynthetic electron transport, mechanism of photophosphorylation. Fixation of carbon dioxide, C3 PCR cycle, C2 photorespiratory carbon oxidation cycle, CO_2 concentration mechanisms, C4 photosynthetic carbon assimilation cycle, Crassulacean Acid Metabolism. Synthesis of sucrose and starch, phloem translocation, loading and unloading. Plant respiration, glycolytic pathway, tricarboxylic acid cycle, electron transport and ATP synthesis.
Laboratory exercises based on above topics.
Recommended Texts:

1. Lehninger, A. L. (1990). *Principles of Biochemistry*. Worth Publishers Inc., New York.
2. Hall, D.D. & Rao, K.K. (1999)**.** *Photosynthesis* (Sixth Edition). Studies in Biology Book Series. Cambridge University Press.
3. Taiz, L. & Zeiger, E. (1999). *Plant Physiology*. Benjemin Cummings Publishing Company, New York.
4. Hopkins, W.G. (1999). *Introduction to Plant Physiology*. John Wiley and Sons, New York.

BT 209 Biostatistics (2 credits)
(Equivalent to ST 202 and ZL 205)
Variables, summarization & presentation of data, variance, standard deviation, standard error, probability of simple events, probability distribution (binomial, Poissan & Normal probability distribution), Z score, t-distribution, hypothesis testing ($\chi 2$ test, paired & unpaired t-test), analysis of variance (ANOVA), CRD, RCBD and LSD, correlation and regression, use of statistical package e.g. Minitab.

Recommended Texts:

1. Flowler, J. & Cohen, L.(1990). *Practical statistics for field biology*. John Willey & Sons, New York.
2. Sokal, R.R. & Rohlf, F.S. (1995). *Biometry*, 3rd Edition, W.H. Freeman & Co., New York.

FS 202 Food Science I (2 credits)
***Chemistry of Food*:** Introduction to Food Science and the food Industry, basic food chemistry: definitions for food components, carbohydrates proteins, lipids, vitamins and minerals, additional food constituents; colours, flavours, emulsifiers, oxidants and antioxidants etc; Natural and synthetic constituents. Properties and significance of each component of food. Tests for identification. Food Analysis: sampling techniques and proximate analysis of food.
***Food Technology* :** Fruit and vegetable technology: physical, chemical and biological methods used in preservation, common unit operations. Post harvest handling of fruits and vegetables. Grain technology: Cereals and pulses-composition, structure, effect of processing, functional properties, post harvest technology. Food of animal origin: problems associated with keeping quality of meat, fish, eggs and milk, Methods of processing. Laboratory work based on above topics.

Recommended Texts:

1. Kirk, R.S. and R. Sawyer (1991). *Pearson's Composition and Analysis of Food,* Longman, Singapore.
2. Vanderwerf, C.A. (1960). *Food Chemistry*, Reinhold Organic Chemistry and Biochemistry Textbook series.

300 LEVEL COURSES

BT 301 Analytical Methods (2 credits)
Application of high precision mass spectrophotometer in stable isotopic research. Soil and foliar analytical techniques, Kjeldahl technique (theory, the equipment, sample preparation, measurements and calculations). Interferences and measures to improve the sensitivity and efficiency of the system and applications in research. Spectrophotometric methods: UV-VIS spectrophotometer (colorimeter), Atomic Absorption Spectrophotometer (AAS), Flame Emission Spectrophotometer (FES) and Mass Spectrophotometer. Use of radioactive isotopes in analytical Techniques: Geiger-Muller counters, Scintillation counters, Cerenkov counters and autoradiogrpahy. Molecular biological techniques, PCR, AFLP, RADP's, RFLP and DNA sequencing. Chromatographic techniques, TLC, Column chromatography, HPLC, GC.
Laboratory exercises based on above topics.

Recommended Texts:

1. Coleman, D.C. & Fry, B.(1997). *Carbon Isotope Techniques*. Academic Press, New York.

2. Unkovich, M, Pate, J.S, McNeill, A. & Gibbs, D. (2001). *Stable isotope techniques in the study of biological processes and functioning of ecosystems*. Kluwer Academic Publishers.
3. Bergersen, F. J. (Ed.) (1980). *Methods for evaluating biological nitrogen fixation*. John Wiley and Sons, Chichester, UK.
4. Wilson, K. and Walker, J. M. (Eds.) (1994). *Principles and techniques of practical biochemistry* (4th edition). Cambridge University Press, UK.

BT 302 Advanced Microbiology (2 Credits)

Population counts, growth cycle of microorganisms. Applied microbiology. Microorganisms in their natural habitats and major activities, microbiology of air (types, diseases transmitted), soil (types, estimation, distribution, role in nutrient cycling), water (types, water pollution, coliform bacteria, sanitary water analysis, water borne diseases, water purification) and food (food microflora, food spoilage, food preservation and food borne diseases). Laboratory exercises based on above topics.

Recommended Texts:

1. Brock, T.D. , Madigan, M.T., Martinko, J.M. and Parker, J. *Biology of Microorganisms* (8th edition), Prentice Hall, USA, 986 pp.
2. Madigan, M.T. Martinko, J.M. Parker . J. Prentice Hall, USA, 986 pp.
3. Giller, K. E. and Wilson, K. F. (1991). *Nitrogen fixation in tropical cropping systems.* CAB. International, UK.
4. McLaren, R. G. and Cameron, K. C. (1996). *Soil Science: Sustainable production and environmental protection*. Oxford University Press, UK.
5. Brady, N. C. (1990). *The nature and properties of soils* (10th edition). Macmillan Publishing Company, UK.

BT 303 Soil Fertility and Management (2 credits)

Basic soil physical properties: structure and aggregation, formation and maintenance of soil structure and management of other soil physical conditions. Soil acidity and alkalinity and their amelioration. Nutrients and crop production: nutrient response relationships, concepts of nutrient availability, plant available nutrients and factors affecting availability and uptake by plants. Soil organic matter and its dynamics. Microbial population of the soil, interaction between plant roots and microorganisms. Nutrient availability, soil and plant nutrient analysis. Major nutrients, micro-nutrients and toxic elements in soil. Soil fertility and fertilizer management, fertilizer recommendations, soil erosion and its control. Flooded and poorly drained soils, sustainable management of soil and land resources. Soils requiring unusual management practices. Soils and the quality of the environment. Laboratory exercises based on above topics.

Recommended Texts:

1. McLaren, R. G. & Cameron, K. C. (1996). *Soil Science: Sustainable production and environmental protection* (New Edition), Oxford University Press, UK.
2. Brady, N. C. (1990). *The nature and properties of soils* (10th Edition). Macmillan Publishing Company, UK.
3. Miller, R. W. & Donahue, R. L. (1992). *Soils: An introduction to soils and plant growth* (6th edition). Prentice-Hall of India Pvt. Ltd. New Delhi.
4. Page, A. L., Miller, R. H. & Keeney, D. R. (Eds.) (1992). *Methods of soil analysis- Part 2 – Chemical and microbiological properties* (2nd Edition). American Society of Agronomy and Soil Science Society of America, Inc., USA.

BT 304 Plant Pathology (2 credits)

Introduction, history of Plant Pathology, terminology & definitions, cause of plant disease, infection process, mechanism of symptom development, fungal pathogenesis, plant defense responses – constitutive and inducible defenses, Systemic Acquired Resistance (SAR), principles of plant disease control, diagnosis of plant disease.

Practical exercises: Laboratory examination of diseased specimens covering major field and post-harvest diseases of food, ornamental and plantation crops, plant pathology techniques, study of plant-pathogen interactions.

Recommended Texts:

1. Agrios, G. N. (1997). *Plant Pathology*, 4th Edition, Academic Press, U.K.
2. Abeygunawardena, D.V.W. (1969). *Diseases of cultivated plants*, Their diagnosis and treatment in Ceylon, The Colombo Apothecaries Co. Ltd., Sri Lanka.
3. Mehrotra, R.S. (1994). *Plant Pathology*, 10th Print, Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
4. Persley, Denis M. (1982). *Diseases of vegetable crops*. Department of Primary Industries, Queensland, Brisbane.
5. Beattie, B.B., W.B. McGlasson (1995). Postharvest *diseases of horticultural produce*, Volume 2*:* Tropical fruit. Department of Primary Industries, Queensland, Brisbane.

BT 305 Developmental Physiology and Postharvest Technology (2 credits)

Terminology of growth, development and differentiation, phytohormones and plant growth regulators, growth promoters, inhibitors and modifiers, their physiological effects, commercial applications, biosynthesis, interactions, theories on mechanism of photoperiodism and vernalization. Signal transduction. Basic techniques of detection of phytohormones: chromatography, immunoassays and bioassays.

Postharvest technology of fruits and vegetables, causes of fruit and vegetable deterioration, maturity indices, harvesting systems, packing house operations, transportation storage: temperature management, modified atmosphere, ethylene, cold chain maintenance, technology at village and industrial level, agrochemical usage and alternatives, quality parameters and methods of determination, minimal processing.

Laboratory exercises based on the above.

Recommended Texts:

1. Raven, P.A. and Johnson, G.B. (1996). *Biology*, 4 th edition, Wm.C. Brown Publishers.
2. Salisbury, F.B. and Ross, C.W. (1992). *Plant Physiology*. Wadasworth Inc. USA
3. Taiz, L and Zeiger, E. (1991). *Plant Physiology*. The Benjamin Cummings Publishing Company, New York, USA.
4. Kays, S.I. (1991). *Postharvest Physiology of Perishable plant products.* Van Nostrand Reinhold, USA.

BT 307 General and Molecular Genetics (2 credits)

Genetic mapping in eukaryotes and prokaryotes, variation in chromosome number and structure, replication of DNA and chromosomes, translation, transcription and genetic code, mutation and DNA repair, genetics of viruses & bacteria, organelles and transposable elements, regulation of gene expression, recombinant DNA technology, genomics, population and evolutionary genetics, speciation, conservation genetics.

Laboratory exercises based on the above.

Recommended Texts:

1. Griffiths, A.J.F., Miller, J.H., Suzuki, D.T., Lewontin, R.C. and Gelbert, W.M. (1996). *An introduction to genetic analysis.* W.H.Freeman and Company, New York.
2. Snusted, D.P. and Simmons, M.J. (1999). *Principles of Genetics*. John Wiley and Sons, Lewin, USA,
3. Benjamin (2003). *Gene* VIII. Prentice Hall, USA.

BT 308 Plant Systematics (2 credits)

General definitions, nomenclature, identification and classification. Taxonomic hierarchy, different classify-cation systems. Different schools of thought as to the origin of the angiosperms. Phenetics, cladistics, different types of data. Plant collection and herbarium techniques.

Practical exercises on floral characteristics of representative species from useful plant families.

Recommended Texts:

1. Stace, C. A. (1993). *Plant taxonomy and biosystematics.* Cambridge University Press, U.K.
2. D.Bridson and L. Forman (Eds) (1998). The herbarium hand book. 3rd Edition. Scientific Publications of the Royal Botanical Gardens, Kew, England.
3. Thomas J. Elpel (2000). Botany in a Day: Thomas J. Elpel's Herbal Field Guide to Plant Families, HOPS Press.
4. Nordenstam, B. & El-Ghazaly, G. (Ed.) (2000). Plant Systematics for the 21st Century. Swedish Museum of Natural History, Sweden and M. Kassas, Cairo University, Egypt.

BT 309 - Biodiversity Conservation and Management (2 Credits)

Biodiversity – Introduction, Global and national Biodiversity estimates; Measuring Biodiversity; Loss of Biodiversity; Threats to Biodiversity; Biodiversity Conservation: *In situ* and *Ex situ* conservation, Sustainable Management, Environmental education, Conservation through legislation; Setting conservation priorities; Ecotourism; Indigenous knowledge and Biodiversity; International conventions on Biodiversity; Laboratory and field exercises related to above topics.

Recommended Texts:

1. Alexander Wood, Pamela Stedman-Edwards and Johanna Mang (Eds.). 2000. *The root causes of Biodiversity loss*. Earthscan Publications Ltd., U.K.
2. Jaboury Ghazoul and Douglas Sheil. 2010. *Tropical Rain Forest Ecology, Diversity, and Conservation*. Oxford University Press.
3. Eric G. Bolen and William Robinson. 2002. *Wildlife Ecology and Management*. Benjamin Cummings.
4. Ann E. Maugurran. 1987. Ecological Diversity and its Measurement Chapman and Hall, UK.
5. William J. Sutherland. 2000. The Conservation Handbook. Blackwell Science. P 1-273.

BT 310 Ecosystems of Sri Lanka: Their Ecology and Conservation (2 credits)

Geography, climate, geology, soils and floristic zones of Sri Lanka. Natural vegetation types of the island in relation to their distribution, extent, climate, vegetation structure, floristic richness, family and species dominance, population size distributions, endemic species, underutilized species. Factors responsible for degradation of natural ecosystems.

Conservation and restoration of natural ecosystems. The ecosystems considered are i) marine, ii) maritime (mangroves, sea shore, and salt marshes) and inland aquatic ecosystems, forest types (rain forests -lowland & montane, dry zone forests and scrub vegetation), grasslands (wet and dry pathanas, thalawas, savannahs and damanas).

Recommended Texts:

1. Ashton, P. M. S. *et al.* (1997). *A field guide to the common trees and shrubs of Sri Lanka*. The Wildlife Heritage Trust, Sri Lanka, 432pp.
2. Whitmore, T. C. (1990). *An introduction to tropical rain forests*. Oxford University Press, Oxford, 226pp.
3. Mabberley, D. J. (1992). *Tropical Rain Forest Ecology*. Blackie and Son Ltd., 300pp.
4. Anon. (2000). *Natural Resources of Sri Lanka*. The National Science Foundation, Sri Lanka, 306pp.

BT 311 Plant Reproductive Biology and Plant Breeding (2 credits)

(Prerequisite: BT 307)

Genetic variation and its estimation, incompatibility and its inheritance. Pollination biology. Plant breeding perspectives, plant reproductive systems, principles of plant breeding, genetic basis of plant breeding, polygenic inheritance, methods of breeding and experimental designs, quantitative inheritance, polyploidy, methods of breeding of self- and cross pollinated crops. Application of molecular marker technologies for genome analysis. Germplasm resources preservation and utilization, hybrid crops, seed production and maintenance. Field visits to Plant Genetic Resource Centre (PGRC) and Rice Research and Development Institute, Batalagoda.

Recommended Texts:

1. Poehlman, J. M. and Sleper, D. A. (1995). *Breeding Field Crops* 4th Edition,. ISU Press.
2. Agarwal, R. L. *Fundamentals of Plant Breeding and Hybrid Seed Production* .Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, India.
3. Sharma, J. R. (1994). *Principles and Practice of Plant Breeding*. Tata Mc Graw – Hill Publishing Company Ltd., New Delhi.

BT 312 Economic Botany (2 credits)

Crop plants and their wild relatives, centres of origin and diversification of crop plants. A brief botanical description of economically important plants selected from cereals, millets, pulses, oil seeds, essential oils, sugar crops, tuber crops, fiber crops, spices and condiments, medicinal plants, beverages, fruits and nuts, vegetables, gums and resins, dyes and tannins, forage crops, cover crops and shade trees, avenue trees, insecticidal plants, plant toxins, invasive plants and weeds. Food plants, plants and plant products of industrial value, medicinal plants and drugs, food adjuncts. Structure and properties of wood, factors affecting the strength of timber, timber processing technology, agencies of destruction of wood, wood preservation; manufactured products of wood and their applications.

Laboratory exercises based on the above.

Recommended Texts:

1. Samba Murthy, A.V.S.S. & Subrahmanayam, N.S. (1998). *A Text Book of Economic Botany*, Wiley Eastern Ltd.
2. Desch, H. E. & Dinwoodies, JM. (1998). *Timber- structure, properties, conversion and use*. Macmillan Press.
3. Tisseverasinghe, A.E.K. (1971). *A manual of timber utilization for Ceylon*. Forest Department, Sri Lanka.

BT 313 Independent study (1 Credit)
A structured programme to encourage active student learning and develop their communication and presentation skills. The students obtain an in-depth understanding of given topics of botanical interest by literature survey and reading research/scientific articles and a deliver seminar.

FS 302 Food Science II (2 credits)
Concepts in Food Engineering **:** Physical concepts in food engineering: Properties of liquids and solids, measuring sensory characteristics, Physical and chemical properties of food products. Heat transfer systems for heating and cooling food products, Evaporation and drying, grinding and size reduction, Psychrometrics and dehydration.
Nutrition and Quality of Food*:* Biochemistry and Nutrition: Digestion and absorption. Food nutrients, their role in human nutrition, sources and availability. Food safety, hygiene and quality control**:** Natural and artificial toxicants in foods, Importance of hygienic handling, Principles of quality control; HACCP and GMP, Use of sensory evaluations, Food laws and standards, Role of International Bodies, i.e. WHO/FAO, International Standards Organization, Biosafety Regulations, Food control infrastructure in Sri Lanka. Laboratory work Based on above topics.

Recommended Texts:

1. B.C.Hobbs (1978),*Food Poisoning and Food Hygiene*, Edward Arnold Publishers.
2. R.T.Toledo (1997), *Fundamentals of Food Process Engineering*, C.B.S. Publishers and Distributors.
3. N.W.Dessroshier(1963), *The Technology of Food Preservation*, The AVI Publishing Company.

HR 301 Human Resource Management (2 credits)
Introduction: Defining the Role, Importance and Challenges of HRM; Historical Development of HRM. Approaches of HRM; HRM and Personnel Management, Roles of HR Managers, Strategic Orientation of HRM. Brief Introduction to HRM Functions: Job Design, Job Analysis, HR Planning, Attraction, Selection, Recruitment, Induction, Training and Development, Career Development, Performance Management, Knowledge Management, Salary Administration, Employee Movements, Labor Relations, Discipline Handling, Managing Health and Safety, Grievance Handling and Reward Management.

Recommended Texts:

1. Mathis, R.L., Jackson, J.H., Valentine, S.R. (2013) Human Resource Management, 14th Edition, CENGAGE Learning.
2. Dessler, G. (2012) Human Resource Management, 14th Edition, Pearson.
3. Nkomo, S.M., Fottler, M.D., McAfee, R.B. (2010) Human Resource Management Applications: Cases, Exercises, Incidents, and Skill Builders, 7th Edition, CENGAGE Learning.

400 LEVEL COURSES

BT 401 Nitrogen Fixation (3 credits)
Nitrogen fixation (abiological and biological), the global cycle, importance and relevance to national development. Oganisms and systems that fix nitrogen, free–living, symbiotic, associative and endophytic. Methods of measuring nitrogen fixation based on, Kjeldahl analysis, acetylene reduction assay, isotopes (radioactive and heavy 15N), direct labelling and substrate labelling techniques. Gas chromatography, Mass Spectrometry

and Emission Spectrometry. Enzymology of nitrogen fixation, the enzyme system, factors affecting the enzyme, oxygen sensitivity and mechanisms to protect the enzyme from oxygen inhibition. Requirements for nitrogen fixation and how these are met in nature. Biochemistry of nitrogen fixation including the mechanism. Genetics of nitrogen fixation, Nif genes and their regulation. Application of nitrogen fixation in agriculture and forestry.
Practical exercises based on above topics.

Recommended Texts:

1. Gallon, J. R. and Chaplin, A. E. (1987). *An Introduction to nitrogen fixation*. Cassell Education limited.
2. Alexander, M. (1984). *Biological nitrogen fixation - Ecology, technology and physiology*. Plenum publishing corporation.
3. Ladha, J. K., George, T. & Bohlool, B.B. (Eds.) (1992). *Biological nitrogen fixation for sustainable agriculture*. Kluwer Academic Publishers.
4. Khush, G. S. & Bennett, J. (1992). *Nodulation and nitrogen fixation in rice.* International Rice Research Institute, Phillipines.

BT 402 Rhizobiology (3 credits)
(Prerequisite: BT 302)
Introduction to the family Leguminosae & the nodule forming bacterium. *Rhizobium* characteristics. Counting *Rhizobium* in soil. Ecology of *Rhizobium*, rhizosphere of legumes. Abiotic and biotic factors affecting rhizobial growth in soil, numbers and distribution in soil, artificial introduction of *Rhizobium* into soil. Species relationships and cross inoculation groups. Effective and ineffective nodulation. Census of nitrogen fixers. Study of infection, nodulation.
Practical exercises based on above topics.

Recommended Texts:

1. The Biology of Nitrogen Fixation. Ed: A. Quispel. *Botanical Laboratory*, State University Leyden, The Netherlands (1974), North Holland Publishing Company, Amsterdam, Oxford American Elsevier Publishing Company, Inc. NewYork.
2. Vincent .J. M. (1970) *A manual for the practical study of root-nodule bacteria*. Blackwell scientific Publications, Oxford and Edinburgh (I B P Handbook No. 15)
3. Somasegaran, P. & Hoben, H.J (1994). *Handbook for rhizobia* . Springer-Verlag , New York.

BT 403 Plant Toxicology (2 credits)
(Prerequisite: BT 207)
Introduction to terminology used in toxicology – LD 50, bioaccumulation, biodegradability, dose – response relationships, microbial toxins – of bacteria, cyanobacteria and fungi (mushroom toxins and mycotoxins), their nature and effects, factors contributing to their formation in food and methods of prevention of contamination and decontamination; case studies, toxins of higher plants, their nature and effects, analytical techniques, legislature in different countries, uses of toxins.
Practical exercises based on above topics.

Recommended Texts:

1. Eaton, D.L. Groopman, J. D. (1994). *The toxicology of aflatoxins*. Academic Press, U.K.

2. Friedman, M. (1990). *Nutritional and Toxicological consequences of food processing. Advances in Experimental Medicine and Biology*. Vol 289. Plenum Press.
3. Jones, J. M. (1993). *Food Safety*. Eagon Press.
4. Miller, J. D. Trenholm, H. L. (1994). *Mycotoxins in grain – compounds other than aflatoxins*. Eagon Press.
5. Vries, D. J. (1997). *Food Safety and Toxicology*. CRC Press, USA.

BT 404 Advanced Plant Pathology (2 credits)

(Prerequisite: BT 304)

Plant-pathogen interactions, mechanism of pathogen attack, natural disease resistance in plants, induced resistance and Systemic Acquired Resistance. Plant disease diagnosis. Conventional and modern plant disease control methods, Plant Quarantine, Integrated Pest Management (IPM). Independent study and seminar. Practical exercises based on above topics.

Recommended Texts:

1. G.N. Agrios (1997). *Plant Pathology*, 4th Edition, Academic Press, U.K.
2. Abeygunawardena, D.V.W. (1969). *Diseases of cultivated plants, Their diagnosis and treatment in Ceylon,* The Colombo Apothecaries Co. Ltd., Sri Lanka.
3. Fox, R.T.V. (1992). *Principles of diagnostic techniques in plant pathology*, CAB International.
4. Bailey, J.A. & M.J. Jeger (1992). *Colletotrichum*: *Biology, Pathology & Control*, CAB International.

BT 405 Plant Biochemistry II (3 Credits)

(Prerequisite: BT 207)

Carbohydrates in plants, chemical classification, classification according to function, nutritional classification of starch, role of carbohydrates in the food industry, food starch modifications; physical and chemical modifications, non-food uses of starch. Proteins and amino acids in plants, types of amino acids and their classification, functional properties of proteins, role of plant proteins in human nutrition, sources of plant proteins and their importance in developing countries, anti-nutritional factors associated with cereal and legume proteins, improving the quality of proteins and the uses of plant proteins in other industries.

Lipids: classification and chemistry of lipids, catabolism of lipids in plants, biological functions, role in human nutrition, oxidation and rancidity reactions in food, plant pigments and related secondary metabolites, classification, functions other than pigmentation, related biosynthetic pathways. Practical exercises based on above topics.

Recommended Texts:

1. Meuser, F. Manners, D. J. & Siebel, W. (Eds.) (1993). *Plant polymeric carbohydrates*. The Royal Society of Chemistry, Cambridge, U.K.
2. Weil, J. H. (1990). *General Biochemistry* (6th Edition). Wiley Eastern Limited, New Delhi, India.
3. Lehninger, A. L. (1986). *Principles of Biochemistry*. Worth Publishers, Inc., New York, USA.
4. Salisbury, F. B. & Ross, C. W. (1992). *Plant Physiology*. Wadsworth Inc., USA
5. Taiz, L & Zeiger, E. (1991). *Plant Physiology*. The Benjamin / Cummings Publishing Company, 546.

BT 406 Plant Molecular Genetics and Biotechnology (3 credits)

(Prerequisite: BT 307)

Structure, regulation and expression of plant genes; gene cloning, Screening methods and isolation of recombinant clones, plasmid and other vector systems; construction of genomic and cDNA libraries; DNA sequencing & DNA synthesis. Manipulation and transforming genes. Enzymes in cloning. Recombinant DNA technology and its application. Bioinformatics and integrative genomics: Web based search for biological information and literature. Analyses of biological data and interpretation. Proteomics: protein structure and function, proteomic analysis, protein separation and identification, 2D gel electrophoresis (IEF & SDS-PAGE),
immunoblotting, MALDI-TOF Mass Spectrometry. Nutrigenomics (Nutritional Genomics): connection between human genetic diversity and nutrition.
Practical exercises based on above topics.

Recommended Texts:

1. Old, R.W. and S.B. Primrose (1994). *Principles of gene manipulation: An introduction to genetic engineering*. (5th Edition), Blackwell Science Ltd, Australia.
2. Lodish, H. *et al*., (1995). *Molecular cell biology*, 3rd Edition, Scientific American Books Inc., New York, USA.
3. Walker, J.M. and E.B. Gingold (1993). *Molecular biology and biotechnology* (3rd Edition), The Royal Society of Chemistry, U.K.
4. Watson, J.D. *et al*., (1992). *Recombinant DNA*. 2nd Edition. Scientific American Books, New York.
5. Brown, T.A. (1998). *Genetics: A molecular approach* (3rd Edition), Stanley Thornes (Publishers) Ltd.
6. Attwood ,T.K. and D.J. Parry-Smith (1999). *Introduction to bioinformatics*, Longman, England.
7. www.nebi.nlm.nih.gov.
8. www.tigr.org
9. www.ebi.ac.uk

BT 407 Advanced Plant Systematics (2 credits)

(Prerequisite: BT 308)

Different types of data: morphological, anatomical, phytochemical, palynological and molecular data. Phylogenetic systematics, constructing classification systems. Angiosperm classification based on molecular data. Role of plant systematics in biodiversity conservation and management. Role of Molecular data in biodiversity conservation management. Selected plant orders and families.
Practical exercises based on above topics.

Recommended Texts

1. Ray, P.M. and Harborne, J.B. (Eds) (1999). *Plant Biochemistry*. Academic Press, San Diego.
2. Judd, W. S., Campbell, C.S., Kellogg, E.A., and Stevens, P.F. (1999). *Plant Systematics*: A phylogenetic approach. Sinauer Associates, Inc., Sunderland, Massachusetts, U.S.A.

BT 408 Advanced Plant Physiology (2 credits)

(Prerequisites: BT 206, BT 207)

Architecture of plant cell walls. Root development, cellular organization and function, functions of root tissues in nutrient and water transport, factors affecting the distribution of roots, exudation and symbiotic associations, effects of the physical environment on the development and growth of roots. Competition between root systems. Physiological and morphological plasticity of the roots and the use of ^{32}P in root uptake studies. Physiological considerations of photosynthesis and water relations, photosynthetic responses of leaves to CO_2 and light, hydraulic architecture of plants, carbon isotope discrimination and plant Water-use-efficiency, eco-physiological adaptations of plants to drought. Plant secondary metabolites.

Practical exercises based on above topics.

Recommended Texts:

1. Lambers, H., Stuart, F., Chapin, I. & Thijs, L.P. (1998). *Plant Physiological Ecology*. Springer –Verlag.
2. Taiz, L. & Zeiger, E. (1999). *Plant Physiology*. Benjemin Cummings Publishing Company, New York, USA.
3. Hopkins WG (1999). *Introduction to Plant Physiology*. John Wiley and Sons, NewYork, USA.
4. Hall, D.D. & Rao, K.K. (1999). *Photosynthesis* (6th Edition). *Studies in Biology Book Series*. Cambridge University Press, U.K.

BT 409 Dynamic Plant Ecology (3 credits)

(Prerequisites: BT 309, BT 310)

Natural ecosystems of Sri Lanka (extension lectures). Ecosystem dynamics (fire ecology, phenology, nutrient cycling, population dynamics, competition). Sustainable utilization of goods and services (including nature tourism). Dendrology, plant-animal interactions. Analysis and interpretation of quantitative ecological data. International conventions and national strategies in relation to conservation and sustainable management of plant diversity.

Recommended Texts:

1. Crawley, M. J. (ed.) (1997). *Plant Ecology* (2nd Edition), Blackwell Science Ltd., USA, 715pp.
2. Magurran, A. E. (1988). *Ecological Diversity and Its Measurement*. Croom, Helm, Australia, 179pp.
3. Kent, M. and Coker, P. (1996). *Vegetation Description and Analyses: A Practical Approach*. John Wiley and Sons, 363pp.
4. Begon, M., Harper, J. L. and Townsend, C. R. (1990). *Ecology: Individuals, Populations and Communities*. Blackwell Scientific Publications, USA, 945pp.
5. Primack, R.B. (2000). *A primer of Conservation Biology*. Sinauer Associates, Inc. Publishers, USA, 319pp.

BT 410 – Forestry (2 Credits)

Natural forests, plantation forests and agro-forestry systems; Local and global demands for forest products; Forests and forest policy in Sri Lanka. Forest mensuration; Silvicultural systems; Species selection and nursery practices; Forest genetics; Site preparation before planting; After-care of plantations: weeding, fertilizing, pruning, thinning; protection from diseases, pests and fire; Harvesting and marketing; Sustainable forest management; Field exercises based on above topics.

Recommended Texts:

1. Raymand A. Young and Ronald L. Giese. (1990). *Introduction to forest science*. 2nd edition. John Wiley and Sons, New York, 575pp.
2. Savill, P.S. and Julian, E. (1986). *Plantation silviculture in temperate regions with special references to the British Isles*. Clarendan press. Oxford, U.K. 235pp.
3. Philip, M.S. (1994). *Measuring trees and forests*. 2nd Edition. CAB International, Wallingford, U.K., 264pp.

BT 411 Herbarium (1 credit)

Students will collect a recommended number of specimens representing lower and higher plants, identify and submit as herbarium specimens.

BT 412 Applied Microbiology (2 credits)

(Prerequisite: BT 302)

Microorganisms with industrial and environmental use and their products. Growth and product formation in industrial processes, large scale fermentations: food, alcoholic beverages, animal feed, single cell proteins, antibiotics, organic acids, amino acids, enzymes, vitamins. Fuel and energy. Waste water treatment and utilization. Setting up a microbiological laboratory. Selected titles from the above course content will be offered each year.

Recommended Texts:

1. Atlas, R.M. (1995). *Principles of Microbiology*. Mosby.
2. Glazer, A.N. and Nikaido, H. (1995). *Microbial biotechnology. Fundamentals of Applied Microbiology*. W.H. Freeman & Company, New York, USA.
3. Madigan, M.T., Martinko, J.M. and Parker. J. (2002). *Brock Biology of Microorganisms*. 10th Edition. Prentice Hall, USA.

BT 413 Advanced Plant Developmental Physiology (2 credits)

(Prerequisite: BT 305)

Classification of natural and synthetic plant growth regulators (PGRs), biosynthetic pathways, transport and catabolism of natural PGRs, molecular basis of action, cell signaling pathways, regulation of hormone levels in plants, role of PGRs in crop production and postharvest technology, effect of PGRs on human health, production of PGRs by microorganisms.

Recommended Texts:

1. Fosket, D.E. (1994). *Plant Growth and Development- A Molecular Approach*. Academic Press, Inc., New York.
2. Howell, H.S. (1998). *Molecular genetics of plant development*. Cambridge University Press, U.K.
3. Moore, T.C. (1974). *Research Experiences in Plant Physiology - A Laboratory Manual*. Springer-Verlag, New York, USA.
4. Srivastava, L.M. (2002). *Plant Growth and Development – Hormones and Environment*. Academic Press, U.K.
5. Taiz, L., Zeiger, E. (1999). *Plant Physiology*. Benjemin Cummings Publishing Company, New York, USA.

BT 414 Independent study (1 credit)
A structured programme to encourage active student learning and develop their communication and presentation skills. The students obtain an in-depth understanding of given topics of botanical interest by literature survey and reading recommended research/scientific articles and deliver seminar/s.

BT 415 Research Project (6-8 credits)
(Prerequisite: BT 209)
Each student will carry out a research project during the final year under the supervision of a staff member. The student is required to deliver two seminars, (a) pre-project seminar, based on preparatory work and research plan and (b) end of the project seminar, based on the outcome of research and prepare a comprehensive report containing Title page, Abstract, Introduction and Literature Review, Objectives, Materials & Methods, Results, Discussion and References.

BT 416 Seed Biology and Technology (2 credits)
Introduction to seeds and seed science; reproductive development of plants; development of fruits and seeds; desiccation tolerance of seeds, seed quiescence, dormancy and non dormancy; seed longevity and seed banks; seed germination; molecular genetic advances of seeds and its consequences; seed production; seed harvesting; Seed purity; Seed handling techniques; post production improvement of seeds; seed vigor and vigor tests; seed deterioration and seed storage; preservation of seeds; somatic embryogenesis and artificial seed production.
Practical component: Seed deterioration experiments; seed moisture measurements; types of seeds; desiccation sensitivity of seeds; seed dormancy; seed vigor and standard germination; seed purity; imbibition of seeds and seed priming; seed isotherms, seed pathology and artificial seed production.

Recommended Texts:

1. Adkins, SW., Ashmore, S. and Navie, SC. (2007). *Seeds: Biology, Development and Ecology*. Wallingford, OX, UK: CABI Publishers.
2. Baskin, CC. and Baskin, JM. (1998). *Seeds: Ecology, biogeography, and evolution of dormancy and germination*. San Diego, USA, Academic Press.
3. Copeland, LO. and McDonald, MB. (2001). *Principles of Seed Science and Technology*, 4th ed. Kluwer Boston, USA, Academic Publications.
4. Hartmann, HT., Kester, DE., Davies, FT. and Geneve, RL. (2002) *Plant Propagation: Principles and Practices*. 7th ed. Upper Saddle River, NJ, USA: Pearson Education Inc.

BT 417 Phytogeography (2 credits)
Introduction to biogeography, phytogeography and its history as a discipline; geodispersal, speciation and isolation barriers; plate tectonics and palaeoclimates; vicariance biogeography; island biogeography; tertiary relict floras.
Practical component: testing phytogeographic hypotheses using phylogenetic trees; multiple sequence alignment techniques; dating phylogenies, vicariance (cladistic) biogeography methods.

Recommended Texts:

1. Lomolino, M.V., Riddle, B.R., Whittaker, R. J. and Brown, J.H. (2010). Biogeography. Sinauer Associates Inc. Sunderland, Massachusetts. 4th edition.
2. Avise, J. C. (2000). Phylogeography: the history and formation of species. Harvard University Press.

3. McLoughlin. (2001). The breakup history of Gondwana and its impact on pre-Cenozoic floristic provincialism. Aust. J. Bot. 49: 271–300.
4. Zachos, J., Pagani, M., Sloan, L., Thomas, E. and Billups, K. (2001). Trends, Rhythms, and Aberrations in Global Climate 65 Ma to Present. Science 292: 686-693.

BT 418 Evolution and Diversity of Cryptogamic Plants (2 credits)

Introduction to Cryptogamic Plants: algae, lichens, bryophytes and pteridophytes; morphological, reproductive and taxonomic diversity of Cryptogamic Plants; evolutionary origins, diversification and phylogenetic relationships among the major lineages of Cryptogamic Plants; economic and ecological importance of Cryptogamic Plants.Practical component will be based on the above topics.

Recommended Texts:

1. Vanderpoorten, A. and Goffinet, B. (2009). Introduction to Bryophytes. Cambridge University Press.
2. Graham, L. E. and Wilcox, L. W. (2009). Algae. (2nd Edition). Benjamin Cummings (Pearson), San Francisco, CA.
3. Nash, T. H. (2008). Lichen Biology. Cambridge University Press.
4. Kenrick, P. and Crane, P.R. (1997). The origin and early diversification of land plants. A cladistic study. Smithsonian Institution Press, Washington & London. Washington: Smithsonian Inst. Press.

BT 419 Physiology and Management of Ornamental Plants (2 credits)

Introduction to floriculture; Plant propagation; Pre- and post-harvest physiology: ultra-structural and biochemical changes related to growth, maturation, senescence, respiration and water relations; Improving the posthravest longevity of ornamental plants; Pests, diseases and their control; Value addition in consumer usage; Flower and foliage supply chain; Laboratory practicals related to above topics and industrial visits.

Recommended Texts:

1. Ingels, J. (2010). Ornamental Horticulture: Science, Operations & Management. 4th Edition, Delmer, Cengage Learning.
2. Öpik, H., Rolfe, S.A., Willis, A.J. (2005). The Physiology of Flowering Plants. 4th edition. Cambridge University Press.
3. Wills, R.B.H., McGlasson, W.B., Graham, D. Lee, T.H. and Joyce, D. (2007). Postharvest. An Introduction to the Physiology and Handling of Fruit, Vegetables and Ornamentals. 5th Edition, University of New South Wales Press.

BT 420 Biological Nitrogen Fixation (2 credits)
(Prerequisites: BT 302)

Introduction to biological nitrogen fixation: Nitrogen cycle, Organisms and systems that fix Nitrogen, Mechanism and requirements for nitrogen fixation: Enzymology of nitrogen fixation, Genetics of nitrogen fixation. Methods of measuring nitrogen fixation, Applications in biological nitrogen fixation: Biofertilizers, Biofilms, Species relationships and Cross inoculation groups, Effective and ineffective nodulation. Future directions in biological nitrogen fixation.

Recommended Texts:

1. Gregory, P. (2006). Plant Roots: Growth, Activity and Interaction with Soils. Blackwell Publishing Ltd, UK.
2. Coleman, D. C., Crossley, D.A. and Hendrix, P. F. (2004). Fundamentals of Soil Ecology, Elsevier Inc.

3. Stacey, G., Burris, R. H. and Evans, H. J. (1992) Biological Nitrogen Fixation. Chapman and Hall, London.
4. Kulasooriya, S. A. (2008) Biological Nitrogen Fixation: Fundamentals and Utilization. Peradeniya Science Publication No 27, Science Education Unit, Faculty of Science, University of Peradeniya.

SI 401 Industrial training (2 credits)
Each student will undergo full time training in the industry for the prescribed period on projects assigned by the industry. Students are required to have a duly maintained 'Daily Diary' which should be submitted to the Head of the Department within two weeks after completion of the training. In addition, the students are expected to write a report and make a presentation on the work carried out by them.

CHEMISTRY

Compulsory courses for the General degree: CH 101, CH 102, CH 108, CH 109**,** CH 211, CH 218, CH 221, CH 228, CH 231, CH 238, CH 328, CH 331, CH 338, CH 348

Compulsory courses for the Special Degree: CH 101, CH 102, CH 108, CH 109, CH 211, CH 212, CH 218, CH 221, CH 222, CH 228, CH 231, CH 232, CH 238, CH 317, CH 319,CH 321, CH 324, CH 326, CH 329, CH 330, CH 331, CH 332, CH 339, CH 341, CH 342, CH 351, CH 369, CH 416, CH 417, CH 425, CH 426, CH 435, at least two out of (CH 436, CH 437, 438), CH 443, CH 448, CH 455, CH 491, CH 492, CH 499.

100 LEVEL COURSES

CH 101 Principles of Chemistry I (3 credits)
General Chemistry I (15L): Modern view of the atomic structure and the development of the atomic theory of matter; Electromagnetic radiation, atomic spectrum of hydrogen, Bohr model, the quantum mechanical description of the atom, quantum numbers, electrons as waves, wave-particle duality, de Bröglie relationship, wave function and its physical meaning, Heisenberg's uncertainty principle; Electron spin and the Pauli exclusion principle,
Hund's rule, Aufbau principle, electron configurations of elements of periodic table and periodic trends in atomic properties; Lewis structures, octaet rule and VESPER model, Bonding: Types of chemical bonds, covalent bonds, electronegativity, polarity and dipole moment, ionic bond, ionic lattices, partial ionic character of covalent bond, non-valence cohesive forces;

Structure and Reactivity (15 L): Types of intermolecular interactions; Factors affecting electron availability in bonds and at individual atoms; Acidity and basicity; Functional groups responsible for reactivity of different classes of organic compounds; Relationships between the main classes of organic molecules; Introduction to reaction mechanisms - bond cleavage processes, types of reagents and reaction intermediates; Energy diagrams; Mechanisms of substitution, addition and elimination reactions; Aromaticity and Huckel's Rule; Reactions in functional group analysis and their mechanisms. IUPAC Nomenclature
Fundermentals and Energetics (15L): The scientific method, microscopic and macroscopic theories,units and dimensions; Stoichiometry: mass balance, charge

balance, extent of reaction, equilibrium constants, limiting reactants, calculations involving various chemical reactions; Thermodynamics: Systems, surroundings, universe, processes, zeroth law of thermodynamics, temperature, first law of thermodynamics, work, heat, internal energy, extent of reaction, enthalpy, thermochemistry, second law of thermodynamics, entropy, Gibbs energy, Helmholtz energy, Gibbs energy versus extent of reaction, reaction quotient, exogernic and endogernic reactions**,**

Recommended Texts:

1. R. Chang (2002) *Chemistry*, McGraw-Hill; P.W. Atkins (1994), *Physical Chemistry*, Oxford University Press.
2. J McMurry (1996) *Organic Chemistry*, Brooks/Cole Publishing Co.; RT Morrison and RN Boyd (1998) *Organic Chemistry*, Prentice Hall.
3. P.W. Atkins and Julio de Paula, (2006), *Physical Chemistry*, Freeman and Co., New York.

CH 102 Principles of Chemistry II (3 credits)

(Prerequisite: CH 101)

General Chemistry II (15 L): Hybridization of atomic orbitals, molecular orbital theory, magnetic properties. Three- center bond, resonance, bonding in homonuclear and heteronuclear diatomic models; applications of size and energy factors in chemistry; Electrode potentials and Nernst equation and their inorganic applications, Basic concepts in chemical analysis: titrations, buffers, indicators, solubility equilibria and applications.

Kinetic Molecular Theory (KMT) and Chemical Kinetics (15L): KMT as a model for microscopic theories, experimental evidence, properties of gases, the perfect gas, state of gases, individual gas laws, combined gas laws, kinetic model for gases, imperfect gases; Molecular collisions; The importance of chemical kinetics: Rates, mechanisms, relationship between rate of reaction and rate of change of concentration of components; Rate law, rate constant and order, overall order of a reaction, initial rate method, integrated rate laws, isolation method, half-life of a reaction and a relationship to rate constant, molecularity of a reaction, the Arrhenius relationship between temperature and rate of a reaction, activation energy and pre-exponential factor, Steady-state approximation, pre-equilibrium.

Stereochemistry (15 L): Configurational isomers, E,Z-nomenclature, symmetry, chirality; R,S-nomenclature, *meso* compounds, diastereomers. conformations in acyclic and cyclic compounds, *cis-trans* and optical isomerism in cyclic compounds; biphenyls, allenes, Stereochemical course of organic reactions (S_N1, S_N2, E1,E2) and effect of solvent on substitution reactions.

Recommended Texts:

1. R. Chang (1996) *Chemistry*, McGraw-Hill; P.W. Atkins (1999), *Physical Chemistry*, Oxford University Press.
2. J McMurry (1996) *Organic Chemistry*, Brooks/Cole Publishing Co; RT Morrison and RN Boyd (1998) *Organic Chemistry*, Prentice Hall.
3. P.W. Atkins and Julio de Paula, (2006), *Physical Chemistry*, Freeman and Co., New York.

CH 108 Elementary Chemistry Laboratory I (1 credit)

Qualitative analysis; Analysis of inorganic anions, cations, Introduction to measurements and errors, Quantitative Inorganic analysis by volumetric titrations.

Recommended Texts:

1. A.I. Vogel, A.I. Vogel, *Qualitative Inorganic Analysis* (2004), Longman Scientific
2. A.I. Vogel, *Quantitative Inorganic Analysis* (2004), Longman Scientific

CH 109 Elementary Chemistry Laboratory II (1 credit)
(Prerequisite: CH108)
Organic functional group analysis.

200 LEVEL COURSES

CH 211 Inorganic Chemistry I (2 credits)
(Prerequisites: CH 101, CH 102)
Some selected trends in the chemistry of elements; Co-ordination chemistry: Co-ordination complexes, structures, stability constants, nomenclature, co-ordination numbers, reaction mechanism, crystal field theory, magnetochemistry, spectra of co-ordination complexes; Solid state chemistry, crystalline state, crystal systems, symmetry elements; Powder diffraction methods.

Recommended Texts:

1. JD Lee (1999) *Concise Inorganic Chemistry*,
2. SFA Kettle (1999) Coordination Chemistry, Appleton Century,
3. G.F. Liprot (1993) *Modern inorganic chemistry*, ELBS series with CollinsEducational.

CH 212 Inorganic Chemistry II (1 credit)
(Prerequisite: CH 211)
Organometallic chemistry; Nuclear and radiochemistry; Non-aqueous and ionic solvents.

Recommended Texts:

1. FA Cotton and G Wilkinson (1997) *A Textbook of Inorganic Chemistry*, Wiley Interscience
2. G.F. Liprot (1993) ELBS series with CollinsEducational.

CH 218 Inorganic Chemistry Laboratory I (1 credit)
(Prerequisite: CH 108, CH 211)
Gravimetric analysis, determination of anions and cations by gravimetry, complexometric titrations involving EDTA, synthesis of inorganic complexes and their analysis, qualitative analysis of simple mixtures.

Recommended Texts:

1. A.I. Vogel, *Qualitative Inorganic Analysis* (2004), Longman Scientific
2. A.I. Vogel, *Quantitative Inorganic Analysis* (2004), Longman Scientific

CH 221 Organic Chemistry I (2 credits)
(Prerequisites: CH 101, CH 102)
Organic Reaction Mechanisms I (15 L): Energetics – thermodynamics and kinetics of organic reactions; Concerted reactions, multi-step reactions; Electrophilic and nucleophilic addition to double bonds; Reactions of carboxylic acids and derivatives; Reactions of carbonyl compounds – carbanions, enols, enolates; Rearrangements reactions;
Spectroscopy I (15 L): UV, IR , ^{1}H-NMR and ^{13}C-NMR spectroscopy; one dimensional and two dimensional NMR

spectroscopy; Mass spectrometry EI-MS, CI-MS

Recommended Texts:

1. RT Morrison and RN Boyd (1998) *Organic Chemistry*, Prentice Hall;
2. RJ Fessenden and JS Fessenden (1990) *Organic Chemistry*, Brooks/Cole Publishing Co;
3. S. Ege (1994) *Organic Chemistry*, DC Heath & Co*;*
4. GP Wannigama (2000) *Organic Reaction Mechanisms*, SEU, University of Peradeniya;
5. TW Graham Solomon, CB Fryhle (2002) Organic Chemistry, John Willey;
6. RM Silverstein, GC Bassler and TC Morrill (1991) *Spectrometric Identification of organic compounds*, John Wiley.

CH 222 Introductory Organic Synthesis (1 credit)

(Prerequisite: CH 221)

Oxidations - alcohols, alkenes, Sharpless asymmetric epoxidation; Reductions-carbonyl compounds using hydride reducing agents, catalytic hydrogenation; Reactions of carbonyl compounds-methods of generating enolates, C-alkylation, O-alkylation, nitrogen analogues of enols and enolates, organocuprates; Carbonyl condensation reactions-aldol reactions; Robinson annulation, Claisen ester condensation, Dieckmann condensation, Thorpe nitrile condensation, Knoevenagal condensation; C=C formation - Wittig reaction and its modifications; Diels Alder reaction; Cope rearrangement; Claisen rearrangement

Recommended Texts:

1. S. Ege (1994) *Organic Chemistry*, DC Heath & Co.;
2. RT Morrison and RN Boyd (1998) *Organic Chemistry*, Prentice Hall.

CH 228 Organic Chemistry Laboratory I (1 credit)

(Prerequisites: CH 109, CH 221)

Techniques in organic chemistry; Separation of mixtures; Synthesis of simple derivatives of organic compounds; Use of spectroscopic methods in identification of organic compounds.

Recommended Texts:

1. RJ Fessenden and JS Fessenden (1993) *Organic Laboratory Techniques,* Brooks/ Cole Publishing Co.
2. AI Vogel, (1989*), A Textbook of Practical Organic Chemistry*, Longman Scientific.

CH 231 Physical Chemistry I (2 credits)

(Prerequisites: CH 101, CH 102)

Quantum Mechanics (10 L): Evidence for quantization, the Schrödinger equation, quantum mechanical principles, postulates in quantum mechanics, operators and observables, superposition and expectation values, the uncertainty principle, probability functions, solutions of Schrödinger equation for 1-, 2-, and 3-dimentional systems, including the hydrogen atom.

Atomic Structure and Atomic Spectra (10 L): Bohr theory and quantum mechanical description of the atom, orbital shapes, radial distribution curves, contour diagrams and polar plots, hybrid orbitals, LCAO method, alkali metal spectra.

Electrochemistry (10 L): Conductometry, electronic and ionic conductors, conductivity and molar conductivity, strong and weak electrolyte solutions, determination of limiting molar conductivity, Kohlrausch's law of independent migration of ions, determination of

ionic concentrations, equilibrium constants and rate constants. Conductometric titrations, electrodes, electrochemical cells, applications of potentiometry, factors effecting cell e.m.f., Thermodynamic functions from emf measurements, potentiometric titrations.

Recommended Texts:

1. P.W. Atkins and Julio de Paula, (2006), *Physical Chemistry*, Freeman and Co., New York.
2. D.A. McQuarrie, (1983) *Quantum Chemistry,* University Science Books.

CH 232 Molecular Properties, Molecular Spectroscopy and Spectroscopic Instrumentation (1 credit)

(Prerequisite: CH 231)

Electrical properties, dipole moment, intermolecular forces, magnetic properties, magnetic susceptibility, permanent and induced magnetic moments; Introduction to molecular spectroscopy; Rotational Spectra, vibrational spectra, electronic spectra, basic components of spectroscopic instrumentation.

Recommended Texts:

1. P.W. Atkins and Julio de Paula, (2006), *Physical Chemistry*, Freeman and Co., New York.
2. W.J. Moore (2005), *Introduction to Molecular Spectroscopy,* Pergammon Press.

CH 238 Physical Chemistry Laboratory I (1 credit)

(Prerequisite: CH 231)

Introduction to physical chemistry laboratory, apparatus and measurements; Error analysis; Equilibria; Thermochemistry; Problems in quantum mechanics and spectroscopy.

Recommended Texts:

1. D.P. Shoemaker, C.W. Garland, J.W. Nibler,(1996) *Experiments in Physical Chemistry*;
2. A Findlay, *Findlay's Practical Physical Chemistry;* Revised Edition, Oxford University Press.
3. P Mathews (1985), *Experimental Physical Chemistry*, Oxford University Press

300 LEVEL COURSES

CH 316 Special Topics in Inorganic Chemistry (2 credits)

(Prerequisite: CH 211)

Chemistry of the transition elements; Lanthanides; Actinides; Transuranium compounds; Rare Earths: Chemistry and extraction (15 L).

Silicates; Boranes; Metal clusters; Intercalates and their applications (15 L).

Recommended Texts:

1. DF Shriver, PW Atkins and CH Langford (1991), *Inorganic Chemistry*; ELBS with Oxford university press.
2. James E. Huheey (1994), *Inorganic Chemistry*.
3. FA Cotton and G.Wilkinson (1997) *Advanced Inorganic Chemistry,* Wiley Inter science.

CH 317 Advanced Inorganic Chemistry (3 credits)
(Prerequisite: CH 211)
***Symmetry*:** Symmetry elements, symmetry operations, classification of molecules/ions according to their symmetry; point groups; determination of point groups of molecules/ions, deduction of polarity and optical activity of molecules from their point group, group multiplication, basis, representative and matrix representation, character of an operation, character tables, reducible and irreducible representations (10 L).
***Spectroscopic Methods*:** NMR, NQR, ESR, Mossbauer, spectroscopy and inorganic applications (10 L).
***Advanced Co-ordination Chemistry*:** Ligand field theory, electronic spectra of complexes, magnetochemistry (15 L)
Diffraction Methods: General aspects of diffraction mechanism, generation of X-rays, Bravais lattices, reciprocal lattices, translational symmetry operations, space groups, systematic absences and space group determination, atomic scattering factors, structure factors, Fourier and Patterson maps, structure determination and refinement using single crystal XRD data, and applications; Neutron diffraction; Electron diffraction. (10 L)

Recommended Texts:
1. FA Cotton (1990), *Chemical Applications of Group Theory*; Oxford University Press, UK.
2. RS Dragon (1965), *Physical Methods in Inorganic Chemistry*, Oxford university Press, UK.
3. DF Shriver, PW Atkins and CH Langford (1994) *Inorganic Chemistry*, Oxford University Press;

CH 319 Advanced Inorganic Chemistry Laboratory (2 credits)
(Prerequisites: CH 218)
Analysis of rare earths, insoluble mixtures, magnetic measurements, X-ray diffraction, UV-visible spectra of transition metal complexes, synthesis of special inorganic compounds.

Recommended Texts:
1. A.I. Vogel, *Qualitative Inorganic Analysis* (2004), Longman Scientific

CH 321 Chemistry of Biomolecules (1 credit)
(Prerequisite CH 221)
Reactions and properties of monosaccharides, structures of disaccharides and polysaccharides; Properties and reactions of amino acids, structure and synthesis of peptides (10 L). Introduction to the chemistry and biosynthesis of flavonoids, terpenoids, steroids and alkaloids (5 L)

Recommended Texts:
1. RJ Fessenden and JS Fessenden (1990) *Organic Chemistry* Brooks/Cole Publishing Co.
2. RT Morrison and RN Boyd (1998) *Organic Chemistry*, Prentice Hall
3. FA Carey and RK Sundberg (1989) *Advanced Organic Chemistry, Part A*, Plenum Press

CH 324 Organic Chemistry II (2 credits)
(Prerequisites: CH 221, CH 222)
Organic Reaction Mechanisms II (15 L): Reactive intermediates –reactions of free radicals, carbenes and nitrenes; Symmetry controlled reactions; Electrocyclic reactions,

cycloadditions and sigmatropic rearrangements. Reactions of carbocyclic and heterocyclic aromatic compounds.

Organic Synthesis II (15 L); Reterosynthetic analysis - disconnection, functional group interchange, transform, synthons, synthetic reagents; Chemoselectivity, regioselectivity, stereoselectivity and stereospecificilty; Types of disconnections- one group and two group disconnections; Amine synthesis; Strategies and control in carbonyl condensation- 1,3-dicabonyl compounds, β-hydroxy carbonyl compounds, α,β-unsaturated carbonyl compounds, specific enolates, intramolecular aldol reaction, 1,5 - dicarbonyl compounds; Strategies in ring synthesis ; Free radicals in organic synthesis

Recommended Texts:

1. S Ege. (1994) *Organic Chemistry*, DC Heath and Co.
2. RT Morrison and RN Boyd (1998) *Organic Chemistry*, Prentice Hall.
3. EJ Corey and X-M Cheng (1989) *The Logic of Chemical Synthesis*, John Wiley;
4. RK Mackie and DM Smith (1990) *Guidebook to Organic Synthesis*, Addison, Wesley and Longman.

CH 326 Advanced Organic Chemistry I (2 credits)

(Prerequisite: CH 221)

Conformational Analysis (15 L): Conformations of simple acyclic molecules, alkenes, carbocyclic ring systems (6-membered rings, 3, 4 and 5-membered rings, large rings), Conformational analysis. Conformation and reactivity, Rules for ring closure, Stereo-electronic effects in organic compounds (15 L); Advanced stereochemistry (10 L); Pericyclic reactions (5 L)

Spectroscopy II (15L) – 2D NMR, MS and GC-MS, ORD-CD (15 L)

Recommended Texts:

1. EL Eliel and SH Wilen (1994) *Stereochemistry of Organic Compounds*, John Wiley & Sons Inc;
2. GM Loudon (1995);
3. RM Silverstein, GC Bassler and TC Morrill (1991) *Spectrometric Identification of organic compounds*, John Wiley and Sons.

CH 328 Organic Chemistry Laboratory II (1 credit)

(Prerequisite: CH 228)

Synthesis of organic compounds. Isolation and characterization of natural products, Application of spectroscopic methods for structure determination of organic compounds.

Recommended Texts:

1. AI Vogel, (1989) *Elementary Practical Organic Chemistry. Part A*, Longman Scientific
2. RM Silverstein, GC Bassler and TC Morrill (1991) *Spectrometric Identification of Organic Compounds*; John Wiley & Sons
3. RJ Fessenden and JS Fessenden (1990), *Organic Chemistry* Brooks; Cole Publishing Co.
4. RT Morrison and RN Boyd (1998) *Organic Chemistry*, Prentice Hall
5. FA Carey and RK Sundberg (1989) *Advanced Organic Chemistry, Part A*, Plenum Press

CH 329 Advanced Organic Chemistry Laboratory (2 credits)
(Prerequisite: CH 228)
Microscale preparation of organic compounds, multistep syntheses; Application of spectroscopic methods for structure determination of organic compounds. (only for Chemistry special students)

Recommended Texts:

1. RM Silverstein, GC Bassler and TC Morrill (1991), *Spectrometric Identification of Organic Compounds*, John Wiley & Sons
2. AI Vogel, (1989*), A Textbook of Practical Organic Chemistry*, Longman Scientific.

CH 330 Advanced Physical Chemistry I (3 credits)
(Prerequisites: CH 232, CH 331)
Quantum Mechanics (15 L): Quantum mechanical models: Review of the particle-in-a-box model, simple harmonic oscillator, rigid rotator, the H-atom, eigen value relationships for observables; Approximate methods: Variation and perturbation theories, the He-atom; Electron spin and the Pauli principle, Slater determinants, spin magnetic moment. Many electron atoms: Atomic units, Hartree-Fock equations and the self-consistent field method, antisymmetric wave functions, Slater determinants, Hartree-Fock-Roothaan method, correlation energy, atomic term symbols; Molecules and Born-Oppenheimer approximation; Quantum mechanical interpretation of molecular orbital and valence bond theories.
Advanced Molecular Spectroscopy (15 L): Spectral line widths and intensities, Microwave spectroscopy; Rigid and non-rigid rotor systems; Symmetric-top molecules; Spectra of isotopes; Vibrational spectroscopy; Harmonic and Anharmonic Oscillators, Fundamentals, Overtones, Combination bands, hot bands; Vibrational-Rotational Spectroscopy: diatomic and polyatomic molecules; Raman Spectroscopy; Determination of molecular structure; Electronic Spectroscopy; Vibrational and Rotational fine structure, Franck – Condon principle.
Statistical Thermodynamics (15 L): Boltzmann distribution, molecular partition functions, canonical ensemble, canonical partition function, translational, rotational, vibrational and electronic partition functions. Statistical entropy, Sackoor-Tetrode equation, calculation of thermodynamic functions from partition function data, equipartition principle and mean energy, calculation of heat capacity, residual entropy and equilibrium constants, equlibrium composition.

Recommended Texts:

1. PW Atkins and Julio de Paula, (2006), *Physical Chemistry*, Freeman and Co., New York.
2. WJ Moore, *Introduction to Molecular Spectroscopy*
3. DA McQuarrie, (1983), *Quantum Chemistry*, University Science Books.

CH 331 Physical Chemistry II (2 credits)
(Prerequisite: CH 231)
Advanced Thermodynamics (10L): Specific applications of the first law and second law of thermodynamics, free energy functions, criteria for spontaneity, fundamental equations of thermodynamics, open systems; temperature dependence of internal energy and enthalpy, Joule-Thompson coefficients, inversion temperature, general relationships between C_p and C_v. third law, third law entropies, reaction entropies; Temperature dependence of Gibb's function, Gibbs-Helmhlotz equation; Pressure dependence of Gibb's function, chemical potential of gases, real gases and fugacity, standard state of

gas; Real solutions, activities, solvent and solute activities; Equilibrium constants for rear gases, response of equilibrium constants to catalysts.

Surface and Colloid Chemistry (10 L): Interfaces and surfaces; Kelvin equation and its applications; Adsorption and absorption, surface excess; Physisorption and chemisorption, adsorption at liquid/gas, solid/gas interfaces, measurement of amount of adsorption, Gibbs and Langmuir adsorption isotherms; Enthalpy of adsorption; Dispersion systems; Surfactants and their uses.

Phase Equilibria (10 L): The phase rule, meaning of phase, component, one component systems and their phase diagrams; Two-component systems, liquid-liquid phase diagrams, distillation of partially miscible liquids, liquid-solid phase diagrams; Phase diagrams for reactive systems; Ultra purity and controlled purity; Three component systems, triangular phase diagrams.

Recommended Texts:

1. PW Atkins and Julio de Paula, (2006), *Physical Chemistry*, Freeman and Co., New York.
2. M Campbell, *Catalysis at Surfaces*.

CH 332 Physical Chemistry III (1 credit)

(Prerequisite: CH 231)

Kinetics: Steady-state approximation, pre-equilibrium, enzyme catalyzed reactions, kinetics of complex reactions, catalysis, photochemistry

Polymer Chemistry: Introduction to polymers, polymerization process, Carother's equation for linear and non-linear step-growth polymerization, kinetics of addition and step-growth polymerization; Melting point and glass transition temperature; Relationship between chemical structure and properties of polymers; Statistical thermodynamics of polymer solutions; Characterization of polymers

Nanotechnology: Timeline, definition, nanotechnology in nature, synthesis and characterization of nanomaterials, industrial applications

Recommended Texts:

1. PW Atkins and Julio de Paula, (2006), *Physical Chemistry*, Freeman and Co., New York.
2. RJ Young and PA Lovell***, Introduction to polymer,*** Oxford University Press

CH 338 Physical Chemistry Laboratory II (1 credit)

(Prerequisite: CH 238)

Experiments in physical chemistry: Electrochemistry, chemical kinetics, spectroscopy.

Recommended Texts:

1. DP Shoemaker, CW Garland, JW Nibler (1996), *Experiments in Physical Chemistry*;
2. A Findlay, *Findlay's Practical Physical Chemistry*; Revised Edition, Oxford University Press.
3. P Mathews (1985), *Experimental Physical Chemistry*; Oxford University Press

CH 339 Advanced Physical Chemistry Laboratory II (2 credits)

(Prerequisite: CH 238)

Experiments in advanced physical chemistry: Electrochemistry, kinetics, spectroscopy.

Recommended Texts:

1. DP Shoemaker, CW Garland, JW Nibler (1996) *Experiments in Physical Chemistry*;

2. A Findlay, *Findlay's Practical Physical Chemistry*; Revised Edition, Oxford University Press.
3. P Mathews (1985), *Experimental Physical Chemistry*; Oxford University Press.

CH 341 Analytical Chemistry (3 credits)
(Prerequisite: CH 231)
Advanced Calculations (12 L): Review of statistics in chemical analysis: test of significance, paired t-test, F-test, etc.; Statistics of linear chemical relationships; Performance characteristics of analytical methods; Interlaboratory testing; Sensor characteristics; Advanced calculations as applied to chemical analysis: derivation and error calculations associated with acid-base, redox and complexometric titrations; Iteration methods; metal-complex equilibria; Solubility equilibria and Gran plots.
Analytical Aspects of Spectrophotometry (9 L): Atomic absorption and emission methods, molecular UV and visible absorption spectroscopy.
Electroanalytical Chemistry (12 L): Potentiometric applications; voltammetry including polarographic methods, pulsed techniques, steady-state and flow injection amperometric methods, bulk electrolysis methods, microelectrodes in chemical analysis, electrochemical sensors,
Separation Methods (12 L): Solvent extraction, partition coefficient, distribution ratio, multiple extractions, extraction of metals, introduction to chromatographic techniques and classifications, gas chromatography, van-Deemter equation, ion-exchange chromatography, thin layer and paper chromatography, introduction to liqiuid-liquid chromatography.

Recommended Texts:
1. DA Skoog, West and Holler (2005), *Analytical Chemistry*; Marcel Dekker.
2. P Kissinger and WR Heineman (1984) *Laboratory Techniques in Electroanalytical Chemistry*; Freeman.
3. Marcel Dekker; AJ Bard and L Faulkner (1980), *Electrochemical Methods*; Marcel Dekker.

CH 342 Computer Applications and Instrumentation (2 credits)
(Prerequisite CH 231). Maximum of **60** students will be allowed to register including chemistry special students. Selection of the general degree students will be based on the **GPA**. *Not allowed for those who have been offered CS 206).*
Introduction to computers: Number systems (decimal, binary, octal and hexadecimal) Logic gates: Combinational and sequential logic, de Morgan's theorems, flip flops, counters, shift registers, computer memory organisation, analog to digital conversion (ADC), data acquisition and Instrument control, Introduction to computational chemistry: Electronic structure calculations, molecularmechanics, force fields, molecular dynamics, monte-carlo simulation.

Recommended Text:
1. P Horowitz and W Hill, (1989), *The Art of Electronics*, Cambridge University Press

CH 348 Analytical and Inorganic Chemistry Laboratory (1 credit)
(Prerequisite: CH 218)
Inorganic preparations, colorimetry, applications of physical methods to study inorganic reactions, quantitative analytical methods.

Recommended Text:
1. WL Jolly, *Inorganic preparations*.

CH 351 Biological Chemistry I (2 credits)
(Prerequisite: CH 321; Not allowed for those who have completed MB 201, MB 221 or BT 204.)
Metabolism (15 L) Metabolism of amino acids, carbohydrates, lipids and nucleic acids
Enzymology (15 L): Enzymes as catalysts in biological systems, structure, classification and nomenclature of enzymes; Mode of enzyme action; Enzyme kinetics; Regulatory enzymes; Applications of enzyme technology in industry; Enzyme systems and human health

Recommended Texts:
1. A Lehninger, DL Nelson and MM Cox (1993), *Principles of Biochemistry*, Worth Publishers Inc.
2. L Stryer (1995) *Biochemistry* WH Freeman and Co.

CH 361 Environmental Chemistry (3 credits)
(Prerequisites: CH 211, CH 221)
Theory Component (30 L): Chemical cycles, aquatic chemistry, water pollution, water treatment, water quality standards. Atmospheric chemistry, particles in the atmosphere Air pollution- inorganic and organic air pollutants, particles in the atmosphere, photochemical smog, global warming, acid rain, depletion of the ozone layer. Municipal and solid waste and their management, hazardous waste, waste as a resource; Pollution prevention and control, clean production mechanism; Environmental biochemistry; Toxicology; Environmental monitoring and analysis, sampling, classical methods and instrumentation; Analysis of data.
Laboratory Component (30 hr): Analysis of water quality parameters, analysis of air pollutants and particles; detection of pesticides.

Recommended Texts:
1. SE Manahan, (1994) *Environmental Chemistry*, Lewis publishers
2. C Baird (2000), *Environmental Chemistry*

CH 369 Industrial Training (1 credit)
Each student following the chemistry special degree is required to undergo a six week training programme at an industry/institution identified by the Department.

CH 371 Industrial Chemistry (3 credits)
(Prerequisites: CH 221, CH 231)
Metallurgy, minerals of Sri Lanka, industrial inorganic chemistry, coal, petroleum, essential oils, polymers, dyes, pharmaceuticals, intellectual property rights, elementary chemical engineering, mass transfer, heat transfer, reactors.

Recommended Texts:
1. PG Cooray (1964*) Geology of Sri Lanka*, Ceylon Museum
2. Industrial organic Chemistry by V, Karunaratne, Publisher :Science Education Unit, Faculty of Science, University of Peradeniy

MB 331 Fermentation Technology (2 credits)
(Prerequisites: CH 101, CH 102)
Microorganisms used in industrial fermentation; isolation and preservation of pure cultures; mutants, factors influencing rate of mutation; bioreactor design and operation; fermentation kinetics; culture media; sterilization; control of different parameters; process monitoring; isolation of products; current applications, synthesis of secondary

metabolites, strain improvement applications of functional genomics in fermentation technology.

Recommended Texts:

1. El-Mansi, E.M.T., Bryce, C.F.A., Dahhou, B., Sanchez, S., Demain, A.L., Allman, A.R. (Ed) Fermentation Microbiology and Biotechnology. CRC Press, Taylor and Francis Group.
2. Dehlinger, C.A. (2014) Molecular Biotechnology, Jones and Bartlett Learning.

HR 301 Human Resource Management (2 credits)

Introduction: Defining the Role, Importance and Challenges of HRM; Historical Development of HRM. Approaches of HRM; HRM and Personnel Management, Roles of HR Managers, Strategic Orientation of HRM. Brief Introduction to HRM Functions: Job Design, Job Analysis, HR Planning, Attraction, Selection, Recruitment, Induction, Training and Development, Career Development, Performance Management, Knowledge Management, Salary Administration, Employee Movements, Labor Relations, Discipline Handling, Managing Health and Safety, Grievance Handling and Reward Management.

Recommended Texts:

1. Mathis, R.L., Jackson, J.H., Valentine, S.R. (2013) Human Resource Management, 14th Edition, CENGAGE Learning.
2. Dessler, G. (2012) Human Resource Management, 14th Edition, Pearson.
3. Nkomo, S.M., Fottler, M.D., McAfee, R.B. (2010) Human Resource Management Applications: Cases, Exercises, Incidents, and Skill Builders, 7th Edition, CENGAGE Learning.

400 LEVEL COURSES

CH 411 Advanced Radiochemistry (1 credit)

(Prerequisites: CH 211, CH 212)

Radiation detectors, particle accelerators (linear accelerators, cyclotron, synchrocyclotron, betatron); Nuclear models (shell model and liquid drop model), stability of isobars; Radioanalytical techniques (isotope dilution analysis, neutron activation analysis)

Recommended Texts:

1. S.Glasstone (1964) *Sourcebook on Atomic* Energy, Chapman and Hall
2. DA Skoog, FJ Holler and TA Neiman (1998), Principles of Instrumental Analysis, Saunders Golden Series.

CH 414 Bio-Inorganic Chemistry (1 credit)

(Prerequisites: CH 211)

Role of metals in biological systems, electron transfer catalysts, cytochromes, iron sulphur proteins, molybdoenzymes, zinc and copper containing enzymes, oxygen carriers, nitrogen fixation, iron metabolism

Recommended Texts:

1. DE Fenton (1997) *Bio-coordination Chemistry*, Oxford University Press
2. SJ Lippard and JM Berg *Principles of Bio-inorganic Chemistry*, University Science Books, Mill Valley California
3. F.A. Cotton and G.Wilkinson, Advanced *Inorganic Chemistry*, Fifth edition, 1988.

CH 416 Advanced Inorganic Chemistry II (2 credits)
(Prerequisite: CH 317)
Organometallic Chemistry: Complexes of olefines, carbonyls, nitrosyls, arenes, and other organic ligands, organometallic complexes as catalysts.
Reaction Mechanisms in Inorganic Chemistry: Substitution reactions of octahedral and square planar complexes, trans effect, electron transfer reactions, Frank-Condon principle, Marcus theory, photochemical reactions

Recommended Texts:

1. GE Coates, MLH Green, P Powell and K Wade (1988)*Organometallic Chemistry*, Chapman and Hall;
2. F.Basolo and RG Pearson, *Inorganic Reaction Mechanism*.

CH 417 Topics in Solid State Chemistry (2 credits)
(Prerequisite: CH 211)
Advanced ceramics, inorganic polymers, conducting polymers and their applications, solid state batteries, nanostructures, sol-gel technology, semiconductor catalysts, photoelectrochemical solar cells, photovoltaics (15 L).
Crystal Lattices, metallic elements, alloys, ionic solids, defects, ceramics, glasses, layered MS_2 structures, Chevural phases, solid state electrolytes, solid state batteries, solid state synthesis**, t**hermal techniques (15 L).

Recommended Texts:

1. Chapman and Hall Ltd; G.H. Stout & L.H. Jensen, *X-ray Structure Determination*; C. Giacovazzo, *Fundamentals of Crystallography*; Edited by F.M. Henry, *International Tables for Crystallography, Volume A*, The Kynoch Press, Birmingham.
2. IS Butler and JF Harrod, (1989*) Inorganic Chemistry*, Benjamin/Cummings publishing company.
3. N.Serpone (ed.) (1989) *Photocatalysis and Phtoreactors*: NATO-SCI series

CH 424 Special Topics in Organic Chemistry (1 credit)
(Prerequisites: CH 221, CH 326)
Molecular modeling for organic chemistry: Molecular mechanics, force fields, conformational searches, ensemble averaged properties, molecular dynamics, computational study of biomolecules, supra-molecules and self assembly (Topics may vary each year)

CH 425 Advanced Organic Chemistry II (3 credits)
(Prerequisites: CH 324, CH 326)
Physical Organic Chemistry (15 L): Analysis of factors that influence the rates and mechanisms of organic reactions
Advanced Stereochemistry (15 L): Stereochemical control in cyclic and acyclic systems. Chiral catalysis.
Problem Solving (15 L): Application of principles of strereochemistry, reaction mechanisms, organic synthesis and spectroscopy in solving problems in organic chemistry

Recommended Texts:

1. NS Isaacs (1995) *Physical Organic Chemistry*, Longman
2. EL Eliel and SH Wilen *(1994) Stereochemistry of Organic Compounds*, John Wiley & Sons Inc.

CH 426 Natural Product Chemistry (3 credits)
(Prerequisite: CH 324)
Carbohydrates (10 L): Conformations of carbohydrates and conformational effects. Reactions of carbohydrates. Synthesis of modified carbohydrate molecules and other natural products
Steroids and Terpenoids (5 L): Studies of steroids, structure and reactions; Terpenoids, classes of terpenoids, structural elucidation, saponins
Alkaloids (7 L): Classification, chemical and spectrosocopic methods in structure elucidation, reactions and synthesis
Oxygen heterocylces (8 L): Characterization, synthesis and reactions of pyrylium salts, anthocyanins, α-pyrones, γ- ***Biosynthesis*** (15 L): Basic structural units, precursors and common reactions in biosynthesis; Acetate, shikimate and mevalonate pathways; Biosynthesis of alkaloids; Investigation of biosynthetic pathways.

Recommended Texts:

1. PM Collins and RJ Ferrier (1995) *Monosaccharide chemistry*, John Wiley and Co.
2. J Mann, RS Davidson, JB Jacobs, DV Banthorpe and JB Harborne (1994) *Natural Products, their Chemistry and Biological significance* Addison, Wesley Longman Ltd.
3. J Mann (1995) *Chemical Aspects of Biosynthesis*, Oxford University Press
4. P M Derwick (1997), *Medicinal Natural Products*, Wiley.

CH 435 Advanced Physical Chemistry II (2 credits)
(Prerequisite: CH 331)
Advanced Electrochemistry (15 L): Solvents, electrolyte solutions, non-ideal nature of electrolyte solutions, ion-solvent interactions, ion-ion interactions; The Debye-Huckel theory, ideal polarized electrodes, electrocapillary curves, determination of surface charge density, surface excess concentrations of ionic and neutral species at electrode surfaces, AC methods, theories of electrode/solution interfaces, electrode kinetics, mass transfer, charge transfer and other processes, Tafel plots, mass transfer-controlled electrode kinetics.
Advanced Topics in Kinetics and Reaction Dynamics (15 L): Review of fundamental laws of kinetics, fast chemical reactions and experimental methods for studying rates of such reactions, relaxation methods, collision theory, activated complex theory, Eyring equation, thermodynamic parameters, potential energy surfaces, applications in surface science and catalysts.

Recommended Texts:

1. PW Atkins and Julio de Paula, (2006), *Physical Chemistry*, Freeman and Co., New York.
2. KJ Laidler (1965), AJ Bard, *Fundamentals of Electrochemistry*, Chemical Kinetics, McGraw Hill, London, Inc.

CH 436 Advanced Physical Chemistry III (2 credits)
(Prerequisite: CH 331)
Surface and Colloid Chemistry **(**15 L)**: G**rowth and structure of solid surfaces, surface defects, Adsorption isotherms: BET, Temkin and Freundlich; rates of surface processes; mobility on surfaces; Catalytic activity of surfaces: Adsorption and catalysis, Herkins Jura isotherms, equation of states Eley-Rideal mechanism, Langmuir-Hinshelwood mechanism, molecular beam studies, examples of catalysis. Colloidal systems:

classification and purification, stability of collids, zeta potential, isoelectric point; Industrial applications.

Polymer Chemistry (15 L): Introduction to polymers, Polymerization processes; Carother's equation for linear and non linear step-growth polymerization; Kinetics of addition polymerization; Kinetics of step-growth polymerization; Melting point and glass-transition temperature, the relationship between the chemical structure and properties of polymers; Statistical thermodynamics of polymer solutions; Characterization of polymers

Recommended Texts:

1. JM Thomas and WJ Thomas, (1996), *Principles and Practice of heterogeneous catalysis*, John Wiley
2. M.Camphbell (1996), *Catalysis at surfaces*, Oxford University Press.
3. RJ Young and PA Lovell (1997) *Introduction to polymers*, John Wiley

CH437 Modern Topics in Physical Chemistry (2 Credit)

(Prerequisite: CH 330, CH 342)

Molecular Quantum Mechanics (10 L): Born-Oppenheimer approximation, hydrogen atom, polyelectronic systems, Hatree-Fock assumption, SCF-MO method, basis functions, electron correlation, higher level calculations, introduction to semi-empirical and density functional methods.

Electronic Structure Calculations (10 L): Computer lab sessions on practicals regarding the above topics. Weekly assignments for calculations of: optimized geometry, absolute energy, molecular orbitals, predicting IR, NMR, and UV spectra, ab initio treatment of chemical reactions.

Nano Technology (10 L): Introduction to nanoscience, divergence of physical properties with particle size, quantum confinement, particle motion, carbon based nanoparticles (graphene, nanotubes, spherical fullerenes), quantum dots, noble metal nanoparticles, nanoporous materials, 'soft' nanoparticles.

Recommended Texts:

1. R. Leach, (2001), Molecular Modelling Principles and Applications, Longman
2. D. Frenkel and B. Smit, Understanding Molecular Simulation, from Algorithms to Applications, Academic Press
3. M. P. Allen and D. J. Tildesley, Computer Simulation of Liquids, Clarendon Press
4. K. J. Klabunde, Nanoscale Materials in Chemistry, Zhong Lin Wang, Characterization of Nanophase Materials

CH 438 States of Matter: (2 credits)

(Prerequisites: CH 317, CH 330)

Gas laws, intermolecular forces and potential energy functions, theories and models of liquids, properties of liquids, ionic liquids; Liquid crystals: Types, properties and applications. Bonding in solids: ionic forces, gadwalls forces, covalent bonding, H-bonding and metallic bonding; Cohesive energy of ionic crystals, calculation of crystal energies, heat capacity of crystals. Theories of solids: Classical theory, Einstein model, Debye model, free electron theory of metals; Properties of solids: conductance, thermal, mechanical, optical and magnetic properties, crystal engineering.

Recommended Texts:

1. A.R. West (2000), *Basic Solid State Chemistry*, John Wiley and Sons, Second Edition
2. A J. Stone, (2002) *Theory of Inter-molecular Forces*, Oxford University Press

3. K.J. Laidler, J. H. Meiser, (2003) *Physical Chemistry*, Houghton Mifflin, Third Edition

CH 443 Advanced Analytical Chemistry (3 credits)
(Prerequisites: CH 341)
Spectroscopic Instrumentation and Spectrochemical Analysis (20 L): Optical components of spectrophotometers: sources, transducers, measurement systems, signal-to-noise ratio; Spectrochemical measurements: methodology and errors in spectrochemical analysis, sensitivity and detection limits, automated spectrochemical measurements; Advanced atomic spectral methods: Plasma, Arc and Spark methods; Atomic fluorescence spectrometry; Infrared and luminescence molecular spectroscopic methods.
Surface Analytical Techniques (10 L**)**: X-ray and UV photoelectron spectroscopies, Auger spectroscopy, Low enery electron diffraction, X-ray microscopy, etc.
Advanced Electroanalytical Techniques (5 L**):** Preparation and applications of chemically modified electrodes; Spectroelectrochemical methods.
Advanced Separation Techniques (10 L): Capacity factor and selectivity ratio as applied to gas chromatography and liquid chromatography, high performance liquid chromatography, size exclusion chromatography, supercritical fluid chromatography, affinity chromatography, Capillary electrophoresis and electrochromatography.

Recommended Text:
1. DA Skoog, (1988) *Instrumental Analysis Chemistry*, Saunders College Publishing Co.

CH 448 Analytical/Instrumental Chemistry Laboratory (1 credit)
(Prerequisite: CH 443)
Experiments in advanced analytical chemistry: Error Analysis as applied to instrumental techniques, Analytical atomic spectrometric methods, Analytical Molecular spectroscopic methods, Advanced electrochemical methods: Cyclic voltammetry and Amperometry, Gas liquid chromatographic and High Performance Liquid Chromatographic techniques in analysis.

Recommended Text:
1. DA Skoog, (1988) *Instrumental Analysis Chemistry*, Saunders College Publishing Co.

CH 455 Biological Chemistry 1I (2 credits)
(Prerequisite: CH 351)
Bioanalytical Chemistry & Biophysical Chemistry (10L): Biochemical techniques, centrifugation and chromatography; Topics in physical chemistry pertinent to biology - conformations of macromolecules, spectroscopy, thermodynamics, dynamics and transport processes, Donan equilibrium; Biological spectroscopy
Food chemistry (10L): Methods in food processing
Toxicology and Reactive species in biology (10L): Natural toxins, environmental pollutants, drug abuse, fats and toxic effects of xenobiotics in biological systems; Reactive oxygen species, lipid peroxidation, free radicals and toxicology, free radical reactions in living systems, diseases associated with free radical damage.

Recommended Texts:
1. A Lehninger, DL Nelson and MM Cox (1993), *Principles of Biochemistry* Worth Publishers Inc.
2. L Stryer (1995) *Biochemistry* WH Freeman and Co.

CH 456 Proteins (1 Credit)
(Prerequisite: CH 321)
Biosynthesis and chemical synthesis of proteins. Biological functions of some selected proteins and their 3D structures. Interaction of proteins with other proteins, carbohydrates, lipids and nucleic acids. Membrane proteins and their functions in transport across membranes.

Recommended Texts:

1. *Biochemistry*. (1994) D. Voet and J.G. Voet. John Wiley and Sons.
2. A Lehninger, DL Nelson and MM Cox (1993), *Principles of Biochemistry* Worth Publishers Inc.

CH 458 Biological Chemistry Laboratory (1 credit)
(Prerequisite CH 351)
Detection, isolation and analysis of amino acids, proteins, carbohydrates and nucleic acids.

MB 416 Environmental Biotechnology (2 credits)
Living organisms as pollution indicators; biodegradation; waste management; pollution treatment; bio-mining; biogas production; microbes in environmental management.

Recommended Texts:

1. R. Barry King, Gilbert M. Long, John K. Sheldon (1997) *Practical Environmental Bioremediation: The Field Guide* (Second Edition) Publisher: CRC Press.
2. Sarina J. Ergas, Daniel P. Y. Chang, Edward D. Schroeder, Juana B. Eweis (Editor) (1998) *Bioremediation Principals*, McGraw-Hill
3. Gareth M. Evans, Judith C. Furlong (2002) *Environmental Biotechnology : Theory and Application* John Wiley & Sons

CH 491 Seminar (1 credit)
(***Compulsory for all special degree students***)
Each student is required to present a seminar on a topic assigned by the Department.

CH 492 General Aspects and Recent Developments in Chemistry (1 credit)
(***Compulsory for all special degree students***)
The students will be evaluated on their knowledge and understanding of the principles of chemistry covered in the compulsory courses, and on general chemistry introduced through seminar- and industrial-presentations.
The three-hour question paper will also include an essay on a topic of general chemical interest.

CH 499 Research Project (6-8 credits)
(***Compulsory for all special degree students***)
Each student will carry out a research project during the final year under the supervision of a staff member. The student is required to give a seminar, based on the research project, and submit a report.

SI 401 Industrial training (2 credits)
Each student will undergo full time training in the industry for the prescribed period on projects assigned by the industry. Students are required to have a duly maintained 'Daily Diary' which should be submitted to the Head of the Department within two weeks after completion of the training. In addition, the students are expected to write a report and make a presentation on the work carried out by them.

COMPUTER SCIENCE

100 LEVEL COURSES

CS 100 Computer Applications (2 credits)
Introduction to Computer and operating Systems,
Micro Computer Applications: Use of Software Packages- Spread Sheet applications, DBMS applications, Utility programs and Word processing.
Data Protection Techniques: Data security techniques, Computer Viruses and prevention.
Data Communication: Email, Internet and Networking of Computers.
Introduction to a Programming Language: Procedures, Functions, File handling, Application of a DB management.
(This course includes both theory and practicals)

Recommended Texts:

1. Computer Science, C.S.French
2. Programmer's Guide to Foxpro 2.0, D. Howard
3. Computer viruses, Robert Slade

CS 101 Introduction to Computer Science (3 credits)
Introduction and overview: Intelligent machines and systems applications, Business, Communications, Educational, Engineering, Environmental, Medical and Scientific applications.
Introduction to computing concepts: Basics of computer programming: data types, declarations, assignments, basic input and out put ASCII files, built-in functions.
Structured programming ideas: selection statements: sequence, iteration (counting loops, while loops, file pointers), conditional (if-then-else statements, case statements), matrix manipulations (addition, subtraction, multiplication, transposition).
Modular programming: functions, procedures with actual and formal parameters, simple sort algorithms, dynamic memory allocation and addressing.
Numerical methods: Linear interpolation, linear regression, pseudo random, roots of functions, solutions of simultaneous linear equations by Gaussian elimination, numerical integration.

Recommended Texts:

1. The Thinking Ape: Evolutionary Origins of Intelligence, R. Byrne.
2. Intelligent Multimedia System : A Handbook for Creating Applications, R.M.Kaplan
3. Artificial Intelligence, E.Rich and K. Knight
4. An Introduction to computer science : An Algorithmic approach Jean-Paul Tremblay & Richard B. Bunt

CS 102 Programming Techniques (3 credits)
Basic concepts, basic components of programming languages, binding, simple algorithms operating on non-structured data, modularity in program construction.
Basics of constructing larger programs :abstraction and instantiation of program components, structured data (lists, stacks, queues, ordered binary trees), storing and accessing data structures, operations on mutable data, working with mutable data, object-based programming, data encapsulation

Recommended Texts:

1. *Data Structures, Algorithms, and Object-oriented Programming*, G.L. Heileman.
2. *Structured programming concepts*, K. Labudde

CS 104 Structured oriented Programming practical (1 credit)
(Prerequisites: CS101, CS102)
Language constructs: data declarations, loops, decision structures, input/output, files, subprograms / procedures, numeric and non-numeric data. Design and construction of software: top-down and bottom-up design, decomposition, structuring, design for reuse, documentation, study of examples, writing software as a team, using software from others. Programming assignments: A variety of progressively more complex assignments

Recommended Text:

1. *The C Programming Language*, 2nd Edition, by Brian W. Kernighan and Dennis M. Ritchie, Prentice Hall, Inc., 1988.

CS105 Object oriented Programming practical (1 credit)
(Prerequisites: CS101, CS102)
Implementation of programs with object oriented language constructs: classes, objects, inheritance, aggregation, composition and polymorphism.

Recommended Texts:

1. *Developing Java Software*, 3rd Edition, by Russel Winder and Graham Roberts, published by John Wiley and Sons, 2006
2. *Java Programming: From the Beginning*, K. N. King, *Georgia State University*

200 LEVEL COURSES

CS 201 Data Structures (2 credits)
(Prerequisites: CS 101, CS 102)
Data Structures: linear and non linear data structures. Arrays, lists: linked list, ordered linked list, and doubly linked list; push down stacks; queues: FIFO queue and deque. Tree structures – trees in general, binary search tree (BST), root insertion to BST, splay tree, 2-3-4 trees, radix tree and red-black tree; Graphs; Implementation of depth first search, breadth first search; Hashing: initial hash, collisions, separate chanining.
Recommended Texts:

1. Sedgwick R., Algorithms in C, Addition Wesley, 1998
2. Standish T. A.; *Data Structures in Java*; Addison-Wesley; 1998
3. Gregory L., Heilemen; Data Structures, Algorithms, & Object-Oriented programming; McGraw-Hill

CS 202 Data Structures Practicals (1 credits)
(Prerequisites: CS 104, CS105, CS 201)
Implementation of data structures studied in CS 201 using C, C++ and Java.

Recommended Texts:

1. Standish T. A.; *Data Structures in Java*; Addison-Wesley; 1998
2. Deitel, H. M.; Deitel, P. J.; *Java how to Program*; (5th Edition**),** Pearson Education Inc., USA, 2003

CS 203 Database Management Systems (2 credits)
(Prerequisites: CS 101, CS 102)
Overview: What is a database? Data and metadata. *Conceptual Modeling:* Entities, attributes, associations, functional determination, 3-level structure, graphical representation. *Relational Databases:* Relational algebra, Relational databases and tables, Query languages. The entity-relationship model, Logical organization of

databases; Physical organization of databases; Characteristics of disks and disk blocks, Storage of relations, Query processing and optimization, Concurrency control; Transactions, Serializability, Locking, Recovery, Functional dependencies and forms, Introduction to Distributed DBMS, OO DBMS, ORDBMS.

Recommended Texts:

1. Connolly, Begg; *Database Systems: A Practical Guide to Design, Implementation and Management*; 4th Edition; Dorling Kindersley (India) Pvt. Ltd., Delhi, India, 2005
2. Ramez Elmasri and Shamkant B. Navathe; *Fundermentals of Database Systems*; 5th Edition; ISBN-10: 0321369572
3. Date, C. J.; *An Introduction to Database Systems*; Addison-Wesley; 2000

CS 204 Programming using Database Management Systems (1 credits)

(Prerequisites: CS 104, CS 105, CS 202, CS 203)

Computer programming using database management packages such as Informix, Sybase, Oracle and FoxPro on PCs and workstations. Programming assignments: A variety of progressively more complex assignments.

Recommended Text:

1. Loney, K.; Koch, G.; *Oracle 8i: The complete reference*; McGraw Hill ; 2000

CS 205 Computer Architecture (3 credits)

(Prerequisites: CS 101, CS 102)

Computer structure: processor, memory, I/O, Secondary storage, buses, clocks, sequential operation, Fetch-Execute cycle. Data representation: Binary and hex integer representations and conversions. Fixed-length arithmetic. 2's complement representation. IEEE FP representation, Analogue versus digital. Memory organization: Addresses. Memory organization into bytes, words, longs. Memory-mapped i/o. Processor: Simple internal structure. Registers, program counter etc. The execution cycle. Instructions: The CPU instruction set – syntax and semantics. Addressing modes, Encoding and decoding. Basic hardware: Structure and operations of basic hardware devices from transistor to memory devices. Simple I/O: Handling simple devices: the interface and the peripheral Device registers and polling Interrupts and interrupts hardware interrupt vectors. More complex devices: Programmable devices, Block-mode devices. DMA: system structure and operation. Magnetic and optical storage: Basic bit storage Tapes and disks: structure and operation of discs Organization of disc blocks into files. Memory management: Paging page tables MMUs Page faults associative page table caches. Performance enhancements: Pipelining caches memory. RISC vs CISC architectures superscalar architectures VLIW multi-threaded and trace-based architectures. Micro controllers: Role: low cost, low power, small size computer systems I/O systems: analogue and digital. Assembly Language Programming and Introduction to Parallel Processing

Recommended Texts:

1. M.Morris Mano, Charles R. Kime, Logic and Computer Design Fundamentals
2. Thomas C. Bartee, Computer Architecture & Logic Design, McGraw-Hill Inc., New York, USA, 1990
3. Thomas P.Skinner; An Introduction to Assembly Language Programming for 8086 Family John Wiley & Sons, Inc., New York, USA, 1985

CS 206 Computer Device interfacing (2 credits)
(Prerequisite: CS 205)
Review of basic features of computer hardware and software; Lab: Introduction to equipment, demo, simple experiment. Input/Output (I/O) concepts and examples; Lab: Experiment involving parallel I/O; More concepts and examples; Lab: Experiment involving serial I/O. Interfacing to the analog world; Lab: Experiment using digital-to-analog (D/A) conversion; Lab: Experiment using analog-to-digital (A/D) conversion. Techniques for analysis of acquired data; Lab: Experiment requiring digital signal processing. Interfacing to local area network (LAN; Lab: Experiment using LAN.

Recommended Text:

1. Horowitz P. & Hill W.; *The art of Electronics*; (2nd Edition), Cambridge Univ. Press; 1989

CS 209 Concurrent Programming (1 credits)
(Prerequisite: CS 105, CS 201)
Program development: Java applets, *GUI's* with Swing. Using tools such as an IDE, Ant and version control. The principles of test-driven development and refactoring. *C*oncurrent Programs*:* Architecture of concurrent systems. Using and managing threads in Java. Synchronization Primitives*:* Mutual Exclusion in Java. Semaphores. Monitors and condition variables. Java thread synchronization synchronized methods and synchronized statements. Simple reasoning about correctness of Concurrent Program: Starvation and Deadlocks, Liveness and Progress, Safety. Example systems: Distributed Systems: message passing. Distributed Systems: rendez-vous (Java/RMI). Database concurrency and transactions: Two-phase commit protocol

Recommended Texts:

1. Concurrent Programming in Java: Design Principles and Patterns. Doug Lea. Second edition published by Addison-Wesley. 1999.
2. Developing Java Software. Russel Winder and Graham Roberts. Third Edition. Wiley. 2006

BC 201 Basic Computing I (2 credits)
(Prerequisites: CS 100)
Introduction to Computers: Basic concepts, General computer Architecture - Components of Computers, Data representation in Computers, Computer Configurations, Hardware and Software, High Level and Low Level Programming Languages.
Structured Programming Concepts: Introduction to Programming, Top-Down Design Methodology, Concept of Modularity, Structured Programming.

Recommended Text:

1. French C.S.; (1990) *Computer Science*; DP Publications;

BC 202 Micro Computer Applications I (1 credit)
(Prerequisites: BC 201)
Lab Course consisting of Practicals using Operating Systems and the Application Packages.

Recommended Text**:**

1. Habraken, J.; Habraken, J.W.; 1999 *Microsoft Office 2000 8 in1;* McMillan Computer Publ.

300 LEVEL COURSES

CS 303 Operating Systems Concepts (3 credits)
(Prerequisie: CS 201)
Introduction, Distributed OS Techniques; Naming, Inter-process communications and remote procedure calls Data and process migration, transactions, file systems, Parallel OS Techniques; Process management, scheduling, synchronization, Data management, caching, coherency, consistency, file systems, Load balancing, Advanced OS Concerns; Memory management, virtual memory, garbage collection, Fault-tolerance, reliability, replication, Protection, authentication, security, cryptography, I/O models, Performance, benchmarking, and monitoring, Client - Server Model.

Recommended Text:
1. Tanenanbaum, A.S.; *Modern Operating Systems* (2nd Edition); Prentice Hall; 2001

CS 304 Project in Computer Science I (3 credits)
(Prerequisites: CS 311, CS 315, CS 303 which shall be taken concurrently).
Students of the batch are organized into teams of four to six students with a department advisor to analyze a problem proposed, to select a suitable solution, and to implement that solution. Students work in teams to solve typical commercial or industrial problems. Work involves planning, design, and implementation (The use of Computer programming in Java or/and Database Management package is essential). Oral and written work is required.

Recommended Text:
1. Texts will be assigned by the instructor

CS 305 Communication Networks (2 credits)
(Prerequisite: CS 303)
Overview; Examples and concepts of layered architecture; overview of higher layer protocols. LAN - Network Topologies, Medium Access Control Methods, LAN Standards, WAN - Introduction to ISO/OSI Model, Introduction to Internet & TCP/IP Protocols, Transport layer; Internet addressing and Internet protocols; socket interface, Network layer, Taxonomies; relevant parameters of network and traffic, Multiple-access methods for broadcast networks, Taxonomies of multiple access methods; contention, methods; polling methods; reservation methods, Switched networks Architectures of switches; scheduling and admission control; routing, flow control, and congestion control, Interconnections of networks Logical data link protocols.

Recommended Text:
1. Tanenanbaum, A.S.; *Computer Networks*; (4th Edition) Prentice Hall; 2003

CS 306 Compiler Construction (3 credits)
(Prerequisites: CS 315, CS 303)
Context-free languages and grammars, Bottom-up parsing, Syntax-directed translation, Storage allocation, Review of symbol tables, type checking, semantic analysis, Project logistics, Code generation, Basic blocks/dags, Expressions, Instruction selection, optimization, integrated, techniques, Control and data flow, Flow graphs, dominators, Iterative and interval analysis, Def-use, use-def, live variable analysis, Dead code, redundant computation elimination, Constant propagation, strength reduction, Program representations (SSA, PDG), Loop optimization, Register allocation, Garbage collection, Dynamic data structures, pointer analysis, aliasing, Code scheduling, pipelining,

Dependence testing, Loop level optimization, Superscalar optimization, Profile-driven optimization, Debugging support, Incremental parsing, Type inference, Advanced parsing algorithms (Tomita/Early), Practical attribute evaluation, Function in-lining and partial evaluation.

Recommended Text:

1. Aho et al; Compiler Construction Principles, Techniques and Tools; Addison Wesley; 1986

CS 307 Computer Graphics (3 credits)

Students who registered for this course should also follow CS 308. (Prerequisite: CS 315)

Introduction; Overview of graphics systems, Components of graphics systems, Display devices, processors, software standards; introduction to GKS, PHIGS and OpenGL, Basic raster algorithms; Generation of output primitives, attributes (color, area filling, etc.), geometric transformations, Structure of graphics packages; 2-D viewing, structures /segments, hierarchical model, graphical user interfaces, interactive input methods, 3-D object representations and manipulations; Polygon mesh, spline surfaces, superquadrics, fractal geometry, octrees, visualization of 3-D, data sets, geometric transformations, 3-D viewing; Parallel and perspective projections, Visible surface identification methods, Illumination models and surface rendering; Constant intensity, Gouraud shading, Phong shading, ray tracing, radiosity, Color models; Basic concepts; RGB.

Recommended Text:

1. Wright R. S. Jr., Sweet M. R.; *OpenGL SuperBible*, Waite Group; 1997

CS 308 Computer Graphics Programming (2 credits)

(Prerequisite: CS 307)

Software, hardware, and mathematical tools for the representation, manipulation, and display of topological and two- and three-dimensional objects; applications of these tools to specific problems. Computer programming on PCs and Workstations.

Recommended Texts:

1. Wright R. S. Jr., Sweet M. R.; *OpenGL SuperBible* Waite Group; 1997
2. Neider J. et al ; *Open GL Programming Guide* Addison Wesley; 1993

CS 309 Object Oriented Analysis and Design (3 credits)

(Prerequisites: CS 102, CS 201)

Fundamental of Object-oriented design: Encapsulation, classes and objects, information hiding, operator overloading, inheritance, overriding, delegation; Analyze problems, determine objects that are necessary to model the system, determine what attributes the objects need to have, determine what behaviors the objects need to exhibit, develop conceptual models, generate designs from the models, and implement the models.

Recommended Text:

1. An Introduction to Object-Oriented Analysis and Design and the Unified Process Second Edition. Craig Larman, 2002.

CS 310 Server Side Web Programming (3 credits)

(Prerequisites: CS104, CS 105, CS203, CS204)

Introduction to HTML, Introduction to Client Side Scripting ***Java Script***: JavaScript syntax, JavaScript object model, JavaScript objects, Static objects, Forms object (Submit () and Reset () methods), Event handling - Mouse related events, Keyboard events, Document events, Output in JavaScript, Introduction to VB Script, ***ASP.net;*** Implement

ASP.net with VBScript, Use SQL & ADO to Interact with ASP.net Databases, Write Cookies on the Client Using ASP.net ***J2EE - Java Enterprise Edition*;** JDBC, JSP, Servlet, ***Hypertext Preprocessor* ;**Program structure, Use php to process html forms, Regular expressions for form validation and other applications, Read and write files, Database applications. ***XML*;** Understand the role of XML, Write XSL Documents to Describe how XML Documents are to HTML, Create Simple DTD & Schema Files to Describe the Grammar of XML, Differences between DTD's & Schema, Differences between Cascading Style Sheets & XSL, ***Other new trends in Web development*;** Eg. SOAP, WSDL

Recommended Texts:

1. Benoit Marchal (1999/2001). *XML by Example* (1st or 2nd Edition).Que Publishers
2. *Java 2 with Swing*: Deitel and Deitel
3. *Internet & World Wide Web How to Program* (Second Edition) 2002

CS 311 Software Engineering (2 Credits)

(Prerequisites: CS 201)

Overview of software engineering: software process; classic life cycle model, iterative models, incremental model. Project planning; Fundamentals of project and system planning, Requirements analysis, Software design fundamentals; Stepwise refinement, bottom-up approach, modularity, Design techniques; Use of UML and design patterns, Testing: Testing objectives, test case design, white box vs. black box testing, overview of testing strategies, Maintenance; Overview of maintenance issues and software configuration management

Recommended Texts:

1. Ian Somerville, *Software Engineering*, 6th edition, Addison Wesley, 1999.
2. *Design Patterns*, 1st edition, Addison Wesley, 1996.

CS 312 Human Computer Interaction Design (2 Credits)

(Prerequisites: CS 201, CS 315)

Designing User-System Interactions: User-centered and participatory design approaches, Prototyping, Creative Design Methods, Analytical Design Methods, Conceptual Design. *Evaluating User-System Interactions and Improving Designs:* Planning and conduct of lab- and field-based evaluation, Advanced Evaluations Techniques (eye tracking, physiological methods), Field trials, living labs. *Emerging technologies and their specific usability issues:* Mobile technologies, E-commerce systems, Multimedia, entertainment and games, Virtual and mixed-reality environments, IT Security and Security Systems

Recommended Text:

1. Alan Dix, Janet E Finlay, Gregory D Abowd: *Human-Computer Interaction* 3rd edition 2003 Prentice

CS 313 Digital Image Processing (2 Credits)

(Prerequisites: CS 315)

Introduction to digital images: why digital images, the digital camera, data types and 2D, 3D and higher dimensional representations, fundamental steps in digital image processing, elements of visual perception, light and electro-magnetic spectrum, image sensing and acquisition , sampling and quantization, relationships between pixels, Image transformations: histogram processing, spatial filtering, fuzzy techniques, Filtering in the frequency domain: Fourier transform, DFT, filtering, Morphological image processing: erosion , dilation , opening, closing, hit-or-miss transform, gray scale morphology, Image

segmentation: point, line and edge detection, threshold, region based segmentation, watersheds, Representation and description: boundary descriptors, regional descriptors, Object recognition: patterns, pattern classes, classification, Color image processing: color models, image segmentation based on color. Performance evaluation and ROC analysis

Recommended Text:

1. Gonzalez, R & Woods, R.: *Digital Image Processing*, 3nd ed., Prentice Hall, 2008.

CS 314 Image Processing practical (1 Credit)
(Prerequisities: CS 313)
Introduction, digital image representations, reading, displaying and writing images, data classes, image types, histogram processing, filtering, morphological processing, image segmentation, classification, Final group assignment

Recommended Texts:

1. Gonzalez, R & Woods, R.: *Digital Image Processing*, 3rd ed., Prentice Hall, 2008.
2. Gonzalez, R & Woods, R., Eddins S.: *Digital Image Processing using MATLAB*, 1st ed., Prentice Hall, 2004.

CS 315 Design and Analysis of Algorithms (2 Credits)
(Prerequisites: CS 201, CS 202)
Analysis of algorithms: time complexity, big O notation. Sorting algorithms: bubble sort, selection sort, insertion sort, quick sort, heap sort, merge sort and external sorting methods. Hashing: hash functions and collision resolution: separate chaining, linear probing and double hashing. Classification of Algorithms by Implementation and Design Paradigm: Divide & Conquer Algorithms, Dynamic Programming, Greedy Algorithms, Recursive Algorithms, Backtracking, Alfa-Beta pruning, Branch & Bound Search; Analysis of Algorithms, NP- completeness; Classification by Field of Study: Searching, Sorting, String matching, Graph, Machine Learning; Genetic algorithms

Recommended Texts:

1. Sara Baase, Allen Van Gelder (2000), *Computer Algorithms - Introduction to Design & Analysis*, Addison-Wesley
2. Thomas H. Cormen, Charles E. Leiserson & Ronald L. Rivest (2000), *Introduction to Algorithms*, McGraw-Hill

BC 301 Basic Computing II (2 credits)
(Prerequisites: BC 201, BC 202)
Database Management Systems: Advantages of DBMS Approach, E-R Modelling, Normalization, Data Sub Languages - SQL.
Introduction to Systems Analysis and Design: Software Life Cycle, Problem Definition, Requirement Specification, Analysis and Design tools, Software Design, CASE tools.

Recommended Text:

1. Pressman, R. S. & Ince, D.; *Software Engineering: A practitioner's Approach;* McGraw-Hill; 2000

BC 302 Micro Computer Applications II (1 credit)
(Followed concurrently with BC 301)
Lab Course consisting of Practicals using a DBMS Package.

Recommended Text:

1. Loney, K.; Koch, G.; *Oracle 8i: The complete reference*; McGraw Hill ; 2000

HR 301 Human Resource Management (2 credits)

Introduction: Defining the Role, Importance and Challenges of HRM; Historical Development of HRM. Approaches of HRM; HRM and Personnel Management, Roles of HR Managers, Strategic Orientation of HRM. Brief Introduction to HRM Functions: Job Design, Job Analysis, HR Planning, Attraction, Selection, Recruitment, Induction, Training and Development, Career Development, Performance Management, Knowledge Management, Salary Administration, Employee Movements, Labor Relations, Discipline Handling, Managing Health and Safety, Grievance Handling and Reward Management.

Recommended Texts:

1. Mathis, R.L., Jackson, J.H., Valentine, S.R. (2013) Human Resource Management, 14th Edition, CENGAGE Learning.
2. Dessler, G. (2012) Human Resource Management, 14th Edition, Pearson.
3. Nkomo, S.M., Fottler, M.D., McAfee, R.B. (2010) Human Resource Management Applications: Cases, Exercises, Incidents, and Skill Builders, 7th Edition, CENGAGE Learning.

400 LEVEL COURSES

CS 401 Artificial Intelligence and Expert Systems: (3 credits)

(Prerequisite: CS 311, CS 315)

Artificial intelligence: Intelligent Agents, Search Techniques, Game Playing, Knowledge and Reasoning, First order logic, Logical reasoning systems, Uncertainty, Probabilistic Reasoning, Simple and complex Decisions, Learning. Expert systems: Characteristics and components of Expert systems, Machine learning, Knowledge base and bank, Rule Knowledge, Inference engine, transit fare rule, Rule interpreter, Inference tree.

Recommended Texts:

1. Russell, S.J; Norvig, P.; *Artificial Intelligence: A Modern Approach*; (2^{nd} Edition), Pearson Education Inc., New Jersey, USA, 2003

CS 402 Intelligent Systems in CIM (2 credits)

(Prerequisite: CS 409)

Introduction to Manufacturing Systems and Computer Integrated Manufacturing (CIM) systems. Components of CIM systems. Computational Intelligencen for Manufacturing. Intelligent systems for Manufacturing. Manufacturing System Modeling and Design. Artificial intelligence in CIM: Process Planning and Scheduling, Manufacturing Process Monitoring and Control, Quality Assuarance and Fault Diagnosis. Robots and tools: modeling industrial manipulators, Kinematics, Dynamics, control, Motion and Grasp planning, Sensor system and sensor fusion.

Recommended Text:

1. Groover, M.P.; *Automation, Production Systems, and Computer Integrated Manufacturing*; 2^{nd} Edition) Prentice Hall Inc., New Jersey, USA, 2001

CS 404 Parallel Processing: (3 credits)

(Prerequisites: CS 206, CS 303, CS 306)

History and Evolution of parallelism in computers: Overlapping of I/O and computation, Interleaving of memory stacks, Pipeline vector computers, Multiprocessor systems, Flynn's classification of parallel computers, The structure of parallel algorithms, The

space of parallel algorithms, Algorithm for synchronous parallel computers, Algorithm for asynchronous parallel computers, Process organization, Types of parallel computers, Designing parallel algorithms.

Recommended Text:

1. Hwang, K.; Briggs, F; *Computer Architecture and Parallel Processing*; McGraw-Hill; 1984.

CS 406 Foundations of Distributed computing (3 credits)

(Prerequisites: CS 102, CS 305)

Networking: network types, network protocols, packet switching, networking technology, internetworking; Interprocessor communication: communication mechanisms, communication models, client-server communication, group communication, remote procedure calling; Distributed operating systems: issues, building blocks, architecture; Distributed file services: file system, file and directory services, sharing, remote access methods; Name and time services: names and attributes, name services, internet domain name system, time and coordination; Replication: architectural models, consistency and request ordering, ordering implementation, process groups; Transaction processing: transaction properties, concurrency control, fault tolerance and recovery, distributed and nested transactions, concurrency control methods.

Recommended Text:

1. G. Coulouris, J. Dollimore, T. Kindberg: *Distributed Systems, Concepts and design*, 3rd Edition. Addison-Wesley 2001.

CS 408 Computer Vision (2 Credits)

(Prerequisites: CS 313, CS 314)

Discrete geometry and quantization, length estimations, automated visual inspection, object recognition and matching, depth perception problems, stereo geometry and correspondence, motion analysis, optical flow, applications of Computer Vision, remote sensing, biomedical imaging, document processing, target tracking

Recommended Texts:

1. *Computer Imaging: Digital Image Analysis and Processing* , SE Umbaugh, CRC Press, 2005
2. *Computer Vision: A Modern Approach* by David A. Forsyth and Jean Ponce, Prentice Hall, 2002

CS 409 Neural Networks and Fuzzy Logics (3 Credits)

(Prerequisite: CS 401)

Fuzzy system models, Fuzziness and certainty, fuzzy sets, basic properties and characteristics, Domains, Alpha- level sets and support sets, Linear representation, Fuzzy set operators, Conventional (crisp) set operations, basic Zadeh type operations, intersection, union and complement of fuzzy sets, General algebraic operations, Fuzzy set hedges, Fuzzy reasoning, linguistic variables, Fuzzy models, Fuzzy systems and modeling, Design methodologies, modeling and utility software. Parallel and distributed processing, Neuron, Connectivity, Activation function, propagation rule, Learning rules, pattern Preparation, Perceptron, Multilayer perceptron, Associative memory, Hopfield neural networks, Self organizing map (SOM), Adaptive Resonance theory, topologies, Training methods, supervised and unsupervised learning

Recommended Text:

1. Russell, S.J; Norvig, P.; *Artificial Intelligence: A Modern Approach*; (2nd Edition), Pearson Education Inc., New Jersey, USA, 2003

CS 410 Internet and Multimedia Systems (2 Credits)
(Prerequisites: CS 305)
Introduction and overview: Discrete Cosine Transform Coefficient Coding. *Audio Coding:* Analogue and digital form: Sample rate, bits/sample, nyquist rate, CD audio Compression techniques: - PCM, ADPCM, LPC, GSM/CELP, MP3/AAC. *Video:* TV Standards: Interlacing vs progressive scan, PAL, NTSC, SECAM Video digitization, Raw Image Representation: RGB, YUV411, YUV422, Indexed color vs true color Image Compression: - GIF, JPEG, Motion JPEG: Video Compression: - Motion estimation - Motion compensation Video Compression Schemes: - H.261, H.263 - MPEG 1, MPEG 2, MPEG 4 Video Adaptation: - Sender-side adaptation, buffering, VBR->CBR conversion. *System Streams:* MPEG program and transport streams H.221 framing (for ISDN) IP-based transport: - packet loss - TCP vs. UDP - Application-level framing – RTP - H.261 as example of payload format – DCCP Audio/Video synchronization – RTCP - MPEG system stream. *Signaling:* H.323 SIP and SDP RTSP Megaco. *OS Issues:* Buffering Scheduling. *Describing Network Traffic:* Traffic patterns Application requirements QoS parameters and descritio
ns. *Congestion control and Resource Management:* TCP congestion control Real-time traffic congestion control Queue management: - Random Early Detection + other AQM - Explicit Congection Notification (ECN) - Scheduling mechanisms (FQ, WFQ). *Enhanced Quality of Service:* Intserv Resource reSerVation Protocol (RSVP) Diffserv. *IP Multicast:* Service Model Layered transmission Multicast congestion control. *Digital rights management:* Legal issues Watermarking

Recommended Text:

1. *Introduction to Multimedia Systems (Communications, Networking and Multimedia)*, by Sugata Mitra and Gaurav Bhatnagar

CS 411 Multimedia practical (1 Credit)
(Prerquisites: CS 410)
Introduction to multimedia packages, sound editing, video editing, 2D and 3D animation design

Recommended Text:

1. *Introduction to Multimedia Systems (Communications, Networking and Multimedia)*, by Sugata Mitra and Gaurav Bhatnagar

CS 412 Mobile and Pervasive Computing (2 Credits)
(Prerequisites: CS 305, CS 406)
Introduction and overview: A look at the general issues that will be addressed on this module. *Properties of wireless PANs, LANs, WANs:* Basic structure and operation. Ad-hoc and infrastructure networks. Physical constraints and limitations (transmission & reception). Network structures and architectures, including hand-off and mobility support at the physical/link level. *Example technologies at the physical/link layers:* PANs - Bluetooth. LANs - IEEE802.11, HiperLAN. Basic GSM and GPRS (2G/2.5G) network structure and protocol architecture. Next generation wireless overview (3G/4G) including UMTS, IMT-2000 and W-CDMA. *Mobile IP:* Mobile IPv4 and Mobile IPv6. Problems with routing, QoS and security. *Overview of use of intelligence in mobile systems:* Power management, replication, adaptation etc. *Power management issues:* From the lowest (physical device) levels, through communication protocols, broadcast methodologies, transcoding, etc. *File systems, Mobile infrastructure support:* Mobile middleware. Resource/neighbour discovery including peer-to-peer and gossip protocols. *Adaptive and reconfigurable systems, Mobile multimedia and its relationship to*

proxying, Context sensitive applications, Ubiquitous computing, pervasive computing and ambient networking, Overlay networks and vertical hand-offs, Programmable networking and applications for mobile systems, Code mobility and control/signaling

Recommended Text:

1. *Mobility: Processes, computers and agents*. Ed. Dejan Milojicic, Frederick Douglis and Richard Wheeler. ACM Press

CS 413 Information and Network Security (2 Credits)
(Prerquisites: CS 305)
Information Security Fundamentals, Attackers and Their Attacks, Security Basics, Security Baselines, Securing the Network Infrastructure, Web Security, Introducing Cryptography, Operational Security, Computer Forensics

Recommended Text:

1. *Security+ Guide To Network Security Fundamentals*; Mark Ciampa, Thompsons, 2004

CS 414 Software Project Management (2 Credits)
(Prerequisites: CS 311)
Project Management Life Cycle, Managing Project Teams, Managing Project Communication, Managing Project Scope, Managing Project Scheduling, Managing Project Resources, Managing Project Quality, Managing Project Risk, Managing Project Execution

Recommended Text:

1. *Information Systems Project Management: A Process and Team Approach*; Mark Fuller, Joe Valacich, and Joey George, Prentice Hall, 2007

CS 415 Industrial Training (3 Credits)
Each student will undergo full time training in the industry for the prescribed period on projects assigned by the industry. Students are required to have a duly maintained 'Daily Diary' and 'Students Record Book' which should be submitted to the Head of the Department within two weeks after completion of training. In addition, the students are expected to write a report and make presentation on the work carried out by them.

CS 421 Project in Computer Science II – Individual Project Work (6-8 credits)
(Prerequisite: CS 311)
The project topic could be selected from any area in the in th
e Computer Science Special Degree which specified above. The selection of the project is done at the beginning of the year and involves at least 8 hours work per week. The project will be done throughout the year and consist of three progress reports (one for term), a dissertation and oral presentation.

CS 423 Seminar (1 credit)
Compulsory for all special degree students in Computer Science. Each student will be assigned a topic on which he/she is expected to make a presentation.

ST 402 Data Mining Techniques(3 credits)
(Prerequisites: CS 409)
Introduction: Basic Data Mining Tasks, Database / OLTP Systems, Data Warehousing, OLAP Systems, Related Concepts (Statistics, Fuzzy Sets and Fuzzy Logic, Information Retrieval, Decision Support Systems, Dimensional Modeling, Machine Learning, Pattern

Matching). Data Preprocessing, Exploratory Data Analysis, Statistical Approaches to Estimation and Prediction. Association Rule Mining. Classification and Prediction: Introduction, Decision Tree Induction Methods, Bayesian Classification, Rule Based Algorithms, Neural Network Based Algorithms. Cluster Analysis: Introduction, Similarity and Distance Measures, Partitioning Methods, Hierarchical Methods, Outlier Analysis. Web Mining: Web Content Mining, Web Structure Mining, Web Usage Mining. Applications and Trends in Data Mining.
Some practical assignments will be given for this course

Recommended Texts:

1. *Data Mining Introductory and Advanced topics,* M.H. Dunham (2003)
2. *Predictive Data Mining,* Weiss SM & Indurkhya N, Morgan Kaufmann (1997)
3. *Principles of Data Mining, Hand DJ et al,* MIT Press (2001)

ST 403 Statistics for Bioinformatics (2 credits)
Review of the following in the context of bioinformatics: Basic probability, statistical inference, stochastic processes, computer intensive approaches to statistical inference, applications. Mathematical models and computational methods of statistical genetics including mendelian genetic traits, population genetics, pedigree relationships and gene identity, meiosis and recombination, linkage detection, multipoint linkage analysis. Course work involves some computation in a Unix environment.

Recommended Texts:

1. *Biological Sequence Analysis,* R. Durbin, S. Eddy, A. Krogh and G. Mitchison (1998)
2. *Statistical Methods in Bioinformatics, An Introduction,* W. J. Evans, G.R. Grant (2001)

Note: Students opting to follow the special degree course in computer science are required to select courses from the following course units in addition to fulfill their credit requirements.

ST102 (3 cr) Introduction to Probability Theory
ST201 (3 cr) Probability Theory
ST203 (3 cr) Theory of Statistics
MT407 (3 cr) Optimization Theory
MT209 (2 cr) Graph Theory
MT308 (2 cr) Combinatories
MT311(3 cr) Linear Programming

ENVIRONMENTAL SCIENCE

300 LEVEL COURSES

ES 301 Concepts in Environmental Science (3 credits)
Human Civilization: Development of human civilizations, man's special place on earth, conflicts with nature, environmental effects of developments in science and technology on human civilization; Addressing environmental problems; Scientific method; Inductive and deductive reasoning, prediction, experimental controls, theories and principles, scientific design and uncertainty; An assessment of risks; Government and environment policy. *Environment and society*: Interaction between human society and the environment; Environmental literacy; Tradeoffs of industrialization and unanticipated natural disasters; Well managed environment and continued economic prosperity with quality of life; Technological, political and social options and strategies for managing the

society and the environment; Food resources and world food problem; Agriculture and its impact on the environment and man; Crop disasters.

Recommended Texts:

1. Environment and Society: Human Perspectives on Environmental Issues, C.L Harpet, Prentice Hall, 2007.
2. Redesigning Animal Agriculture. The Challenge of the 21st Century, D L Swain, E Charmley, J W Steel, S G Coffey, 2007.

ES 302 Biological Indicators in Environmental Assessments (2 credits)
(similar to ZL 306)
Changes and challenges of environment of emerging Asia, Indicator organisms: background, principles and examples; The use of Biota, sediments and water in environmental monitoring; Indicators of land and water quality and sustainable management; A systematic approach using indicator organisms to measuring and reporting environmental problems such as acidification, air pollution and climatic changes; Framework for the development of environmental health indicators; Biological indicators of environmental health; Rapid urban environmental assessment and case studies of urban development in the developing world; developing a national set of environmental indicators.

Recommended Texts:

1. Limnology - Lake and River Ecosystems, R.G. Wetzel. Harcourt Brace College Publishers, San Dieg, 2002.
2. Pollution of Lakes and Rivers, A Paleolomnological Perspective, J. Smol, Oxford University Press, 2004.
3. Data Analysis in Community and Landscape Ecology, ed. R.H.G. Jongman, C.J.F. ter Braak & O.F.R. Tongeren, Cambridge University Press, 1999.

ES 303 Water and Soil Pollution (3 credits)
Aquatic environment and water resource; Properties of freshwater and seawater; Lotic and lentic waters; Man-made lakes and other aquatic facilities; Water pollutants; Types and sources of pollutants; Eutrophication and algal toxins; Biological oxygen demand and chemical oxygen demand and opacity; Run-off from agricultural land and roads; Sediment pollution; Seepage from mine tailings and landfill operations; Water quality parameters and standards; Chemical and ecological water pollution control; Techniques of containment and dispersal; Water-borne diseases.
Chemistry of soil, The classification of common pollutants in soils, soil functions, soil and sediment, soil pollutant load and soil quality parameters; Soil pollution.
Groundwater geochemistry: Fundamentals; Aquifer geochemical system; Rain water and groundwater; Solute transport; Contaminant interactions and reactive transport; Vadose zone processes; Water/rock interactions; Solution, redox and gas exchange processes; Classification of groundwater quality; Contamination of groundwater by inorganic and organic compounds and by microorganisms; Groundwater monitoring and remediation; Practical applications- landfills, metals contamination, acid mine waste, organic compound contamination; Water quality standards; Development of conceptual geochemical models; Numerical modeling.

Recommended Texts:

1 Geochemistry, Groundwater and Pollution. C.A.J. Appelo D. A.A. Balkema Rotterdam-Brookfield, 2006.
2. Environmental Chemistry, S.E. Manahan, 8th edition. CRC Press, 2007.

3. Groundwater and Surface Water Pollution D.H.F. Liu and BG Liptark, Lewis Publishes, 2000.

ES 304 Environmental law and Environmental Impact Assessment (2 credits)
Environmental acts and their enforcement. Legal aspects of environmental standards, case studies**.** Resource development and Environmental Impact Assessment (EIA) in Sri Lanka; Resources needed for EIA; Important principles in managing an EIA; The EIA process and Case studies**.**

Recommended Texts:

1. Handbook on Environmental Impact Assessment: Impact and Limitations . J. Pette, Cambridge press, 1999.
2. Environmental Protection, Law and Policy, Second edition by J.Holder and M.Lee,Cambridge press, 2005.

ES 305 Remote sensing and GIS (2 credits)
(similar to GL327)
Fundamental characteristics of electromagnetic radiation and the interaction of radiation with matter; Concepts of spectral resolution and detection; Remote sensing platforms; Active and passive sensing systems; Visual-digital interpretation; Applications of remote sensing in geology; Resource Exploration; Land use and land pattern analysis; Environmental and natural hazards; Introduction to GIS: Overview, history and concepts of GIS, scope and application areas, purpose and benefits of GIS, functional elements of GIS; Mapping concept – Map elements, map scales and representation map projection, geometric rectification, data structure – Raster and vector data structure, data acquisition, digitization; Laboratory work with GIS programs (e.g.,Arcview and arc-Info).

Recommended Texts:

1. Remote Sensing Geology, 2nd Ed, Gupta, R.P, Springer, 2002
2. Principles of Geographical Information Systems, P.A. Burrough and R.A.McDonnell, Oxford University Press, 1998.
3. Techniques for Image Processing and Classification in Remote Sensing, R. A. Schowengerdi Academic Press, 1983.

ES 306 Ecosystems of Sri Lanka: Their Ecology and Conservation (2 credits)
(similar to BT 310)
To provide a background on toxicological aspects of environmental chemicals and on mitigation of environmental toxins.
Geography, climate, geology, soils and floristic zones of Sri Lanka. Natural vegetation types of the island in relation to their distribution, extent, climate, vegetation structure, floristic richness, family and species dominance, population size distributions, endemic species, underutilized species. Factors responsible for degradation of natural ecosystems. Conservation and restoration of natural ecosystems. The ecosystems considered are i) marine, ii) maritime (mangroves, sea shore, and salt marshes) and inland aquatic ecosystems, forest types (rain forests -lowland & montane, dry zone forests and scrub vegetation), grasslands (wet and dry pathanas, thalawas, savannahs and damanas).

Recommended Texts:

1. Ashton, P. M. S. et al. (1997). A field guide to the common trees and shrubs of Sri Lanka. The Wildlife Heritage Trust, Sri Lanka, 432pp.
2. Whitmore, T. C. (1990). An introduction to tropical rain forests. Oxford University Press, Oxford, 226pp.

3. Mabberley, D. J. (1992). Tropical Rain Forest Ecology. Blackie and Son Ltd., 300pp.
4. Anon (2000) Natural Resources of Sri Lanka. The National Science Foundation, Sri Lanka, 306pp.

ES 307 Wetlands and Their Exploitation (2 credits)
(prerequsite: ZL 206)
Wetland types; Wetlands and wildlife; Fauna and flora of wetlands; Threats to wetlands; environmental problems associated with wetland exploitation; Salinisation and desalinization of wetlands**;** Ancient and recent irrigation systems of Sri Lanka; Water based tourism and its environmental effects; Wetland reclamation; Wetland and fisheries; Capture and culture fisheries; Effects of fisheries on the environment.

Recommended Texts:

1. Biology, N.A. Campbell, J.B. Reece and L.G. Mitchel, Cambrdge Press 2004.
2. The Biology of Lakes and Ponds, C. Bronmakr and B. Mamquist, Lewis Publishes 2002
3. The Biology of Streams and Rivers, P.S. Gilter and L.A. Hansso, Lewis Publishers, 2002.

ES 308 Marine Resources and Marine Pollution (2 credits)
(prerequsite: ZL 206)
Marine resources; Marine habitats and biodiversity (fauna and flora): coastal zone, open water and deep sea; coral and other reefs, Mangroves and salt marshes. Fishing and whaling; Over exploitation of marine resources; Marine and coastal pollution; Marine transportation and its effects on the sea; Desalination; Salt and chemical production.

Recommended Texts:

1. An Introduction to the Biology of Marine Life, J. Sunrich, 1999.
2. The Living Ocean: Understanding and Protecting Marine Diversity, B. Thorne – Miller, 2006.

ES 309 Analytical Chemistry (3 credits)
(similar CH 314, prerequsite: CH 231)
Advanced Calculations: Review of statistics in chemical analysis: Test of significance, paired t-test, F-test, etc.; Statistics of linear chemical relationships; Performance characteristics of analytical methods; Inter laboratory testing; Sensor characteristics; Advanced calculations as applied to chemical analysis: derivation and error calculations associated with acid-base, redox and complexometric titrations; Iteration methods; metal-complex equilibria; Solubility equilibria and Gran plots.
Analytical Aspects of Spectrophotometry: Atomic absorption and emission methods, molecular uv and visible absorption spectroscopy. Electroanalytical Chemistry: Potentiometric applications; voltammetry including polarographic methods, pulsed techniques, steady-state and flow injection amperometric methods, bulk electrolysis methods, microelectrodes in chemical analysis, electrochemical sensors,
Separation Methods: Solvent extraction, partition coefficient, distribution ratio, multiple extractions, extraction of metals, introduction to chromatographic techniques and classifications, gas chromatography, van-Deemter equation, ion-exchange chromatography, thin layer and paper chromatography, introduction to liqiuid-liquid chromatography.

Recommended Texts:

1. Analytical Chemistry, D.A. Skoog, West and Holler, Saunders College Publishing 1998
2. Laboratory Techniques in Electroanalytical Chemistry, P. Kissinger and W.R. Heineman, Marcel Dekker, 1984.
3. Electrochemical Methods, A.J. Bard and L. Faulkner, Marcel Dekker, 1980.
4. Analytical Chemistry, G.A. Christian, John Wiley & Sons, 2000.

ES 310 Hydrology (2 credits)

(similar to GL 321)

Introduction to basic principles of hydrology including mathematical, physical and chemical concepts; Discussion on practical applicability of common-used analytical techniques in understanding the different components of the hydrological cycle – climate, precipitation, evapotranspiration, runoff and infiltration. Hydrological Cycle: sources of stream flow, uniform and steady state flow; Hydrographs and hydrologic routing: basin study and water balance, probability and statistical techniques; Computer applications in hydrology.

Recommended Texts:

1. Handbook of Applied Hydrology – A Compendium of Water Resource Technology, Ven T. Chouw, McGraw-Hill, 1964.
2. Hydrology for Engineers, 3rd Ed. R.K Linsle, M.A. Kohle and J.L. Paulthus, Mc Graw-Hill,1982.

ES 311 Mining and the Environment (2 credits)

Methods of exploration and mining geology, including mapping, geophysics, remote sensing, exploration geochemistry, inclusion studies and diamond drilling. Technical and economic aspects of exploration programme design and reserves evaluation procedures. Open cast mining, underground mining, mining in the soft ground, underwater and deep sea**;** Use of minerals, mineral distribution and formation, mining, processing and extraction. Environmental implications, Mineral conservation and recycling; Mining and its environmental problems in Sri Lanka (gems, dolomite, sand, clays, silica)**.**

Recommended Texts:

1. Geophysics and Geochemistry in the Search for Metallic Ores, Proceedings of Exploration 77, International Symposium held in Ottawa, Canada, Economic Geology Report No. 31, Hood, Peter J. (Editor), Geological Survey of Canada, 1977.
2. An Introduction to Geophysical Exploration (2nd Ed.) P. Keare, and M. Brooks Blackwell Scientific Publications, 1991.
3. Applied Geophysics (2nd Ed), W.M. Telford, L.P. Geldart, R.E. Sherif, Cambridge University Press, 1990.

ES 312 Biodiversity Conservation and Management (2 credits)

(similar to BT 309)

Biodiversity : Introduction, global biodiversity estimates, measuring biodiversity, loss of biodiversity, threats to biodiversity; Biodiversity conservation and sustainable development, setting conservation principles, species management, habitat management, conservation education & ecotourism; Indigenous knowledge and biodiversity, international conventions on biodiversity, Field visits.

Recommended Texts:

1. Global Biodiversity: Status of the Earth's Living Resources, B. Groombrige, Chapman and Hall, 1992.
2. Global Biodiversity Assessment, R.T .Watson, V.H Heywood, UNEP, 1995.

ES 313 Energy, Weather and Environment (3 credits)

Renewable and non-renewable energy sources; The nature of electricity; The World's energy problem; Generation of electricity/Basic mechanics; Potential/ Kinetic energy: frictional energy losses; Exponential growth and energy usage; Feedback Loops/ Hydrological Cycle; Fossil fuel production/ Consumption; Nuclear structure and energy; How a reactor works; Nuclear waste management; Urbanization and environment. Energy conservation I: Lightning and Insulation; Energy conservation II: Transportation and fuel savings; an overview of alternative energy; Atmosphere: Composition and structure; Earth –sun geometry; Energy and energy transfer; Nuclear radiation; Energy balance; Temperature; Atmospheric moisture; Atmospheric stability; Clouds and precipitation; Forces and winds; Wind systems; Weather systems; Severe storms; Climate change.

Recommended Texts:

1. Energy and Problems of a Technical Society, J.J. Kraushaar and R.A. Ristine, 2002.
2. J.M. Moran, and M.D. Morgan, Meteorology, 2002.
3. The Physics of Atmosphere, 2nd Ed. J.T. Haughton, Cambridge University Press, 2001.

ES 314 Geological Environment and Earth Resources (2 credits)

Evolution of the earth, minerals and rocks, formation of rocks, rock cycles, weathering and soil formation, processes of landform development, interior of the earth, earth's internal processes, geological time scale, earth's resources.

Environmental effects of resource extraction, conserving geological resources, introduction to geological hazards (landslides and mass wasting, earthquakes and tsunamis, volcanoes, erosion)**.**

Recommended Texts:

1. Environmental Geology, B.W. Murck, John Wiley & Sons, 1996.
2. Geohazards - Natural and Ma-made, G.J.H. McCall, Chapman and Hall, 1992.
3. Goals, Opportunities and Priorities for the USGS Earthquake Hazard Reduction Program. A. Robert, USGS Circular 1079, 1992.

ES 315 Advanced Microbiology (2 credits)

(similar to BT 302)

Population counts; Growth cycle of microorganisms; Applied microbiology; Microorganisms in their natural habitats and major activities; microbiology of air (types, diseases transmitted); soil (types, estimation, distribution, role in nutrient cycling); water: (Types, water pollution, coliform bacteria. sanitary water analysis, water borne diseases, water purification); and Food: (food microflora, food spoilage, food preservation and food borne diseases); Laboratory exercises based on above topics.

Recommended Texts:

1. T.D. Brock, M.T. Madigan, J.M.Martinko and J. Parker, Biology of microorganisms (8th edition), Prentice Hall, USA.
2. M.T. Madigan, J.M. Martinko, J. Parker, Prentice Hall, USA, 986 pp.

3. Nitrogen fixation in tropical cropping systems K.E . Giller, and K.F Wilson, CAB. International, UK, 1991.
4. R.G. McLaren, and K.C. Cameron, Soil Science: Sustainable Production and Environmental Protection, Oxford University Press, UK,1996.
5. The Nature and Properties of Soils (10^{th} edition), N.C Brady, Macmillan Publishing Company, UK, 1990.

ES 316 Mathematics for Environmental Modeling (3 credits)

Linear Algebra: Introduction to matrices, the algebra of matrices, the transposed matrix, the inverse matrix, solving simultaneous linear equations by Gaussian elimination, finding the inverse of a matrix, determinants, eigenvalues and eigenvectors, numerical methods. Ordinary differential Equations: Introduction to differential equations, first order differential equations. (Variables separable differential equations, population models, epidemic models), linear differential equations, systems of first order differential equations.Recurrence equations: Introduction recurrence equations, first order recurrence equations, linear constant coefficient recurrence equations.
Mathematical modeling: Mathematical modeling through ordinary differential equations, Mathematical modeling through difference equations, mathematical modeling through mathematical programming.

Recommended Texts:

1. A First Course in Differential Equations, D.G. Zill, 1998.
2. Linear Algebra, K. Hoffman and R. Kunze, 1999.
3. Mathematical Modelling, J.N. Kapur, 1998.

400 LEVEL COURSES

ES 401 Geological and Hydrologic Hazards (2 credits)

(similar to GL 417)
Landslides: Causes, types and processes of slope movement, slope stabilization and mitigation, landslide hazard zonation maps; Earthquake: ground shaking, surface faulting, ground failure, subsidence; Tsunamis: Tsunami warning system, reduction of losses from earthquakes and tsunamis**;** Floods: causes of flooding, flash flooding, riverine floods, tidal floods, reduction of losses from floods; Volcanic eruptions: different kinds, hazards from volcanoes, forecasting of volcanism, reduction of losses from volcanism.

Recommended Texts:

1. Our Geologic Environment, H. Blatt, Prentice Hill, 1997.
2. Earthquake Protection, A. Coburn and R. Spencer, Wiley Publishers, 1992.
3. Facing Geologic and Hydrologic Hazards – Earth Science considerations. USGS
   Professional Paper, W.W. Hays 1240-B ,p 108, 1981.
4. Environmental Geology, B.W. Murck, John Wiley, 1996 .
5. Geohazards-Natural and Man made, G.J.H. McCall, Chapman and Hall, 1992.
6. Goals, Opportunities and Priorities for the USGS
   Earthquake Hazard Reduction Program, A. Robert, USGS Circular 1079, 1992.

ES 402 Cleaner Production for Industry (2 credits)
(similar to AS 432)
Introduction to cleaner production, cleaner production tools; assessment and audits; Introduction of cleaner production in an enterprise and cleaner production methodology; Prerequisite for success of cleaner production; Cleaner production assessment, cleaner production team, process mapping and process flow diagram, data sources, material balance, energy balance, costing of waste; Alternating option generations; Better process control, equipment and product modification, technology change, onsite recovery/reuse; implementation of cleaner production options and pay back period; ISO 14000 standards; case studies and group exercises.

Recommended Text:

1. Cleaner Production, A Way to Improve Your Enterprise, National Cleaner Production Centre, Sri Lanka, 2005.

ES 403 Environmental Management and Sustainable Development (2 credits)
Basic principles of management; Renewable and non renewable natural resources; Management of natural resources; Sustainable development; Local and international quality standards; Traditional and recent management practices; Land use policies and legislation; Education and research in conservation management.

Recommended Text:

1. Sustainable Environmental Management: Principles and Practice R. Ker Turner Belhaven Press, London, 1988.

ES 404 Air and Noise Pollution (3 credits)
Atmospheric composition and climate: Air pollution: Classes of air pollutants; Urban air pollution, air pollution modeling, global warming; Possible effects of greenhouse gasses; Ozone layer depletion and the Montreal protocol; Acid rain and its effects on biota; Air quality standards; causes and consequences of photochemical smog; Kyoto protocol, clean development mechanism, carbon trading.
What is sound pollution, sources of sound pollution, measurements, Decibel scale, adverse effects, legal aspects and regulations, Noise prevention and reduction.
Laboratory Component: Air sampling and air quality monitoring, biomonitoring of air pollution, Effects of pollutants on plants.

Recommended Texts:

1. Atmosphere, Ocean and Climatic Dynamics: An introductory Text, J. Marshall and R.A. Plump, 2007.
2. Environmental Chemistry, S.E Manahan, Lewis Publishers, 1994.

ES 405 Waste and Waste Management (3 credits)
Disposal of waste water and waste water treatment: physical, chemical and biological. Design and specification of air, land and water pollution control and systems. Hazardous waste management and treatment; Industrial effluent treatment; Hospital waste treatment**.** Types of solid waste, disposal of solid waste; Municipal waste management, 3R's (reduce, recover and recycle) strategy, Incineration of solid waste, Biological treatment and its incineration; Waste as a resource for energy and fertilizer; Useful products from waste**;** Control of gaseous pollutants, cyclones, electrostatic precipitators. Laboratory exercises and field studies.

Recommended Texts:

1. Hazardous Industrial Waste Treatment, L.K. Wang, H.H. Lo, CRC Press, 2006.

2. Solid waste Management, Second edition by P.T. Williams, John Wiley & Sons, 2005.

ES 406 Environmental Analysis Laboratory (2 credits)
(prerequisites: ES 309, CH 238)
Instrumental methods in environmental analysis: electroanalytical methods (ion selective electrodes potentiometry and amperometry), molecular spectroscopic methods (UV/Vis and IR), atomic spectroscopic methods (absorption and emission techniques), chromatographic methods (Gas-Liquid, Ion exchange and HPLC); Field work related to purification of drinking water and industrial effluent treatment; Water quality analysis including both biological and chemical analysis.

Recommended Text:
1. Principles of Instrumental Analysis, S.A. Skoog, F.J. Holler and T.A. Nieman, Harcourt Asia PTE Ltd, 2001.

ES 407 Ecotourism and Nature Conservation (3 credits)
(similar to ZL 405, prerequsite: ZL 216, ZL 332)
Types of tourism; Potential for ecotourism: Landscapes (ecosystems), man-made ecosystems, cultural background, biological diversity, protected Areas, coral reefs, Elephant orphanage; Ecotourism services: Sources of information, travel operators, transport facilities, hotel and other facilities; Potential for joint ecotourism with nearby countries; Constraints to tourism; Ancillary benefits of ecotourism; Negative impacts of tourism; Improvement of ecotourism facilities.

Recommended Texts:
1. Tourism, Ecotourism and Protected Areas: The State of Nature-Based Tourism around the World and Guidelines for Its Development. H. Cebellos-Lascurdin, 2005.
2. Ecotourism: An Introduction. D.A. Fennell, 2006.
3. Ecotourism: Sustainable Nature and Conservation Based Tourism. P.S. Ashton, R.E. Jr Ashton, 2002.

ES 408 Biodiversity and Conservation Biology (3 credits)
(similar to ZL 412, prerequsite: ZL 216, ZL 332)
Ecosystem - and genetic diversity; Global patterns and Values of biodiversity; Effective population size, Inbreeding and Gene flow; Overexploitation; Demography and Extinction processes; Population viability analysis; Endangered species and their protection; Exotic introductions and Invasive species; Ecosystem degradation, Habitat fragmentation and Edge effects; Habitat pollution; Modified ecosystems; Ecosystems management and Restoring ecosystems; Protected areas; Captive breeding and reintroduction; Zoos and Gardens; Human population growth ; Human impact; Sustainable development; Law and politics; Social factors in conservation; Economics of conservation; Conservation politics.

Recommended Texts:
1. Principles of Conservation Biology, G.K. Meffe & C.R. Carroll. 1997.
2. A Primer of Conservation Biology, R.B. Primack., 1994.
3. Global Biodiversity Assessment, V.H. Heywood, 2002.

ES 409 Oceanography and Coastal Geomorphology (2 credits)
(similar to GL 439)
Sea flow spreading and tectonic history of the Indian Ocean; Physical properties of sea water, distribution of temperature, salinity and density in space and time, light in the sea,

oceanic water circulation, major and minor elements in sea water, geochemical balance of the oceans, residence times, dissolved gasses in sea water, sea as a biological environment, effects of temperature, salinity, pressure and light on marine organisms. Distribution and composition of marine sediments; Formative processes and classification of coastal land forms with emphasis on coastal geomorphology of Sri Lanka. Coastal process and environments. Coastal and marine pollution.

Recommended Texts:

1. Marine Geochemistry, A. Chester, 1990.
2. Chemical Oceanography, Millcro and M.L. Saha, 1992.
3. Elements of Oceanography, M.J. McCormick and J.V. Thiruvathukal, Saunders College Publishing, 1981.
4. An Introduction to the Coastal Geomorphology of Sri Lanka, National Museums of Sri Lanka, B. Swan, 1983.

ES 410 Environmental Biotechnology (2 credits)

(similar to MB 416)

Living organisms as pollution indicators; biodegradation; waste management; pollution treatment; bio-mining; biogas production; microbes in environmental management.

Recommended Texts:

1. R. Barry King, Gilbert M. Long, John K. Sheldon (1997) *Practical Environmental Bioremediation: The Field Guide* (Second Edition) Publisher: CRC Press.
2. Sarina J. Ergas, Daniel P. Y. Chang, Edward D. Schroeder, Juana B. Eweis (Editor) (1998) *Bioremediation Principals*, McGraw-Hill
3. Gareth M. Evans, Judith C. Furlong (2002) *Environmental Biotechnology : Theory and Application* John Wiley & Sons

ES 411 Medical Geology and Environmental Toxicology (2 credits)

Definitions and terminology of medical geology/geochemistry; Classification of elements; Major, minor and trace elements in geological and biological materials; Geochemical classifications; Elemental link between geosphere and biosphere; Essential and non-essential elements with reference to human health; Trace element speciation in human health; Tropical environmental geochemistry; Case studies- (fluoride, iodine, water hardness, arsenic, selenium etc.); Geophagy; Natural radioactivity and health; Environmental toxicology of natural dust; Analytical methods; Health benefits of rocks and minerals. Toxic chemicals in the environment, persistent organic pollutants, heavy metal toxicity, carcinogenic and Mutagenic effects of industrial chemicals, pesticides and their problems, Improper use of pesticides and laws relating to use of pesticides; Integrated Pest Management (IPM); Good Agricultural practices (GAP); Alternatives to synthetic pesticides; Bioaccumulation and biomagnifications; Chronic toxicity; Mixture of poisons; Sub lethal effects; Environmental factors affecting toxicity, Biochemical assays in environmental toxicology; Environmental Risk assessment.

Recommended Texts:

1. Essentials of Medical Geology - Impacts of the Natural Environment on Public Health, O.B.J. Selinus, J.A. Alloway, R.B. Centeno, R. Finkelman, U. Fuge Lind and P. Smedle, Elsevier Academic Press, 2005.
2. Medical Geology - Effects of Geological Environments on Human Health, M. Komatina, Elsevier Science Publishing Co., 2004.
3. Geosciences, Environment and Man, H. Chamley, Boston, MA: Elsevier Science Publishing Co., 2003.

4. C.B. Dissanayaka, R. Chandrajith, Medical Geochemistry of Tropical Environments, Earth Science Reviews 47: 219-258, 1999.
5. Chemical Fate and Transport in the Environment, H.F. Hemond and E.J. Fechner- Levy, 2000.
6. Environmental Toxicology, Cambridge Environmental Chemistry Series (No 11) D.A. Wrightk, P Welbourn, Cambridge Press, 2002.

ES 412 Nanotechnology and the Environment (2 credits)

Introduction to nanoparticles: Structure, aggregation and characterization of nanoparticles, thermodynamics and kinetics of nano particles; Fate of engineered nanoparticles; Environmental toxicology of nanoparticles; Nanotechnology for environmental remediation; Nanoparticle based water treatment systems; Nanoparticles in natural water systems.

Recommended Text:

1. Spinger Hand Book of Nanotechnology, Bharat Bhushan, 2004.

ES 413 Environmental Economics (2 credits)

Concept of the externality, the Coase theorem and the importance of property rights as a determinant of market failure. Alternative revelation methods for determining the value of public goods; Pigouvian tax based solutions and other regulatory methods of pollution control including tradable permits, environmental subsidies; Implementation of these measures within the context of imperfect competition, imperfect mixing and with imperfect monitoring; Uncertainty and tax interaction effects; The monitoring and enforcement of environmental regulations; The ex-post regulation of environmental hazards using strict and negligence based liability versus ex-ante standards.

Recommended Text:

1. Environmental Economics, C. Kolstad, Oxford University Press, 2000.

ES 414 Applied Microbiology (2 credits)

(similar to BT 412; prerequisites: BT 302)

Microorganisms with industrial and environmental use and their products; Growth and product formation in industrial processes, large scale fermentations: Food, alcoholic beverages, animal feed, single cell proteins, antibiotics, organic acids, amino acids, enzymes, vitamins; Fuel and energy; Water microbiology; Waste water treatment and utilization; Setting up a microbiological laboratory; Selected titles from the above course content will be offered each year.

Recommended Texts:

1. Principles of Microbiology, R.M. Atlas, Mosby Publishing, 1995.
2. Microbial Biotechnology. Fundamentals of Applied Microbiology, A.N. Glazer, and H. Nikaido, W.H. Freeman & Company, 1995.
3. Brock Biology of Microorganisms. M.T. Madigan, J.M. Martinko, J. Parker (10^{th} Edition). Prentice Hall, 2002.

ES 415 Research Methodology and Scientific Writing (2 credits)

(similar to AS 402)

Literature survey and quantitative research method; Writing scientific papers and project Proposals; Organization and content; Guidelines for writing under different headings; Scientific presentations; Guidelines for preparation of presentations; Effective use of visual aids; Delivery and presentation style.

ES 416 Seminar (1 credit)
Seminars on assigned topics in Environmental Science should be presented after due preparation and literature survey by the students.

ES 417 Research Project (6-8 credits)
Each student will carry out a research project during the final year under the supervision of a staff member. The student is required to deliver two seminars, (a) pre-project seminar, based on preparatory work and research plan and (b) end of the project seminar, based on the outcome of research and prepare a comprehensive report containing Title page, Abstract, Introduction and Literature Review, Objectives, Materials & Methods, Results, Discussion and References.

GEOLOGY

100 LEVEL COURSES

GL 111 Earth Processes (3 credits)
Introduction to Geology. The universe, the solar system and the earth. Structure of the Earth. Earth's atmosphere, biosphere, hydrosphere and lithosphere, their origin and evolution. Processes shaping the earth: Exogenous processes (weathering, actions of rivers, oceans, glaciers and wind, soil formation, erosion, transportation, mass movement, deposition and landforms etc.). Study of the Earth's internal processes: Endogenous processes (plate tectonics, orogenesis, volcanism, plutonism, earthquakes, deformation, diagenesis and metamorphism). Geological Time Scale. Laws of Uniformitarianism and superposition of strata. Criteria to determine top and bottom of layered sequences. Unconformities. Relative and absolute dating. Geological History of Sri Lanka.

Recommended Texts:

1. Summerfield, M.A. (1991). Global Geomorphology. Routledge, OX.
2. Byatt, A., Fothergill, A., Holmes, M. and Sir David Attenborough (2001). The Blue Planet. BBC Books.
3. Grotzinger, J. and Jordan, T.H. (2010). Understanding Earth. 4th Edition, Freeman, W.H. Publishers, NY.

GL 112 Earth Processes Practical (1 credit)
Study and interpretation of topographic, orographic, geological, agricultural and land use maps. Preparation of cross sections and identification of landforms and drainage patterns. Introduction to geological maps; horizontal, inclined, folded and faulted sequences. Introduction to basic field methods and equipment.

Recommended Texts:

1. Lisle, R.J. (1995). Geological Structures and Maps: A Practical Guide. 2nd Revised Edition, Butterworth-Heinemann, OX.
2. Grotzinger, J. and Jordan, T.H. (2010). Understanding Earth. 4th Edition, Freeman, W.H. Publishers, NY.

GL 113 Earth Materials (3 Credits)
Common crystal forms, habits and twinning, point group symmetry of crystals and their classification into crystal systems and classes. Bravais lattices. Introduction to common

rock-forming minerals, their composition, physico-chemical properties, classification and identification. Introduction to igneous, sedimentary and metamorphic rocks, their classification, mineralogy, texture and identification. Introduction to paleontology. Trace, index, micro and plant fossils and their preservation and interpretation. Rock-, bio-, soil- and time-stratigraphy. Introduction to rocks of Sri Lanka.

Recommended Texts:

1. Nield, E.W. and Tucker, V.C.T. (1985). Paleontology – An Introduction. Pergamon.
2. Klein, C. Jr. and Hurlbut, C.S. (1993). Manual of Mineralogy. Willey, NY.
3. Grotzinger, J. and Jordan, T.H. (2010). Understanding Earth. 4th Edition, Freeman, W.H.
   Publishers, NY.

GL 114 Earth Materials Practical (1 credit)

Identification of common crystal forms, habits and twinning. Study of point group symmetry of crystals and their classification into classes and systems. Identification of common rock forming minerals on the basis of physico-chemical properties. Study of mineralogy and texture of igneous, sedimentary and metamorphic rocks. Laboratory study of fossils, their taxonomy and identification. Introduction to geological field mapping (Road mapping).

Recommended Texts:

1. Nield, E.W. and Tucker, V.C.T. (1985). Paleontology – An Introduction. Pergamon.
2. Klein, C. Jr. Hurlbut, C.S., Dana, J.D. (1993). Manual of Mineralogy. Willey, NY.
3. Deer, W.A., Howie, R.A. and Zussman, J. (1993). An Introduction to Rock-Forming Minerals. 2nd Edition, John Wiley and Sons, NY.

200 LEVEL COURSES

GL 211 Optical Mineralogy (3 credits)

(Prerequisites: GL 111, GL 112, GL 113, GL 114)

Introduction to Petrographic microscope and orthoscopic and conoscopic arrangements. Light and polarized light, reflection, refraction and Snell's Law. Double refraction, isotropy and anisotropy, uniaxial and biaxial minerals and their indicatrices. Minerals under polarized light; colour and pleochroism, relief, forms and habit, twining and zoning, cleavage. Interference colors and birefringence, extinction, interference figures. Systematic study of optical mineralogy of common rock forming minerals, essentially silicates and non-silicates. Laboratory work and exercises on identification of common rock forming minerals using petrographic (polarizing) microscope.

Recommended Texts:

1. Kerr, Paul F. (1959). Optical Mineralogy. McGraw-Hill, London.
2. Mackenzie, W.S., Donaldson, C.H. and Guilford, C. (1982). Atlas of Rock-Forming Minerals. John Wiley and Sons, NY.
3. Gribble, C.D. and Hall, A.J. (1985). A Practical Introduction to Optical Mineralogy. George Allen and Unwin, London.
4. Deer, W., Howie, R. and Zussman, J. (1993). An Introduction to Rock-Forming Minerals. 2nd Edition, John Wiley and Sons, NY.

GL 212 Introductory Petrology (3 Credits)
(Prerequisites: GL 111, GL 112, GL 113, GL 114)
Introduction to igneous rocks, mode of occurrence, texture, mineralogy of igneous rocks, classification, field relations, petrogenesis of common igneous rocks. Study of common sedimentary rocks and their textures, structures and genesis. Introduction to metamorphism, classification, mineralogy and fabrics of common metamorphic rocks and their field associations. Factors controlling metamorphism. Introduction to sedimentary rocks, environments, processes and their products. Study of igneous, sedimentary and metamorphic rocks in hand-specimens and thin-sections.

Recommended Texts:

1. Selley, R.C. (1982). An Introduction to Sedimentology. John Wiley and Sons, NY.
2. Yardley, B.W.D. (1989). An Introduction to Metamorphic Petrology. Longmann Publishers.
3. Philpotts, A.R. (1990). Principals of Igneous and Metamorphic Rocks. Prentice Hall.
4. Blatt, H. and Tracy, R.J. (1996). Petrology- Igneous, Sedimentary, and Metamorphic Rocks. W.H. Freeman, NY.

GL 213 Geochemistry (2 Credits)
(Prerequisites: GL 111, GL 112, GL 113, GL 114)
Introduction to geochemistry. Primary differentiation of the earth and solar system. Classification and distribution of elements and isotopes. Geochemistry of rocks and minerals. Energy, entropy and fundamental thermodynamic concepts and their application to natural systems. Aqueous solutions in geology. Cosmochemistry. Geochemistry of solid earth. Soil, stream and organic geochemistry. Oxidation-reduction.

Recommended Texts:

1. Gill, R. (1989). Chemical Fundamentals of Geology. Unwin Hymann, London.
2. Mason, B. (1966). Principles of Geochemistry. John Wiley and Sons, NY.
3. Krauskopf, K.B. (1994). Introduction to Geochemistry. John Wiley and Sons, NY.

GL 214 Geophysics (2 Credits)
Introduction to geophysics, structure of the Earth. Earth's gravity, magnetic and electric fields. Seismicity and earthquakes, plate tectonics, paleomagnetism. Earth's internal heat, geothermal energy, radiometric dating.

Recommended Texts:

1. Vogelsang, D. (1994). Environmental Geophysics. John Wiley and Sons, NY.
2. Dmowska, V. and Rena, H. (1996). Advances in Geophysics. John Wiley and Sons, NY.
3. Sleep, N. and Norman, S. (1997). Principles in Geophysics. Unwin Hymann, London.

GL 215 Economic Geology (3 Credits)
(Prerequisites: GL 111, GL 112, GL 113, GL 114)
Introduction to ore-forming processes, Physico-chemical characteristics of economic mineral deposits formed in igneous, sedimentary, metamorphic and hydrothermal environments. Basic introduction to metallic, non-metallic and placer deposits. Overview of industrial minerals. Rocks and minerals as industrial raw materials. Identification of economic minerals in the laboratory. Ore microscopy.

Recommended Texts:

1. Bateman, A.M. (1960). Economic Mineral Deposits. John Wiley and Sons, Indian Print 1962.
2. Edwards, R. and Atkinson, K. (1985). Ore Deposits Geology. Chapman & Hall, London.
3. Evans, A.M. (1993). Ore Geology and Industrial Minerals – An Introduction. 3rd Edition, Black-Well Scientific Pub.

GL 216 Geomorphology (1 Credit)

Landform types, climate, climatic changes and landform development. Volcanic landforms, karst landforms, structural landforms, marine and coastal landforms. Methods of landform analysis.

Recommended Texts:

1. Swan, B. (1983). An Introduction to the Coastal Geomorphology of Sri Lanka. National Museums of Sri Lanka.
2. Rice, R.J. (1988). Fundamentals of Geomorphology. 2nd Edition, Longman Scientific and Technical, London.
3. Gupta, A. (2011). Tropical Geomorphology. Cambridge University Press.

GL 217 Soil and Rock Mechanics (2 Credits)

(Prerequisites: GL 111, GL 112, GL 113, GL 114)

Physical properties of soil, Classification of soil, soil permeability and seepage, stress and effective stress, shear strength, compressibility, consolidation and settlement. Lateral earth pressures and retaining structures, slope stability analysis. Bearing capacity and foundations, ground improvement techniques. Introduction to physical and mechanical properties of rocks, defects in rock masses, rock testing, strength and failure of rocks, improvement of properties of rock masses.

Recommended Texts:

1. Dunn, I.S. (1995). Fundamentals of Geotechnical Analysis. John Wiley and Sons, NY.
2. Bell, F.G. (1996). Engineering Properties of Soils and Rocks. McGraw Hill, NY.
3. Goodman, R.E. (1996). Rock Mechanics. John Wiley and Sons, NY.

GL 218 Photogeology (2 Credits)

(Prerequisites: GL 111, GL 112, GL 113, GL 114)

Basics of photogrammetry, practical uses of aerial photographs in structural geology, economic geology, geomorphology, engineering geology, hydrology, hydrogeology, agriculture and land-use. Geological mapping and geological and structural analysis of a selected area. Visual interpretation of aerial photographs, resource exploration, land-use, land pattern and drainage analysis.

Recommended Texts:

1. Saif, S.I. (2014). Aerial Photography, Photogeology, GIS, R.S. and Image Processing. Lap Lambert Academic Pub.
2. Pandey, S.N. (2013). Principles and Applications of Photogeology. New Age International (P) Ltd.
3. Allum, J.A.E. (1966). Photogeology and Regional Mapping. Pergamon.

GL 219: Introductory Field and Structural Geology
(Prerequisites: GL 111, GL 112, GL 113, GL 114)
Introduction to basic geological structures: foliation, lineation, folds, faults, shear zones, slickensides. Methods, techniques and instruments used in field and structural geology. Planning of traverses based on maps and aerial photographs. Use of geomorphology in geological mapping. Terrain mapping and production of geological maps and reports.

Recommended Texts:

1. Mosely, F. (1981). Methods in Field Geology. W.H. Freeman and Co., California.
2. Compton, S. and Robert, R. (1985). Geology in the Field. John Wiley and Sons, NY.
3. Angela, L. Coe Eds. (2010). Geological Field Techniques. Willey Blackwell Publishers.
4. Hobbs, B.E., Means, W.D. and Williams, P.F. (1976). An Outline of Structural Geology. John Wiley and Sons, NY.

300 LEVEL COURSES

GL 321: Hydrology (2 Credits)
Introduction to basic principles of hydrology including mathematical, physical and chemical concepts. Practical applicability of analytical techniques in understanding the different components of the hydrologic cycle – precipitation, runoff, infiltration and evapo-transpiration. Sources of stream flow, uniform and steady-state flow, hydrographs and hydrologic routing. Basin study and water balance, probability and statistical techniques. Computer applications in hydrology.
Recommended Texts:

1. Linsley, R.K., Kohler, M.A. and Paulhus, J.L.W. (1982). Hydrology for Engineers. 3rd Edition, Mc Graw-Hill.
2. Ward, A.D. and Trimble, S.W. (2004). Environmental Hydrology. Lewis Publishers.
3. Subramanya, K. (2013). Engineering Hydrology. 4th Edition, Mc Graw Hill Education, India Pvt. Ltd, New Delhi.

GL 322 Geology of Sri Lanka (2 Credits)
Introduction to lithology, structure, tectonics, petrology, geomorphology, economic geology and soils. Quaternary Geology of Sri Lanka. Subdivision of the Precambrian and Phanerozoic rocks of Sri Lanka. Sri Lanka in Gondwana. Metamorphic and structural history of Sri Lankan rocks. Genesis of Igneous and igneous looking rocks of Sri Lanka, Geochemistry of Sri Lankan rocks, soils and water. Hydrogeology of Sri Lanka. Slope stability and engineering geological aspects of Sri Lanka. Geomorphology of Sri Lanka.

Recommended Texts:

1. Cooray, P.G. (1984). An introduction to Geology of Sri Lanka. National Museum Publ.
2. Kröner, A. (Ed.). (1991). The Crystalline Crust of Sri Lanka. Part 1, summary of research of the German-Sri Lankan consortium, Geological Survey Department Professional Paper 5.
3. Herath, J.W. (1991). Economic Geology of Sri Lanka. Natural Resources Series - No. 1. Natural Resources, Energy and Science Authority, Colombo.

GL 323 Metamorphic Petrology (3 Credits)
Phase rule and equilibrium in metamorphic rocks. Equilibrium mineral assemblages and their graphical representation using ACF, AKF, AFM diagrams. Disequilibrium and metamorphic reactions. Constructing bundle of reactions using Shreinemaker's method. Depth zones to facies concept. Facies series of metamorphism, granulite facies. Partial melting and migmatite formation. Laboratory study of hand-specimen and thin-section study of rocks of various facies and subfacies. Laboratory exercises on Schreinemaker's method.

Recommended Texts:

1. Yardley, B.W.D. (1989). An Introduction to Metamorphic Petrology. Longman Publishers.
2. Philpotts, P.A.R. (1990). Principles of Igneous and Metamorphic Rocks. Prentice Hall Pub.
3. Bucher, K. and Frey, M. (1994). Petrogenesis of Metamorphic Rocks. Springer Verlag, Heidelberg.

GL 324 Igneous Petrology (3 Credits)
Magma generation and migration, crystallization, intrusion and eruption. Partial melting and magmatic processes: crystal fractionation, magma mixing and assimilation. Kinetics of crystallization. Igneous rock associations. Hand-specimen and thin-section study of igneous rocks.

Recommended References:

1. Best, M.G. (1982). Igneous and Metamorphic Petrology. Freeman and Sons.
2. Wilson, M. (1989). Igneous Petrogenesis. Unwin Hyman.
3. Philpotts, A.R. (1990). Principles of Igneous and Metamorphic Rocks. Prentice Hall Pub.

GL 325 Sedimentary Petrology (3 Credits)
Sedimentary Facies and their distribution. Sedimentary Cycles, associations and sequences. Deltaic, glacial, desert, coastal, and continental margin environments; their definition, classification, geomorphology, sedimentary processes, sediment characteristics and ancient and modern examples. Siliciclastic sediments, sandstones and sandstone diagenesis, Provenance and distribution. Conglomerates, breccia, mud rocks; chert, carbonate and siliceous sediments.

Recommended References:

1. Pettijohn, F.J. (1975). Sedimentary Rocks. Harper and Row, New York.
2. Reineck, H.E. and Singh, I.B. (1986). Depositional Sedimentary Environments. Springer Verlag, NY.
3. Tucker, M.E. (1996). Sedimentary Petrology. Blackwell.
4. Mial, A.D. (1996). The Geology of Fluvial Deposits. Springer.

GL 326 Applied Geophysics (2 Credits)
Principles of applied geophysics. Investigations of earth resources and geologic structures by geophysical methods, seismic surveying, gravity surveying, magnetic surveying, electrical surveying, electromagnetic surveying, bore-hole geophysics. Introduction to geothermal and nuclear energy and their applications.

Recommended Texts:

1. Keary, P. and Brooks, M. (1992). An Introduction to Geophysical Exploration. 2nd Edition, Black Well Scientific Pub.

2. Kelly, W.E. and Mares, S. (1993). Applied Geophysics in Hydrogeological and Engineering Practices. Mc Graw-Hill.
3. Parasnis, D.S. (1986). Principles of Applied Geophysics. 4th Edition, Chapman and Hall, USA.

GL 327 Remote Sensing, GIS and GPS (3 Credits)

Overview and basic concepts of Remote Sensing (RS), Aerial Photography, fundamental characteristics of electromagnetic radiation, concepts of resolution, Remote sensing platforms. Satellite systems and sensors, active and passive sensing systems, overview of RS applications, Introduction to GPS, application of GPS technology in geology. Introduction to GIS, overview and concepts of GIS, scope and application areas, purpose and benefits of GIS. Hardware and software in for GIS. Functions of GIS software. Installation of GIS. Mapping Concept, map elements, map scales and representations, map projection, Raster and Vector data structures, input of geospatial data, sources of data and input devices. Geo referencing, concept of spatial databases, data acquisition and management techniques, data manipulation and analysis. Map output generation.

Recommended Texts:

1. Burrough, P.A. and McDonnell, R.A. (1998). Principles of Geographical Information Systems. Oxford University Press.
2. Gupta, R.P. (2002). Remote Sensing Geology. 2nd Edition, Springer.
3. Canada Centre for Mapping and Earth Observation (2014). Fundamentals of Remote Sensing. Natural Resources, Canada
4. Saif, S.I. (2014). Aerial Photography, Photogeology, GIS, R.S. and Image Processing. Lap Lambert Academic Pub.

GL 328 Structural Geology and Tectonics (3 Credits)

(Prerequisites: GL 211, GL 212)

Concepts of force, stress, strain and deformation. Mechanisms and processes of formation of brittle and ductile structures. Strain ellipsoid. Classification of faults, folds and shear zones. Principles of stereographic projection and graphical analysis of structural data. Crystal defects, recovery and dynamic recrystallization. Sea floor spreading and concept of formation and break-up of supercontinents. Geodynamic evolution of Sri Lanka. Study of microscopic to megascopic structures and related fabrics in the laboratory and in the field.

Recommended Texts:

1. Phillips, F.C. (1971). The Use of the Stereographic Projection in Structural Geology. 3rd Edition, Edward Arnold.
2. Ramsay, J.G. and Huber, M.I. (1983). The Techniques of Modern Structural Geology. Vol 1, Strain Analysis, Academic Press, London.
3. Ragan, D.M. (2009). Structural Geology: An Introduction to Geometrical Techniques. 4th Edition, Cabbridge University Press.
4. Passchier, C.W. and Trouw, R.A.J. (1996). Microtectonics. Springer-Verlag.

GL 329 Analytical Techniques in Geology (3 Credits)

Basic principles of sampling, preservation, preparation, and method selection, quality control in sampling and analysis, laboratory safety, principles and applications of spectroscopic (AAS, ICP, UV-Vis), X-ray and IR (XRF, XRD, EPMA, SEM, FTIR etc.) methods. Interpretation of analytical results. Basic statistics, surface contouring and modeling, graphical data representation and simple computer modeling of geological processes. Hands on experience with wet chemistry lab techniques, sample dissolution

and digestion, colorimetric methods, quality control. Use of analytical instruments such as AAS, ICP, XRD and SEM-EDS.

Recommended Texts:

1. Fletcher, W.K. (1981). Analytical Methods in Geochemical Prospecting. Handbook on exploration Geochemistry, Vol. 1, Govett, G.J.S. (ed.), Elsevier, The Netherlands.
2. Davis, J.C. (1986). Statistics and Data Analysis in Geology. John Wiley and Sons.
3. Jenkins, R. and Snyder, R.L. (1996). X-Ray Powder Diffractometry. Wiley and Sons, New York.
4. Gill, R. (1997). Modern Analytical Geochemistry (Longman Geochemistry Series). Addison Wesley Longman.

GL 330 Hydrogeology (2 Credits)

Surface and sub-surface distribution of water. Unsaturated and saturated zones, aquifers and their properties. Darcy's law and groundwater flow. Draw-down discharge relationships. Aquifer types and groundwater environments. Chemical characteristics of groundwater. Field and Laboratory studies and hydrogeological properties of soils and rocks. Maps, airphoto and satellite imagery interpretations in groundwater studies. Laboratory and field exercises in hydrogeology.

Recommended Texts:

1. Todd, D.K. (1980). Groundwater Hydrology. John Wiley and Sons.
2. Karnath, K.R. (1993). Groundwater Assessment Development and Management. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
3. Fetter, C.W. (1994). Applied Hydrogeology. 3rd Edition, Prentice Hall, EnGLewood Cliffs, NY.

GL 331 Environmental Geology (2 Credits)

Introduction to environment; environmental issues, resources and the environment. Pollution of the Earth's environments (atmosphere, water and soil). Environmental effects of geological resource extraction, conserving mineral resources, land-use planning. Environmental Impact Assessment (EIA), Biogeochemical cycles. Chemistry of ecosystems: Heavy metal pollution- sources and origins, mobility of heavy metals in the environment, bioaccumulation and bio magnification. Dose-response relationships and toxic elements. Medical geochemistry: Geochemical health problems pertaining to Sri Lanka.

Recommended Texts:

1. Andrews, J.E. (1996). An Introduction to Environmental Chemistry. Blackwell Sciences.
2. Dissanayake, C.B. and Chandrajith, R. (1999). Medical Geochemistry of Tropical Environments. Earth Science Reviews, Vol. 47.
3. Siegel, F.R. (2002). Environmental Geochemistry of Potentially Toxic Metals. Springer.
4. Schlesinger, W.H. and Bernhardt, E.S. (2013). Biogeochemistry: An Analysis of Global Change. Academic Press Elsevier.

GL 332 Engineering Geology (3 Credits)

Responsibilities of an Engineering Geologist, during construction of dams, reservoirs, tunnels, highways and major structures. Engineering geological site investigations. Natural and man-made geologic hazards and their mitigation techniques. Laboratory tests

for engineering properties of soils and rocks. Drilling methods in site investigation and in-situ soil testing. Standard Penetration Test, Cone Penetration Test. Rocks and soils as construction materials. Use of maps as a tool in engineering geological studies.

Recommended Texts:

1. Bell, F.G. (1983). Fundamentals of Engineering Geology. Mc Graw-Hill.
2. McCarthy, P.E. (1993). Essentials of Soil Mechanics and Foundations. Prentice Hall.
3. Goodman, R.E. (1993). Engineering Geology. Mc Graw-Hill.
4. Michael, D.G.de. (2009). Engineering Geology. Springer.

GL 333 Economic Geology and Gemmology (2 Credits)

Magmatic, sedimentary and metamorphic deposits of precious metals, base metals and other industrial metals. Volcanogenic ore deposits Cu-Zn, Pb-Zn and Cu-Mo etc. Examples of world's typical metallic and non-metallic mineral deposits. Overview of ore genesis related to plate tectonics through geological time.

Introduction to precious and semi-precious gem minerals and their properties. Types of gem deposits, mining and recovery methods. Organic and inorganic gem materials and their properties. Basic gem identification methods, dichroism, refractive index, specific gravity and their internal characteristics. Cutting, polishing and value addition to gems. Evaluation and trade of gems.

Recommended Texts:

1. Edwards, R. and Atkinson, K. (1985). Ore deposits Geology. Chapmann and Hall, London.
2. Evans, A.M. (1993). Ore Geology and Industrial Minerals – An Introduction. 3rd Edition, Black-Well Scientific Pub.
3. Gunaratne, H.S. and Dissanayake, C.B. (1995). Gems and Gem Deposits of Sri Lanka. National Gem and Jewellery Authority of Sri Lanka, Colombo.
4. Read, P.G. (1995). Gemmology. Butterworth and Heinemann.
5. Shuffer, P.R., Zim, H.S. and Perlman, R. (2001). Rocks, Gems and Minerals. St. Martins Press.

GL 334 Field Geology (2 Credits)

(Prerequisites: GL 211, GL 212, GL 219)

Geological and structural mapping of a selected area. Preparation of a geological map, cross-sections and block diagrams. Interpretation of geological and structural information and field data. Field camps/excursions. Geological report writing.

Recommended Texts:

1. Lahee, F.H. (1981). Field Geology. McGraw-Hill Co., NY.
2. Mosely, F. (1981). Methods in Field Geology. W.H. Freeman and Co. Publ., California.
3. Compton, R.R. (1985). Geology in the Field. John Wiley and Sons.Passchier, C.W., Myer, J. and Kröner, A. (1990). Field Geology of High-grade Gneiss Terrains. Springer Verlag, Heidelberg.

400 LEVEL COURSES

GL 431 Applied Hydrogeology (2 Credits)
(Prerequisites: GL 330)
Groundwater exploration, well design and construction. Evaluation of aquifer properties, well hydraulics and pumping tests. Pumping equipment, quality of groundwater and water treatment, groundwater recharge and balance. Groundwater development and management.

Recommended Texts:

1. Todd, D.K. (1980). Groundwater Hydrogeology. John Wiley and Sons.
2. Kamath, K.R. (1993). Groundwater Assessment, Development and Management. Tata McGrew Hill Publishing Co., New Delhi.
3. Fetler, C.W. (1994). Applied Hydrogeology. 3rd Edition, Prentice Hall, Englewood Cliffs, NY.

GL 432 Isotope Geology (2 Credits)
Isotopes - stable and radioactive, stable isotope fractionation, stable isotopes in the lithosphere, hydrosphere, biosphere and in the mantle. Radioactive isotopes, their decay schemes. Isotopic dating of minerals and rocks and inference of geological history of earth materials. Isotopic signatures of mantle reservoirs and mantle isotope paradoxes. Applications of isotopes in geology and use of radiogenic isotopes in multi component mixing.

Recommended Texts:

1. Faure, G. (1976). Isotope Geology. John Wiley.
2. Hoefs, J. (1997). Stable Isotope Geochemistry. Springer.
3. Dickin, P. (1998). Radiogenic Isotope Geology. Camb. Univ. Press.
4. Allegre, C.J. (2008). Isotope Geology. Camb. Univ. Press.

GL 433 Surveying and Leveling (2 Credits)
Introduction to surveying. Basic principles of surveying. Maps and plans. Chain surveying. Plotting and Checking. Principles and use of theodolite and levelling instruments, traversing, traverse computations, and plotting. Other methods of surveying-triangulation. Plane Table surveying and Tacheometry levelling-Plotting cross sections and longitudinal sections, contouring.

Recommended Texts:

1. Kavanagh, B.F. and Bird, S.J.G. (1998). Surveying Principles and Applications. Reston Pub., US
2. Bannister, A.S. and Raymond, S. (1999). Surveying. ELBS/Pitman.
3. Basak, N.N. (2000). Surveying and Levelling. Tata Mcgraw Hill Education.

GL 434 Scientific Writing and Communication (1 Credit)
Overview of Scientific writing. Scientific thinking, problem definition and research methodology for problem solving. Introduction to journal-style scientific writing. Making sense from data- effective tables and figures. Writing an abstract dealing with proofs. Citations and references, submission of a manuscript, reviewing and role of editor. Ethics in scientific writing (plagiarism, authorship etc.), Project repots, research proposals and budget estimation.

Recommended Texts:

1. Cooray, P.G. (1992). Guides to Scientific and Technical Writing. Geological Society of Sri Lanka special publication.
2. Day, R.A. and Gastel, B. (2006). How to Write and Publish a Scientific paper. 6th Edition, Cambridge Univ. Press.
3. Cargill, M. and O'Connor, P. (2009). Writing Scientific Research Articles. Wiley-Blackwell.
4. Swales, J.M. and Fead, C.B. (2012). Academic Writing for Graduate Students. 3rd Edition, University of Michigan Press.

GL 435 Seminar on Special Topics in Geology (1 Credit)

A structured program of reading and seminars leading to an in-depth understanding of a chosen topic in geology.

Recommended Texts:

1. Steve, M. (1995). Effective Presentation Skills. Crisp Publications.
2. Andrew, B. (2006). Successful Presentation Skills. 3rd Edition, Kogan Publishers.

GL 436 Field Geology Assessment (2 Credits)

(Prerequisites: GL 334)

Each student is required to individually prepare a detailed geological and structural map of a given area and submit a report and make an oral presentation on his/her study. The report (and the presentation) shall consist of laboratory studies pertaining to the area in addition to field observations.

Recommended Texts:

1. Lahee, F.H. (1981). Field Geology. McGraw-Hill Co., NY.
2. Compton, R.R. (1985). Geology in the Field. John Wiley and Sons.
3. Passchier, C.W., Myer, C.W. and Kröner, A. (1990). Field Geology of High-grade Gneiss Terrains. Springer Verlag, Heidelberg.

GL 437 Seismology (2 Credits)

Seismic waves and earth models, seismic sources and source parameters, seismic signals and noise, seismic sensors and recording systems, site selection, preparation and installation of seismic stations, seismic networks and arrays, seismic data formats archival and exchange, data analysis and interpretation. Seismic hazard assessment.

Recommended Texts:

1. Stein, S. and Wysession, M. (2003). An Introduction to Seismology, Earthquakes and Earth Structure. Blackwell.
2. Havskov, J. and Alguavil, G. (2004). Instrumentation in Earthquake Seismology. Springer.
3. Bormann, P. (Ed) (2013). New Manual on Seismic Observatory Practice (NMSOP). Geo Forschungs Zentrum (GFZ) Potsdam.

GL 438 Quaternary Geology (1 Credit)

Quaternary geological environment. Major events and the significance of the Quaternary Period. Red and brown earth deposits, laterite and bauxite, nodular ironstones, lagoonal and estuarine deposits and swamps, littoral sandstones, sand dunes.

Recommended Texts:

1. Cooray, P.G. (1984). The Geology of Sri Lanka. National Museums Pub.

2. Catt, J.A. (1995). Soils and Quaternary Geology: A Handbook for Field Scientists (Monographs on Soil Resources Survey). Oxford University Press.

GL 439 Oceanography (2 Credits)

Introduction to chemical, geological, biological and physical oceanography. Sea floor spreading, marine sediments, sea floor morphology, waves, tides, currents, global thermostat, ocean-atmosphere-climate connection and marine life, biological productivity and ocean ecology, productivity and costal processes. Global environmental changes due to rise and fall of sea-levels and related processes of sedimentation/erosion.

Recommended Texts:

1. McCormick, M.J. and Thiruvathukal, J.V. (1981). Elements of Oceanography. Saunders College Publishing.
2. Chester, C.K. (1990). Marine Geochemistry. Springer.
3. Millcro, W. and Saha, M.L. (1992). Chemical Oceanography. John Wiley.
4. Garrison, T. (2012). Essentials of Oceanography. Wadsworth Publishing Company.

GL 440 Exploration and Mining Geology (2 Credits)

Methods of exploration and mining geology, mapping, geophysics, remote sensing, exploration geochemistry, inclusion studies and diamond drilling. Technical and economic aspects of exploration programme design and reserve evaluation and estimation procedures. Open cast mining, underground mining, mining in the soft ground, underwater and deep sea. Mine waste management.

Recommended Texts:

1. Hood, P.J. (Ed), (1977). Geophysics and Geochemistry in the Search for Metallic ores. Proceedings of Exploration 77, An International Symposium held in Ottawa, Canada, Economic Geology Report No. 31, Geological Survey of Canada.
2. Telford, W.M., Geldart, L.P. and Sheriff, R.E. (1990). Applied Geophysics. 2nd Edition, Cambridge Univ. Press, New York, Port Chester, Melbourne, Sydney.
3. Kearey, P. and Brooks, M. (1991) An Introduction to Geophysical Exploration. 2nd Edition, Blackwell Scientific Publications.

GL 441 Petroleum Geology (2 Credits)

Nature, occurrence, distribution and origin of petroleum and gas. Mode of occurrences and petroleum genesis. Sequence stratigraphy. Organic matter in depositional environment, preservation and maturation, oil shale and petroleum. Petroleum source rocks, migration, traps, reservoirs of petroleum and their characteristics and formation. Porosity and permeability. Tectonic approach in petroleum exploration. Basin analysis and seismic interpretation. Well logging and geophysical techniques in petroleum exploration. Petroleum prospects of the Gulf of Mannar.

Recommended Texts:

1. Dandekar, A.Y. (1985). Petroleum Reservoir Rocks and Fluid Properties. Taylor and Francis, NY.
2. Richard, C. and Selly, H. (1995). Elements of Petroleum Geology. Academic Press.

GL 442 Advanced Metamorphic Petrology (3 Credits)
(Prerequisites: GL 323)
(Compulsory to students who do not offer GL 443 or GL 444)
Principles and application of the P-T-t path concept. Petrogenetic grids and reaction histories. P-T-t path determination using reaction histories and compositional zoning in minerals. P-T-t path case studies. Laboratory study of P-T-t history of a metamorphic terrain using mineral reactions and reaction textures in thin-sections, with emphasis on Sri Lanka. Introduction to thermodynamics of mineral equilibrium in metamorphic rocks and use of geothermometry and geobarometry.

Recommended Texts:

1. Wood, B.J. and Fraser, D.G. (1976). Elementary thermodynamics for Geologists. Oxford Univ. Press.
2. Spear, F.S. (1994). Metamorphic Phase Equilibria and Pressure-Temperature-Time Paths Min. Soc. Am.
3. Bucher, K. and Frey, M. (1994). Petrogenesis of Metamorphic Rocks. Springer Verlag, Heidelberg.

GL 443 Advanced Igneous Petrology (3 Credits)
(Prerequisites: GL 324)
(Compulsory to students who do not offer GL 442 or GL 444)
Application of phase diagrams, field and petrographic relationships to understand the origin of magmas. Layered intrusions, Ophiolite complexes, Igneous processes and Global tectonics. Planetary differentiation. Composition of the earth's core, mantle and crust. Geochemical modeling of Mantle melting and genesis of peridotites, pyroxenites and basalts. Examples of magmatic systems at mid-ocean ridges, volcanic arcs and mantle hotspots and their geochemical affinities. Mantle heterogeneity and phase transitions. Introduction to experimental petrology.

Recommended Texts:

1. Yoder, H.S. (1979). The Evolution of the Igneous Rocks. Princeton University Press.
2. Hall, A. (1985). Igneous Petrology. 2nd Edition, Unwin Hyman.
3. Wilson, M. (1989). Igneous Petrogenesis. Chapman and Hall.
4. Winter, J.D. (2007). Introduction to Igneous and Metamorphic Petrology. 1st Edition, Academic Internet Publishers.

GL 444 Advanced Sedimentary Petrology (3 Credits)
(Prerequisites: GL 325)
(Compulsory to students who do not offer GL 442 or GL 443)
Limestone- carbonate diagenesis and microfabrics; dolomitization and de-dolomitization. Evaporites and sequences. Sedimentary ironstones and iron formations (Phanerozoic and Precambrian). Sedimentary phosphate deposits, nodular and bedded phosphorite, bioclastic and pebble bed phosphorites, Guano phosphorites. Geology of fluvial deposits and volcaniclastic sediments. Origin and mineralogy of clays. Methods in palaeontology. Fossils and fossilization. Trace fossils, plant fossils, microfossils and their uses.

Recommended Texts:

1. Pettijohn, F.J. (1975). Sedimentary Rocks. Harper and Row, New York.
2. Reineck H.E. and Singh. I.B. (1986). Depositional Sedimentary Environments. Springer Verlag, NY.
3. Tucker, M.E. (1996). Sedimentary Petrology. Blackwell.

4. Nield, E.W. and Tucker, V.C.T. (1985). Paleontology – An Introduction. Pergamon.

GL 445 Advanced Engineering Geology (2 Credits)

(Prerequisites: GL 332)

Ground improvement engineering. Soil compaction, dynamic stabilization, chemical stabilization, geotextiles. Foundation engineering. Bearing capacity, designing and construction. Foundations on weathered rock. Lateral earth pressures and retaining structures. Soil and rock slope stability analysis. Environmental geotechnical applications. Solid waste disposal, Environmental impact assessments and preparations of geotechnical reports. Ethics for Geologists.

Recommended Texts:

1. McCarthy, P.E. (1993). Essentials of Soil Mechanics and Foundations. Prentice Hall.
2. Bell, F.G. (1983). Fundamentals of Engineering Geology. Mc Graw-Hill.
3. Goodman, R.E. (1993). Engineering Geology. Mc Graw-Hill.
4. Michael, D.G.de. (2009). Engineering Geology. Springer.

GL 446 Research Project (8 Credits)

A supervised field/laboratory study on a problem of current geological interest. A dissertation has to be submitted necessarily incorporating abstract, objectives, methodology, results, interpretation, conclusions and bibliography. Oral examinations based on the project will be held as a part of this course. The candidates will have to make a summary presentations of the project at this oral examinations conducted by a panel of Academic Staff Members of the Department of Geology.

Recommended Texts:

1. Comstock, G. (2011). Research Ethics: A Philosophical Guide to the Responsible Conduct of Research. Cambridge University Press.
2. Stewart, C.N. (Jr) (2011). Research Ethics for Scientists: A Companion for Students. Willey-Blackwell.

GL 447 Industrial Training (4 Credits)

Each student will undergo full-time training in a geology-related industry for eight weeks, on a project assigned by the industry, approved by the Department of Geology. Students are required to maintain a 'Daily Diary', which should be certified by the Head of the relevant industry and submitted to the Head of the Department of Geology, within two weeks after completion of the training. Each student is also required to write a report and make a presentation on work carried out during the period of training.

Recommended Texts:

1. Whetten, D.A. and Cameron, K.S. (2010). Developing Management Skills. Prentice Hall.

MATHEMATICS

100 LEVEL COURSES

MT 101 Vector Methods (2 credits)

***Vector algebra*:** Introduction to vectors, Linear combinations, Linear dependence and independence. Bases and
dimension, Scalar product. Vector product. Triple scalar product. Triple vector product. Solutions of vector
equations involving products.

Vector Geometry: Collinear Vectors, Coplanar vectors, Vectors equation of a line, Vector equation of a plane,
Tetrahedron, Parallelepiped, pyramid and the prism, Coplanar and skew lines, Intersecting and parallel planes
Cylindrical polar coordinates, Spherical polar coordinates, Simple surfaces: Sphere-Cone, Cylinder, Cosine and
Sine formulac in Spherical Trigonometry.

***Vector Functions of a Single Scalar Variable*:** Differentiation, Integration, Space curves, Tangent and normals.

Recommended Texts:

1. *Elementary Vector Analysis,* C.E. Weatherbum
2. *Vector Analysis,* M.D. Raisinghania

MT 102 Introduction to Probability Theory (3 credits)

(Same as ST102)

MT 103 Differential Equations (2 credits)

***First Order Ordinary Differentials Equations*:** Review of fist order equations, Exact equations, Clairaut's equation, Ricarti's equation.

***Higher Order Ordinary Differential Equations*:** Linear equations with constant coefficients, Wronskian, Differential operators, Undetermined coefficients. Variation of parameters.

Recommended Texts:

1. *A First Course in Differential Equations,* D.G. Zill
2. *Differential Equations,* H.T.H. Piaggio

MT 104 Abstract Algebra I (3 credits)

***Number Theory*:** Euclid's Algorithm, Greatest common divisor and least common multiple, and their Relationship, Solution of Linear Diophantine equations in two variables, Linear congruences, Systems of linear Congruences having he same modulus, Chinese Remainder Theorem.

***Relations, Functions and Binary Operations*:** Equivalence relation. Partitions, Orbits and transversals functions a subset of a relations, bijective functions, inverse of a function.

***Permutations*:** Theorems on the product of disjoin cycles, Transpositions and the uses, parity and signature of a permutation.

***Group Theory*:** Group Tables, Subgroups, Elementary properties of Cyclic groups, Dihedral group of order 2n and its properties, Symmetric and Alternating group: Direct product of two groups, Identification of non-isomorphic groups of order up to 10.

Recommended Texts:

1. *A First course in Abstract Algebra,* J.B. Fraleigh
2. *Elementary Number Theory,* D.M. Burton

MT 105 Real Analysis I (3 credits)

Real number system as a complete ordered field, Complex number system, Topology of the real line, Neighborhoods, Sequences and limits, Limit theorems, Monotonic Sequences, Limit Concept of a Real-Valued Function, Algebra of limits, Continuity, Monotonic functions, Differentiability, Role's Theorem, Mean-Value Theorems, L'Hospital's Rule, Riemann Integral and the basic properties. Fundamental theorem of Calculus, Improper integrals.

Recommended Texts:

1. *Elementary Real Analysis,* H.G. Eggleston
2. *Analysis,* S.R. Lay

MT 106 Classical Mechanics I (3 credits)

(Prerequisite: MT 105)

***Motion of a particle in a plane*:** Velocity and acceleration components in Cartesian and polar coordinates, Newton's second law: Inertial fame, Use of poplar coordinates, Impulse- Momentum Integral Work-Energy Integral.

Constrained motion: Motion in a space curve. Use of intrinsic coordinates, Varying mass: Mass increasing or decreasing at a constant race.

***Dynamics of a system particles*:** Linear momentum and equation of the center of mass. Angular Momentum, Kinetic energy, Equations for impulsive motion, Rotation of a rigid body abut a fixed axis: Kinetic Energy of rotation and energy Conservation equation, Forces exerted on the axis of revolution, Angular Momentum and impulse, conservation of angular momentum about a fixed axis.

***Plane motion of a rigid body*:** Instantaneous center of a lamina, Motion of the center of mass, motion relative to the center of mass, Equations of motion and their use, Kinetic energy and energy conservation equation, Angular momentum about any axis, conservation of linear momentum/angular momentum.

Recommended Texts:

1. *Textbook a/Dynamics,* F.Chorlton
2. *New Tertiary Mathematics,* C.Plumpton

NOTE: MT 104 and MT 105 are compulsory for students who offer Mathematics as a principal subject.

200 LEVEL COURSES

Courses MT 201 and MT 202 shall be compulsory for students offering Mathematics as a single subject.

Courses MT 201, MT 202, MT 204, MT 206 and MT 207 shall be compulsory for students offering Mathematics as two subjects.

MT 201 Groups, Rings and Fields (3 credits)

(Prerequisite: MT 104)

Groups: Cosets, Normal Subgroups and Factor Groups, Direct Product and Semi-direct Products, omomorphisms, Isomorphisms, Isomorphism Theorems, Permutation Groups,

Cayley's Theorem, Isomorphism between Dihedral and Symmetric Groups, Conjugacy and the Class Equation.

Rings: Commutative rings, Rings with unity, Integral Domains and Fields, Subrings, Ring Homomorphisms, Ideals and Factor Rings, Principal Ideal Domains, Euclidean Domains and Unique Factorisation Domains, Quotient Fields.

Polynomials: Polynomials with Integer Coefficients, Solution of Cubic and Quartic Polynomials, General Polynomial over a field, Roots of a Polynomial, Existence of Roots, Factorisation, Irreducible polynomials, Gauss's Lemma, Eisenstein's Irreducibility Criterion.

Fields: Properties of a Field, Properties of a multiplicative group of a Field, Field Extensions, Finite Fields.

Recommended Texts:

1. J. B. Fraleigh (1999), *A First Course in Abstract Algebra*, Addison-Wesley Publishing Company
2. M. Artin, *Algebra* (1994), Prentice-Hall
3. I.N. Herstein (1964), *Topics in Algebra*, Blaisdell

MT 202 Real Analysis II (3 credits)

(Prerequisite: MT 105)

Cauchy sequences, Convergence tests, Absolute and conditional convergence, Power series, Integration and differentiation of power series, Taylor series, Uniform continuity, Upper and lower Riemann integrals, Characterization of Riemann integrable functions, Functions of several variables, Limits and continuity, Partial derivatives, Differentials, Chain rule, Extrema of functions of several variables, Lagrange Multipliers.

Recommended Texts:

1. S. R. Lay (1986), *Analysis An Introduction to Proof*, Prentice-Hall
2. T. M. Apostol (1974), *Mathematical Analysis*, Addison-Wesley

MT 203 Ordinary Differential Equations (3 credits)

(Prerequisite: MT 103)

Series solutions, Picard iterates, Existence and uniqueness of solutions, eigenvector method for linear systems, Fundamental matrix solutions, Non-linear autonomous systems, Phase plane, Phase portraits of linear systems, stability, Liapunov functions, Periodic solutions, Poincare-Bendixson theorem, Introduction to bifurcation theory.

Recommended Text:

1. M. Braun (1992), *Differential Equations and Their Applications*, Springer-Verlag

MT 204 Mathematical Methods (3 credits)

(Prerequisite: MT 101)

***Differentiation of Vectors*:** Scalar and vector point functions and their partial derivatives with respect to coordinate variables, Gradient of a scalar point function; Directional derivative, Divergence and curl of a vector point function**.** ***Integration of Vectors*:** Line integrals and their evaluation using parametric representation, Surface integrals, Green's theorem in the plane Stokes theorem, Circulation and flux of a vector point function, Volume integrals, Divergence theorem, Irrotational and Solenoidal vector fields, Orthogonal Curvilinear Coordinates, Grad, Div, Curl in OCC, Cylindrical polar and spherical coordinate systems, Use of these coordinate systems in evaluation of surface and volume integrals. ***Special Solution of Laplaces Equation*:** Solutions in two-

dimensions, Axi-symmetric solutions. ***Integral Transforms*:**
Laplace transforms; Elementary Properties, Inverse Laplace transform and its properties, Convolution theorem and its use in evaluation of integrals, Uses of Special functions connected with Laplace transform, Evaluation of integrals using LT, Applications in ODE and integro-differential equations, Applications in PDE, Fourier Transforms; Infinite-Fourier sine/cosine transforms and their inverse formulae, Finite-Fourier sine/cosine transforms, Derivation of inverse formulae, Use of Fourier series, Boundary value problems-Use of Fourier transforms.

Recommended Texts:

1. M.R. Spiegel (1968), *Vector Analysis*, McGraw-Hill
2. M.D. Raisinghania (1997), *Vector Analysis*, S. Chand & Comp. Ltd.
3. M.D. Raisinghania (1995), *Integral Transforms*, S. Chand & Comp. Ltd.

MT 205 Classical Mechanics II (2 credits)
(Prerequisite: MT 106)
Statics
Catenary*:** Equation of catenary; Standard relations, Tension at a point, Examples on equilibrium of heavy strings, Tightly stretched catenary. ***Strings on plane curves*:** Heavy string on smooth space, Heavy string on rough space.Thin rigid beams*:** Shear force and SF diagram, Bending Moment and BM diagram, Relationship between SF, BM and Loading (continuous/ concentrated). ***Deflection of beams*:** Equilibrium of slightly elastic beams, Bending of slightly elastic beams, Equation of three moments.
Dynamics
***Central Orbits*:** Particle motion under a central force, Use of polar and reciprocal polar coordinates, Use of pedal coordinates, Elliptic, Parabolic and Hyperbolic Orbits, Kepler's Laws of planetary motion, Distributed central orbits. ***Small Oscillations*:** Expressions for Kinetic/Potential Energies, Equation of motion and their solutions, Normal modes of oscillation, Normal coordinates and their determination.

Recommended Texts:

1. S.L. Green (1962), *General Degree Applied Mathematics*, University Tutorial Press Ltd
2. F. Chorlton (1985), *Dynamics*, CBS publishers

MT 206 Mathematical Modelling (3 credits)
Dimensions and Units, Scaling, Approximation and reasonableness of answers, Linear and quadratic models, Polynomial and rational models, Traffic flow models, Exponential models, Catastrophe theory, usage of differential equations and Bifurcation
Economic Functions: supply; Demand; *TC*; *TR*; *AC*; *AR*; *MC* and *MR*. Elasticity, Cosumer's Surplus, Producer's Surplus, Income determination model, Cobweb model, Harod model, Equilibrium in Economic Resources, Economies, Attainable states, Private ownership, Fixed point theory,
Continuous-time systems, Controllability, Liner feed back, Discrete-time systems, Stability theory, Optimal controls.

Recommended Texts:

1. R. Haberman (1998), *Mathematical Models*, SIAM
2. F.R. Giordano and M.D. Weir

MT 207 Numerical Analysis I (2 credits)

Difference equations, Solutions of equations in one variable: Bisection method, Fixed-point iteration, Newton-Raphson method, Error analysis for iterative methods.

Interpolation and Polynomial Approximation: Taylor polynomials, Interpolation and Lagrange polynomial, Iterated interpolation, Divided differences, Hermite interpolation, Cubic spline interpolation.

Numerical Differentiation and Integration: Numerical differentiation, Richardson's extrapolation, Elements of numerical integration.

Recommended Texts:

1. Kendall E. Atkinson (2008), An introduction to numerical analysis, 2nd Edition. Wiley India Pvt. Limited.
2. Arieh Iserles (2008), A First Course in the Numerical Analysis of Differential Equations, 2nd edition. Cambridge University Press.
3. Richard L. Burden, J. Douglas Faires (2011). Numerical Analysis, 9th Edition. Brooks/Cole.

MT 208 Set Theory (1 credits)

Axiom schema of comprehension, Formulas, classes, ZFC-model; Algebra of sets, Principle of Duality, Indexing, Countability, Cardinal Arithmetic, Cantor's Theorem; Continuum Hypothesis, Partial ordering and Zone's Lemma, Ordinal numbers and Transfinite Induction, Well-ordering Principle.

Recommended Text:

1. K.J. Delvin (1993), *The Joy of Sets : Fundamentals of Contemporary Set Theory* (*Undergraduate Texts in Mathematics*), Springer-Verlag

MT 209 Graph Theory (2 credits)

Isomorphism of Graphs, Paths, Circuits, Eulerian graphs, Hamiltonian graphs, Shortest path problem, Chinese postman problem, Directed graphs, Graph Colouring, Four colour problem, Proof of five colour theorem, Planar graphs, ***Trees and Searching*:** Properties of trees, Travelling salesman problem, Tree Analysis of sorting algorithms, Hall's Theorem, Transversal theory, Applications to game theory.

Recommended Texts:

1. F. Harary (1988), *Graph Theory*, Narosa Publishing House
2. R. J. Wilson (1996), *Introduction to Graph Theory*, Addison-Wesley Longman
3. K.H. Rosen, Descrete Mathematics and its Application, McGraw-Hill.

300 LEVEL COURSES

Courses MT 301 and MT 302 shall be compulsory for students offering Mathematics as a single subject.

Courses MT 301, MT 302, MT 310 and MT 312 shall be compulsory for students offering Mathematics as two subjects.

Courses MT 301, MT 302, MT 305, MT 306, MT 307, MT 309, MT 310 and MT 312 shall be compulsory for students following Special Degree Course in Mathematics.

MT 301 Linear Algebra (3 credits)
(Prerequisite: MT 201)

Vector Spaces*:** The abstract definition using the definition of vectors in $\Re^3$, $\Re^n$, $\mathbf{C}^n$. Subspaces, Dimension Theorem, Isomorphism Theorems. ***Linear Transformations and Matrices: Null Space and Range, Linear Operators, Rank-Nullity Theorem, Matrix Representation of a Linear Transformation, Composition of Linear Transformations, Change of Coordinate Matrix, Similar Matrices, Matrix of Change of Bases. ***Symmetric, Hermitian and Unitary Matrices*:** Properties of these Matrices, Shur's Theorem, The Reyleigh-Ritz Theorem. ***Elementary Matrices*:** Block Matrices, Elementary Matrix Operations and Elementary Matrices. ***Systems of Linear Equations*:** Augmented Matrix, Theoretical Treatment of Systems of Linear Equations. ***Determinants*:** Determinants of Order n, Properties of Determinants, Properties of the Adjoint. ***Diagonalisation of Matrices*:** Eigenvalues and Eigenvectors, Diagonalisability, Invariant Subspaces, Matrix Polynomials and Cayley-Hamiltion Theorem, Minimum Polynomial.
***Inner Product Spaces*:** Abstract Inner Products and Norms, Distance and angle between two vectors, Cauchy -Schwarz Theorem, The Gram-Schmidt orthogonalisation Process, Linear Operator in Inner Product Spaces, Positive definite linear operators.

Recommended Texts:

1. S. Lipschistz (1989), *Linear Algebra -Shaum Solved Problem Series*, McGraw-Hill
2. K. Hoffman and R. Kunze (1997), *Linear Algebra*, Prentice-Hall
3. G. L. Bradley (1975), *A Primer of Linear Algebra*, Prentice-Hall

MT 302 Real Analysis III (3 credits)
(Prerequisites: MT 202)
Jacobian, Inverse and Implicit Functions Theorem, Multiple integrals, change of variables (transformations) in multiple integrals, Function of Bounded Variation, Total variations, Rectifiable curves, Uniform convergence of infinite series, Infinite products, Special Functions (Gamma, Beta, Bessel, Legendre etc), Riemann Stieltjes Integral.

Recommended Texts:

1. W. Rudin (1976), *Principles of Mathematical Analysis*, McGraw-Hill
2. T. M. Apostol (1974), *Mathematical Analysis*, Addison-Wesley Longman

MT 303 Differential Geometry (2 credits)
Curves in space: Serret-Frenet formulae, Osculating plane, Osculating circle and osculating sphere, Involutes and evolutes, Helices.
Surfaces: Envelopes, Developable surfaces, Fundamental forms, Lines of curvature and Asymptotic curves, Ruled surfaces, Geodesics.

Recommended Texts:

1. T. J. Willmore (1959), *An Introduction to Differential Geometry*, Oxford University Press
2. CE. Weatherburn (1927), *Differential Geometry*, Cambridge University Press,

MT 304 Partial Differential Equations (2 credits)
(Prerequisite: MT 103)
***First order partial differential equations*:** Linear equations, Non-linear equations, Characteristics.

***Second order partial differential equations*:** Equations with constant coefficients, Equations with variable coefficients, Laplace equation, Wave equation, Diffusion equation, Boundary value problems,
Use of Fourier series.
Numerical methods of solving partial differential equations.

Recommended Texts:

1. R. V. Churchill & J.W. Brown (1987), *Fourier Series and Boundary Value Problems*, McGraw-Hill
2. E.T. Copson (1975) *Partial Differential Equations*, Cambridge University Press

MT 305 Group Theory (3 credits)
(Prerequisite: MT 201)
Classes of groups, Radicals and Residuals, Group Action on a set, Orbits and Stabiliser, Sylow's Theorems, Simple groups, Applications of Sylow's Theorems, Subnormal and Normal Series, Jordan-Holders Theorem, p-groups, Soluble and Nilpotent groups, Non-solubility of S_n (n>4) and Simplicity of A_n (n>4), Action of groups on groups.

Recommended Texts:

1. J. B. Fraleigh (1999), *A First Course in Abstract Algebra*, Addison-Wesley Publishing Company
2. R. Scott (1964), *Group Theory*, Prentice-Hall
3. J. S. Rose (1978), *A Course in Group Theory*, Cambridge University Press

MT 306 Topology I (3 credits)
(Prerequisite: MT 105)
Metric spaces, open and closed sets, continuous and Bi-continuous functions, complete metric spaces and Banach's Fixed Point Theorem, Topology on $\Re^n$, General topological spaces, Neighborhood Axioms, Bases and Local Bases Homeomorphisms, Subspaces, Finite Products and Quotients, Separation Axioms, Convergence, Compactness, Connectedness, Homotopy of paths.

Recommended Texts:

1. E. T. Copson (1978), *Metric Spaces*, Cambridge University Press
2. J. R. Munkres (1975), *Topology: A First Course*, Prentice-Hall

MT 307 Complex Analysis I (2 credits)
(Prerequisite: MT 202)
The complex field, Riemann sphere, Topology of the complex plane, Analytic functions, Cauchy- Riemann equations, Elementary functions, Cauchy's Theorem (Proof based on Green's theorem), Cauchy's integral formulae, Taylor series, Laurent series, Classification of singularities, Residue Theorem, Evaluation of real-valued integrals by means of residues, Conformal mappings.

Recommended Text:

1. R. V. Churchill & J. W. Brown (1984), *Complex Variables and Applications*, McGraw-Hill

MT 308 Combinatorics (2 credits)
(Prerequisite: MT 209)
***Recurrence relations and generating functions*:** Computing solutions to recurrence relations, The principle of Inclusion and Exclusion, Latin squares, System of distinct representatives, Extremal set theory.
***Steiner triple systems*:** Direct construction, Recurrence construction, Tournaments and Kirkman's school girls problem, Further Graph Theory, Networks, Matroids, Designs, Hadamard matrices.
***Error-Correcting codes*:** Linear Codes and Hadamard codes.

Recommended Texts:

1. P. J. Cameron (1994), *Combinatorics: Topics, Techniques, Algorithms*, Cambridge University Press
2. K.J. Haradam, Hadamand Matrics and it's Applications, Princeton University Press.

MT 309 Number Theory (3 credits)
(Prerequisite: MT 201)
Continued fractions, Linear congruences in two or more variables, System of congruences, Congruences of higher order, Euler ϕ-function and related theorems, Properties of the group $\phi(n)$, Euler's theorem, Wilson's theorem, Primitive roots, Quadratic residues, Gauss Quadratic Reciprocity law and its applications, Fermat numbers and Pepin's test.

Recommended Texts:

1. K. H. Rosen (1992), *Elementary Number Theory And Its Applications*, Addison-Wesley Publishing Company
2. I. Niven and H.S. Zuckerman (1980), *An Introduction to the Theory of Numbers*, John Wiely

MT 310 Fluid Mechanics I (3 credits)
(Prerequisites: MT 202, MT 204)
***Kinematics of Fluid Motion*:** Real and Perfect Fluids, Velocity of a fluid at a point, Streamlines and their differential equations, Steady and Unsteady motions, Vorticity and Circulation; Stokes's theorem, Irrotational flow and the velocity potential, Local, convectional and material rates of change of flow quantities, Acceleration as a material derivative, Equation of Continuity, Compressible and Incompressible fluids Conditions satisfied by a perfect fluid at a rigid boundary.
***Euler's Equation of Motion*:** Pressure at a point in a fluid (moving or at rest), Euler's Equation in vector form, Motion under conservative body force; Steady Rotation about a fixed vertical axis, Bernoulli's Equation in irrotational motion; Radial flow, Theorems on velocity potential,Kinetic Energy; Kelvin's theorems.
***Three-dimensional flow fields*:** Source, Sink and Doublet, Flow past a fixed sphere; Moving sphere in a fluid, Motion generated by impulses on boundaries of fluid, Concentric Spherical boundaries of fluid.
***Two-dimensional flow fields*:** Velocity and Vorticity in terms of the Stream Function in incompressible fluid, The Complex Potential and the Complex Velocity, in irrotational motion, Source, Sink, Doublet and Vortex, Image Systems for straight and circular boundaries Circle Theorem of Milne-Thomson, Flow past a fixed circular cylinder with singularities in the field outside.

Recommended Texts:

1. M. D. Raisinghania (2003), *Fluid Dynamics*. S. Chand Pvt. Limited
2. F. Chorlton (1990), *Fluid Dynamics*, Oxford University Press
3. G. K. Batchelor (2000), *An Introduction to Fluid Dynamics*, Cambridge University Press

MT 311 Linear Programming (3 credits)

***Convex Analysis*:** Convex combinations, Convex sets, Extreme points of a convex set, Convex polyhedron, Hyperplanes, Half-spaces and polytopes, Convex functions.

***Linear Programming (LP)*:** Mathematical formulation of the LP problem, LP in two-dimensional space, Graphical solution methods, General LP problem.

***The Simplex Method*:** Simplex algorithm, Two-phase simplex algorithm, Revised simplex algorithm, LP problems with unrestricted variables, LP problems with bounded variables.

***Duality in LP*:** Duality in LP problems, Duality theorems, Applications of duality, Dual simplex algorithm.

***Special Types of LP Problems*:** Transportation problem, Assignment problem.

Recommended Texts:

1. G. B. Dantzig & M. N. Thapa (1997), *Linear Programming*: *Introduction*, Springer-Verlag New York
2. K. Kapoor (1998), *Operations Research*, Sultan Chand & Sons
3. Laurance A. Wolsey. (1998), *Integer Programming*
4. Mukund N. Thapa. (1997). *Linear Programming*. Springer Pbulishing
5. Katta G. Murty. (1983). *Linear Programming*
6. Gerge B. Danzing (1998). *Linear Programming and Extensions.* Princeton University Press.

MT 312 Numerical Analysis II (3 credits)

(Prerequisite: MT 207)

***Initial-value Problems For Ordinary Differential Equations*:** Euler's method, Higher-order Taylor methods, Runge-Kutta method.

***Direct Methods for Solving Linear Systems*:** Linear systems of equations, Gaussian elimination and backward substitution.

***Numerical Solutions of Non-Linear Systems of Equations*:** Fixed points for functions of several variables, Newton's method, Quasi-Newton methods, Steepest descent techniques.

***Boundary-Value Problems for Ordinary Differential Equations*:** The linear shooting method, The shooting method for non-linear problems, Finite-difference methods for linear problems, Finite-difference methods for non-linear problems.

Recommended Texts:

1. Richard L. Burden, J. Douglas Faires (2011), *Numerical Analysis*, 9th Edition. Brooks/Cole.
2. Kendall E. Atkinson (2008), *An introduction to numerical analysis*, 2nd Edition.. Wiley India Pvt. Limited.
3. Peter A. Stark (1992), *Introduction to Numerical analysis*, 2nd Sub Edition. Macmillan Pub Co.
4. John H. Mathews, Kurtis D. Fink (2006), *Numerical Methods Using MATLAB*. Pearson Education, Limited.

HR 301 Human Resource Management (2 credits)
Introduction: Defining the Role, Importance and Challenges of HRM; Historical Development of HRM. Approaches of HRM; HRM and Personnel Management, Roles of HR Managers, Strategic Orientation of HRM. Brief Introduction to HRM Functions: Job Design, Job Analysis, HR Planning, Attraction, Selection, Recruitment, Induction, Training and Development, Career Development, Performance Management, Knowledge Management, Salary Administration, Employee Movements, Labor Relations, Discipline Handling, Managing Health and Safety, Grievance Handling and Reward Management.

Recommended Text:

1. Mathis, R.L., Jackson, J.H., Valentine, S.R. (2013) Human Resource Management, 14th Edition, CENGAGE Learning.
2. Dessler, G. (2012) Human Resource Management, 14th Edition, Pearson.
3. Nkomo, S.M., Fottler, M.D., McAfee, R.B. (2010) Human Resource Management Applications: Cases, Exercises, Incidents, and Skill Builders, 7th Edition, CENGAGE Learning.

400 LEVEL COURSES

All of the following courses shall be compulsory for students following Special Degree Course in Mathematics.

MT 401 Galois Theory (3 credit)
(Prerequisites: MT 301, MT 305)
Field extensions, Ruler and Compass Constructions, Three classical Problems, Galois groups of field extensions, Automorphisms of a field, Theorem of the Primitive Element, Splitting Fields, Automorphisms of a field extension over a fixed field, Galois Groups, Separable and Inseparable Extensions, Normal Extensions and Galois Extensions, Subgroups of the Galois group and intermediate fields of the extension, Fundamental Theorem of Galois Theory, Solubility of polynomials, Galois group of a polynomial, Radical Extensions, Solubility by radicals, Proof that a polynomial is irreducible if and only if its Galois group acts transitively on its roots, Proof of the Fundamental Theorem of Algebra.

Recommended Texts:

1. M. Artin (1994), *Algebra*, Prentice-Hall
2. I. Kaplansky (1972), *Rings and Fields*, University of Chicago Press
3. I.N. Stewart (1973), *Galois Theory*, Chapman and Hall

MT 402 Measure Theory (3 credit)
(Prerequisite: MT 302)
Lebesgue Measure on the real line, σ-algebras, Measurable functions, Measure spaces, Lebesgue integral, Fatou's Lemma, Monotone Convergence Theorem, Dominated Convergence Theorems, L^p spaces, Modes of Convergence, Product measures, Fubini's Theorem.

Recommended Texts:

1. G. De Barra (1974), *Introduction to Measure Theory*, Van Nostrand Reinhold Company
2. H.L. Royden (1988), *Real Analysis*, Macmillan

MT 403 Topology II (3 credits)
(Prerequisite: MT 306)
Box Topology and Tychonoff Topology, Inadequacy of sequences, Nets and Filters ; Tychonoff spaces and Normal spaces, Uryshon's Lemma and Tietze's Extension theorem;

Paracompactness and BNS- Metrization Theorem; G_δ - Sets and Baire Spaces;

Totally disconnected spaces, The Cantor set , Homotopy relations, Fundamental group; Triangulating spaces, Infinite Complexes , Euler Characteristics and Surgery, Knots and covering spaces

Recommended Texts:

1. J. R. Munkres (1975), *Topology: A First Course*, Prentice-Hall
2. R. Brown (1968), *Elements of Morden Topology*, McGraw-Hill

MT 404 Complex Analysis II (3 credits)
(Prerequisites: MT 306, MT 307)
Homotopy of paths and Cauchy's theorem, Winding numbers and Cauchy's integral formulae, Power series and uniform convergence, Miscellaneous contour integrals, Maximum modulus principle, Schwarz's lemma, Liouville's theorem, Fundamental theorem of algebra, Morera's theorem, Argument principle, Rouche's theorem, Open mapping theorem, Reflection principle, Normal families, Riemann mapping theorem.

Recommended Texts:

1. L. V. Ahlfors (1979), *Complex Analysis*, McGraw-Hill
2. J. B. Conway (1980), *Functions of One Complex Variable*, Narosa Publishing House

MT 405 Functional Analysis (3 credits)
(Prerequisites: MT 301, MT 306, MT 402)
Normed Linear Spaces , Banach Spaces, Riesz-Fischer Theorem, Linear maps and functionals or normal linear spaces, Dual Spaces; Geometry of Banach Spaces , Hanch Banach Theorems (Separation Form, Extension Form); Uniform Boundedness Principle, Open Mapping Theorem, Banach's Isomophism Theorem, Closed Graph Theorem; Second Dual Space, Projections and direct sums in Banach Spaces , Schauder Basis, Hilbert Spaces; Banach Algebras, Topoligical Vector Spaces.

Recommended Text:

1. E. Kreyszig (1978), *Introductory Functional Analysis With Applications*, John Wiley

MT 406 Fluid Mechanics II (3 credits)`
(Prerequisite: MT 310)
Perfect Fluid Theory
Two-dimensional flow: Complex potential, Blasius Theorem, Conformal Transformation; Joukowski and Schwartz Christoffel. Discontinuous Motion, Vortex Motion.
Three-dimensional flow: Stokes' stream function in axi-symmetric flows, Image systems in 3-D.
Viscous Flow
Navier-Stokes equation of motion; its exact solutions, Steady slow motion past a fixed sphere, Reynold's Number, Prandtl's Boundary Layer.

Recommended Texts:

1. L.M. Milne (2011), *Theoretical Hydrodynamics*, 5th edition, Thomson Dover Publications.
2. F. Chorlton (1990). *Fluid Dynamics*, Oxford University Press.
3. M. D. Raisinghania, (2003). *Fluid Dynamics*, S. Chand Pvt. Limited.
4. P. G. Drazin (2006), *The Navier-Stokes Equations: A Classification of Flows and Exact Solutions*, Volume 13, Cambridge University Press.

MT 407 Optimization Theory (3 credits)

(Prerequisite: MT 311)

Advanced Linear Programming: Dantzig-Wolf decomposition algorithm, Goal programming.

Integer Programming: Cutting plane algorithms, Branch and bound algorithms.

Non-Linear Programming: Kuhn-Tucker conditions, Quadratic programming, Separable programming.

Recommended Texts:

1. D. A. Pierre (1998), *Optimization Theory with Applications*, Dover Publications Inc
2. Donald A. Pierre (2012). *Optimization Theory with Applications*, General Publishing Company

MT 408 Independent Study/Project Work (6-8 credits)

Supervised independent study on a project approved by an academic staff member of the department.

Candidates are required to present their work at a seminar and submit the work in a report/dissertation form.

MT 416 Nonlinear Dynamics (3 credits)

(Prerequisite: MT 204, MT 304)

Types of dynamical systems and their characteristics, examples of non-equilibrium patterns and dynamics, linear stability analysis of dynamical systems. Bifurcations: saddle-node, transcritical, pitchfork and Hopf bifurcation. Center manifold theory. Lorenz Equation and its stability analysis. The amplitude equation description and weakly nonlinear theory, analysis of dynamics near threshold to chaos. Applications of nonlinear dynamics to different disciplines. Introduction to numerical simulations.

Recommended Texts:

1. Strogatz, S. H. (1994) Nonlinear Dynamics and Chaos with Applications to Physics, Chemistry, and Engineering. Addison-Wesley.
2. Cross, M. and Greenside, H. (2009) Pattern formation and dynamics in nonequilibrium systems. Cambridge University Press.
3. Hoyle, R. (2006) Pattern Formation: An Introduction to Methods. Cambridge University Press.
4. Baker, G. L. and Gollub, J. P. (1996) Chaotic Dynamics. 2nd ed. Cambridge University Press.

SI 401 Industrial training (2 credits)

Each student will undergo full time training in the industry for the prescribed period on projects assigned by the industry. Students are required to have a duly maintained 'Daily Diary' which should be submitted to the Head of the Department within two weeks after completion of the training. In addition, the students are expected to write a report and make a presentation on the work carried out by them.

MOLECULAR BIOLOGY AND BIOTECHNOLOGY

100 LEVEL COURSES

BL 101 Basic Biology (2 credits)

Cell Biology - Chemical nature of life, origin of life, scientific method, prokaryotic and eukaryotic cells, cell types, structure and function of cell membranes and organelles, cell division, structure and function of genetic material.

Classification of organisms - Early and current systems of classification.

Genetics and evolution - Chromosome theory of inheritance, Mendelian genetics and deviation, linkage and recombination, mutations, Hardy-Weinburg principle, sources of variation, natural selection, origin of species. Laboratory exercises based on above topics.

Recommended Texts:

1. Campbell, N. A., Reece, J. B. and Mitchel, I. G. (1996). Biology 4th Edition. The Benjamin/Cummings Publishing Company, Inc.
2. Marder, S. S. (2001). Biology 7th edition. McGraw – Hill Book Company Inc., USA.
3. Raven, P. H. and Johnson, G.B. (1996). Biology. 4th Edition. Wm. C. Brown Publishers.
4. Tauro, P. Kapoor, K. K. and Yadav, K. S. (1986). An Introduction to Microbiology. Wiley Eastern Limited, New Delhi.
5. Winter, P. C., Hickey, G. T. and Fletcher, H. L. (2000). Genetics. 2nd Edition. Vivo Books Private Ltd., New Delhi.

CH 101 Principles of Chemistry I (3 credits)

General Chemistry I (15L): Modern view of the atomic structure and the development of the atomic theory of matter; Quantum mechanics and atomic theory: Electromagnetic radiation, atomic spectrum of hydrogen, Bohr model, the quantum mechanical description of the atom, electrons as waves, wave-particle duality, de Bröglie relationship, wave function and its physical meaning, Heisenberg's uncertainty principle; Electron spin and the Pauli exclusion principle, Aufbau principle and the periodic table, electron configurations of elements, periodic trends in atomic properties; Bonding, types of chemical bonds, electronegativity , polarity and dipole moment, ionic bond, ionic lattices, packing of spheres, partial ionic character of covalent bond; Covalent bond: covalent bond energies and chemical reactions, non-valence cohesive forces.

Structure and Reactivity (15 L): Types of intermolecular interactions; Factors affecting electron availability in bonds and at individual atoms; Acidity and basicity; Functional groups responsible for reactivity of different classes of organic compounds; Relationships between the main classes of organic molecules; Introduction to reaction mechanisms - bond cleavage processes, types of reagents and reaction intermediates; Energy diagrams; Mechanisms of substitution, addition and elimination reactions; Aromaticity and Huckel's Rule; Reactions in functional group analysis and their mechanisms. IUPAC Nomenclature

Reactivity and Energetics (15L): The scientific method, microscopic and macroscopic theories, Kinetic Molecular Theory (KMT): KMT as a model for microscopic theories, experimental evidence, properties of gases, the perfect gas, state of gases, individual gas laws, combined gas laws, kinetic model for gases, imperfect gases; Thermodynamics: Systems, surroundings, universe, processes, zeroth law of thermodynamics, temperature, first law of thermodynamics, work, heat, internal energy, extent of reaction, enthalpy,

thermochemistry, second law of thermodynamics, entropy, Gibbs energy, Helmholtz energy, Gibbs energy versus extent of reaction, reaction quotient, exogernic and endogernic reactions, reactions at equilibrium, thermodynamic equilibrium constant, activity, temperature dependence of equilibrium constant, effect of concentration, pressure, volume, temperature, etc, on the position of equilibrium.

Recommended Texts:

1. R. Chang (2002) *Chemistry*, McGraw-Hill; P.W. Atkins (1994), *Physical Chemistry*, Oxford University Press.
2. J McMurry (1996*) Organic Chemistry*, Brooks/Cole Publishing Co.; RT Morrison and RN Boyd (1998) *Organic Chemistry*, Prentice Hall.

CH 102 Principles of Chemistry II (3 credits)

(Prerequisite: CH 101)

General Chemistry II (15 L): Molecular structure: Lewis structures, explanations to octet rule; Three- center bond, resonance, the VSEPR model, hybridization of atomic orbitals, molecular orbital theory, bonding in homonuclear and heteronuclear diatomic models; Periodic table and periodicity, periodic properties, applications of size and energy factors in chemistry, magnetic properties; Basic concepts in chemical analysis: titrations, buffers, indicators, solubility equilibria and applications.

Chemical Kinetics (10L): Molecular collisions; The importance of chemical kinetics: Rates, mechanisms, relationship between rate of reaction and rate of change of concentration of components; Rate law, rate constant and order, overall order of a reaction, initial rate method, integrated rate laws, isolation method, half-life of a reaction and a relationship to rate constant, molecularity of a reaction, the Arrhenius relationship between temperature and rate of a reaction, activation energy and pre-exponential factor.

Electrochemistry (5L): Introduction to Electrochemistry, Conductometry and Potentiometry

Stereochemistry and Spectroscopy (15 L): Configurational isomers, E,Z-nomenclature, symmetry, chirality; R,S-nomenclature, meso compounds, diastereomers. conformations in acyclic and cyclic compounds, cis-trans and optical isomerism in cyclic compounds; Biphenyls, allenes, introduction to spectroscopy (UV, IR) and 1H-NMR spectra.

Recommended Texts:

1. R. Chang (1996) Chemistry, McGraw-Hill; P.W. Atkins (1999), *Physical Chemistry*, Oxford University Press.
2. J McMurry (1996) *Organic Chemistry*, Brooks/Cole Publishing Co; RT Morrison and RN Boyd (1998) Organic Chemistry, Prentice Hall.

CH 108 Elementary Chemistry Laboratory (1 credit)

Apparatus and measurements; Error analysis; Introduction to inorganic analytical method; Organic functional group analysis.

CH 109 Inorganic Chemistry Laboratory (1 credit)

(Prerequisite: CH 108)

Qualitative analysis; Analysis of Inorganic anions, cations and their mixtures .Quantitative Inorganic analysis including titrimetry and gravimetry.

BL 120 Introduction to Biotechnology and its Applications (2 credits)

Introduction to Molecular Biology and Biotechnology, historical development, land mark discoveries and pioneering scientists, diverse applications of Biotechnology in medicine, food production and environmental protection. World Wide Web Resources on

Biotechnology and their reliability, the fraudulent nature of bioterrorism and how to circumvent it through proper and safe use of Biotechnology. In the contexts of humanitarian and environmental catastrophes, the use of Biotechnology as a developmental tool to face the challenges in the present and future.

Recommended Texts:

1. Thieman, W.J., and Palladino, M.A. (2012) Introduction to Biotechnology, (Third Edition). Benjamin Cummings.
2. Walker, S. (2006) Biotechnology Demystified, (Fifth Edition). The McGraw-Hill Companies.
3. National Center for Biotechnology Information, U.S. National Library of Medicine, 8600 Rockville Pike, Bethesda, MD, 20894, USA. Website: http://www.ncbi.nlm.nih.gov/ .
4. International Service for the Acquisition of Agri-biotech Applications (ISAAA), Operated in USA, Kenya and Philippines. Website: http://www.isaaa.org/.
5. GMO Compass, the task of GMO Compass is to collect objective, science-based information on the use of genetic engineering in the agri-food industry and present it to the public in a way that is easy to understand and readily accessible. Maintained at Genius GmbH, Robert-Bosch-Str. 7, 64293 Darmstadt, Germany. Website: http://www.gmo-compass.org/eng/.

200 LEVEL COURSES

MB 201 Biological Chemistry (3 credits)
(Prerequisites: BL 101, CH 101, CH102)
The cell as a basic unit of life; major intracellular organelles and their functions; structure, function and metabolism of biomolecules (carbohydrates, lipids, nucleic acids and proteins) in plant and animal cells; membrane and transport; protein trafficking and organelle biogenesis; bioenergetics; cell-cell communication; moving signals across membranes; types of signals and receptors; second messengers; G-Proteins and other membrane associated signal transmitters.

Recommended Texts:

1. L. Stryer (1995) *Biochemistry*, W. H. Freeman & Co.
2. R. K. Murray, D. K. Granner, P. A. Mayes and V. W. Rodwell (1996) *Harpers Biochemistry*, Appleton and Lange.
3. David L. Nelson, Michael M. Cox (2000) *Lehninger Principles of Biochemistry* (third edition), Worth Publishers, Inc.
4. Harvey Lodish, Arnold Berk, S. Lawrence Zipursky, Paul Matsudaira, David Baltimore, James Darnell (1999) *Molecular Cell Biology* W.H. Freeman & Company.

MB 206 Principles of Genetics (3 credits)
(Prerequisite: BL 101)
Mendalian genetics; alterations of Mendal laws; linkage; sex determination; cytoplasmic inheritance; cytogenetics; macro and micro mutations; polyploidy and aneuploidy; population genetics; quantitative genetics; heterosis and hybrid vigor; principles and practical aspects of breeding.

Recommended Texts:

1. Strickberger, M. W. (1999) *Evolution* (second edition), Jones and Bartlett Publishers.
2. Robert F. Weaver (2002) *Molecular Biology* McGraw-Hill.

MB 211 Cell and Tissue Culture (2 credits)

(Prerequisite: BL 101)

Introduction and general techniques in cell and tissue (plants and animals) culture; preparation of culture media; isolation and culture of animal cells and tissues for assays; cell counting techniques; embryo and meristem cultures; somatic embryogenesis; protoplast isolation and culture. somatic hybridization; applications of cell and tissue culture.

Recommended Texts:

1. O. L. Gamborg and G. C. Phillips (1995) *Plant Cell, Tissue and Organ Culture*, Springer-Verlag, Gmbh.
2. M. K. Razda (2003) *Introduction to Plant Tissue Culture* (2nd edition) Science Publishers, Inc.

MB 216 General Microbiology (1 credit)

(Prerequisite: BL 101)

Introduction to microorganisms (bacteria, viruses, fungi); classification and morphology; microbial genetics; growth and metabolism of bacteria; microbial techniques (culture media, aseptic techniques, isolation and culture of bacteria, enumeration, staining, identification).

Recommended Texts:

1. Lim, D. (1998) Microbiology (Second Edition) WCB/McGraw-Hill.
2. Madigan, M. T., Martinko, J. M., Parker, J. (1997) *Biology of Microorganisms* (eighth edition), Prentice Hall.

MB 221 Enzymology (2 credits)

(Same as BT 204)

(Prerequisites: BL 101, CH 101, CH 102)

Enzymes as catalysts in biological systems; protein structure and folding; classification and nomenclature of enzymes; mechanism of enzyme action; kinetics of enzymatic reactions; quantitative and qualitative aspects of enzyme activity; effect of temperature, pH, substrate, enzyme concentration and inhibitors on enzyme activity; mode of enzyme regulation; qualitative tests for different types of enzymes; isozymes and isozyme analysis; enzyme assay methods; purification and characterization and characterization; application of enzyme technology in industry; protein engineering.

Recommended Texts:

1. Robert K. Scope (1993) *Protein Purification: Principles and Practice* (third edition) Springer Verlag
2. Alan Fersht (1998) *Structure and Mechanism in Protein Science: A Guide to Enzyme Catalysis and Protein Folding* (third edition) W H Freeman & Co.
3. David L. Nelson, Michael M. Cox (2000) *Lehninger Principles of Biochemistry* (third edition), Worth Publishers, Inc.

MB 226 Molecular Genetics (3 credits)
(Prerequisites: BL 101, CH 101, CH 102)
Organization of prokaryotic and eukaryotic genomes; genes and chromosomes; mitochondrial and chloroplast DNA; mobile genetic elements; genome replication; genetic recombination; DNA repair; RNA synthesis, processing and metabolism; the genetic code; protein synthesis; regulation of gene expression; DNA cloning and microarrays; genetic disorders and gene therapy.

Recommended Texts:

1. David L. Nelson, Michael M. Cox (2000) *Lehninger Principles of Biochemistry* (third edition), Worth Publishers, Inc.
2. Robert F. Weaver (2005) *Molecular Biology* (third edition) McGraw-Hill.

BT 201 Plant Diversity I (2 credits)
Basic concepts of biodiversity, levels (species, genetic, ecosystem); range of diversity in relation to size, life span, form, nutrition, reproduction, habitats, life cycles etc. Nomenclature and classification, importance of biodiversity, its conservation and sustainable utilization. Diversity among lower organisms: Monera (Prokaryota), Protista, algae, Chromista, Fungi. Basic characters, modern classification systems, range of form, reproduction and life cycles with reference to type examples. Importance of fungi in nature, biodeterioration, medicine, agriculture & industry.
Laboratory exercises based on above topics.

Recommended Texts:

1. Pandy, B. P. (1994). *A Text Book of Botany*, Fungi. S. Chand & Co. Ltd., New Delhi.
2. Mehrotra, K.R & Anjela, K.R. (1990). *An Introduction to Mycology*. Wiley Eastern Ltd., New Delhi.

BT 206 Plant Physiology (2 credits)
Functions of water in plant, concept of water potential and its measurements, water balance of the plant. Overview of soil-plant-atmospheric continuum, active and passive absorption of water. Stomatal physiology, solute transport in apoplast and symplast, passive and active transport of solutes across membrane barrier, essential nutrients in plants, nutrient solutions and deficiencies. Laboratory exercises based on above topics.

Recommended Texts:

1. Taiz, L & Zeiger E (1999*). Plant Physiology*. Benjemin Cummings Publishing Company, New York.
2. Hopkins, W.G. (1999). *Introduction to Plant Physiolog*y. John Wiley and Sons, New York.
3. Salisbury, F.B. & Ross, C.W. (1996*). Plant Physiology.* Wadsworth Publishers, London.
4. Kramer, P.J. & Boyer, J.S. (1996). *Water Relations of Plants and Soils.* Academic Press, London
5. Marschner, H. (1995). *Mineral Nutrition of Higher Plants*. Academic Press, London.

CH 221 Organic Chemistry I (2 credits)
(Prerequisites: CH 101, CH 102)
Organic Reaction Mechanisms I (15 L): Energetics – thermodynamics and kinetics of organic reactions; Concerted reactions, multi-step reactions; S_N1 and S_N2 reactions,

effect of solvents, protic, polar aprotic solvents etc, neighbouring group participation, Internal S_N2; Elimination reactions E1, E2; Electrophilic and nucleophilic addition to double bonds; Electrophilic aromatic substitution; Nucleophilic aromatic substitution
Spectroscopy I (15 L): 1H-NMR and 13C-NMR spectroscopy; one dimensional and two dimensional NMR
Mass spectrometry EI-MS, CI-MS

Recommended Texts:

1. RT Morrison and RN Boyd (1998) *Organic Chemistry*, Prentice Hall; RJ Fessenden and JS Fessenden (1990) *Organic Chemistry*, Brooks/Cole Publishing Co; S. Ege (1994) *Organic Chemistry*, DC Heath & Co; GP Wannigama (2000) *Organic Reaction Mechanisms*, SEU, University of Peradeniya; TW Graham Solomon, CB Fryhle (2002) *Organic Chemistry*, John Willey; RM Silverstein, GC Bassler and TC Morrill (1991) *Spectrometric Identification of organic compounds*, John Wiley.

CH 231 Physical Chemistry I (2 credits)
(Prerequisites: CH 101, CH 102)
Quantum Mechanics (10 L): Evidence for quantization, dynamics of microscopic systems, the Schrödinger equation, quantum mechanical principles, postulates in quantum mechanics, operators and observables, superposition and expectation values, the uncertainty principle, probability functions, solutions of Schrödinger equation for 1-, 2-, and 3-dimentional systems, including the hydrogen atom;
Atomic Structure and Atomic Spectra (10 L): Bohr theory and the quantum mechanical description of the atom, orbitals and wave functions, LCAO method, bonding in solids.
Electrochemistry (10 L): Conductometry, electronic and ionic conductors, conductivity and molar conductivity, strong and weak electrolyte solutions, determination of limiting molar conductivity, Kohlrausch's law of independent migration of ions, determination of ionic concentrations, equilibrium constants and rate constants. Conductometric titrations, electrodes, electrochemical cells, applications of potentiometry, factors effecting cell e.m.f., Thermodynamic functions from emf measurements, potentiometric titrations.

Recommended Text:

1. P.W. Atkins (1999), *Physical Chemistry*, Oxford University Press; D.A. McQuarrie,(1983) Quantum Chemistry, University Science Books.

CH 232 Molecular Properties, Molecular Spectroscopy and Spectroscopic Instrumentation (1 credit)
(Prerequisite: CH 231)
Electrical properties, dipole moment, intermolecular forces, magnetic properties, magnetic susceptibility, permanent and induced magnetic moments; Introduction to molecular spectroscopy; Rotational Spectra, vibrational spectra, electronic spectra, basic components of spectroscopic instrumentation.

Recommended Text:

1. P.W. Atkins (1999), *Physical Chemistry*, Oxford University Press; W.J. Moore, *Introduction to Molecular Spectroscopy.*
2.

PH 261 Medical Physics (2 credits)
Biomechanics of the human body: forces on and in the body, metabolism and energy balance of the body, fluid dynamics of the human circulatory system; Physics of the cardiovascular system and cardiovascular instruments: mechanics of cardiac contraction,

pressure volume curves, ECG, pacemakers, defibrillators; Fiber optics in medicine: physics of fiber optics, endoscopes; Laser in medicine: physics of Laser, Laser treatment, Laser safety; Physics of diagnostic techniques: ultrasound imaging (MRI); Nuclear medicine and Radiation physics: properties of nuclear radiation, radioisotopes for nuclear medicine, radiopharmaceuticals, nuclear medicine instrumentation, radiation dosimetry, radiation protection.

Recommended Texts:

1. P. Davidovits (2001) *Physics in Biology and Medicine*, Harcourt/Academic
2. R.K. Hobbie (1997) *Intermediate Physics for Medicine and Biology*, Springer.
3. J.R. Cameron, J.G. Skofronic and R.M. Grant (1999) *Physics of the Body*, Madison: Medical Physics Publishing
4. R.S. Khandpur (2003) *Hand book of Biomedical Instrumentation*, Tata McGraw-Hill.
5. J.G. Webster (1998) *Medical Instrumentation: Application and Design*, Houghton Mifflin.

ST 202 Applied Statistics (2 credits)

This course cannot be offered by students who offered ST 101 or ST 201. Some practical assignments will be given for this course.

Types of data, Data summarization: Histogram, Frequency polygon, Ogive.

Measures of location, Measures of Dispersion, Representation of data using Stem-Leaf diagrams and Box plots. Some Statistical distribution functions and their properties.

Test of hypothesis, Estimation and tests on difference between two means and proportions, Tests on variances.

Simple linear regression and correlation, Lack of fit residual plots, Introduction to Analysis of variance, and analysis of two-way contingency tables.

Recommended Texts:

1. Harper W.M. (1991) S*tatistics*, ELBS
2. Moore D.S. (1995) T*he basic practice of Statistics*, W.H. Freeman & Company
3. Bluman A.G. (1997) *Elementary Statistics*, McGraw Hill

ZL 201 Animal Embryology (2 credits)

Gametogenesis; Fertilization; Cleavage; Gastrulation; Neurulation; Early development of amphioxus, frog, chick, and man; Early development of selected invertebrates.

Practicals based on above.

Recommended Texts:

1. *Animal Biology.* Grove & Newell
2. *Introduction to Embryology.* B.I. Balinsky.
3. *Langman's Medical Embryology.* T.W. Sadler & J. Langman.

300 LEVEL COURSES

MB 301 Biochemistry and Molecular Biology Laboratory (2 credits)

(Prerequisites: MB 201, MB 226)

UV-visible spectroscopy; chromatographic methods; elctrophoresis; DNA and RNA purification and analysis; polymerase chain reaction; restriction fragment length polymorphism (RFLP) and random amplified polymorphic DNA (RAPD) techniques; DNA sequencing; southern and northern transfer techniques; immunochemical methods; radioactive and non radioactive detection methods; biosensors.

Recommended Texts:

1. J. Sambrook, E. F. Fritsch and T. Maniatis (1989) *Molecular Cloning – A Laboratory Manual*, Cold Spring Harbor Laboratory Press.
2. Alexander J. Ninfa, David Ballou (1998) *Fundamental Laboratory Approaches for Biochemistry and Biotechnology*. Fitzgerald Science Press, Inc.
3. Ed Harlow, David Lane (1988) *Antibodies: A Laboratory Manual* Cold Spring Harbor Laboratory.

MB 306 Recombinant DNA Technology (3 credits)

(Prerequisites: MB 201, MB 226)

Introduction to Recombinant DNA technology; purification and manipulation of DNA; cloning vectors; transformation; production of gene libraries; isolation, identification & characterization of cloned genes; gene expression; restriction mapping; generation of transgenic plants and animals.

Recommended Texts:

1. J. Sambrook, E. F. Fritsch and T. Maniatis (1989) *Molecular Cloning – A Laboratory Manual*, Cold Spring Harbor Laboratory Press.
2. Frederick M. Ausubel et al. (2001) *Current Protocols in Molecular Biology*, John Wiley & Sons, Inc.

MB 311 Molecular Cell Biology (3 credits)

(Prerequisite: MB 201)

Structure of eukaryotic and prokaryotic cells; cell organelles and functions; cell membrane, function and transport cross membranes; protein trafficking; organelle biogenesis; cytoskeleton and cell motility; extracellular matrix and cell adhesion; cell-to cell signaling; signaling in the sensory system; cell cycle, regulation and apoptosis.

Recommended Text:

1. Harvey Lodish, Arnold Berk, S. Lawrence Zipursky, Paul Matsudaira, David Baltimore, James Darnell (1999) *Molecular Cell Biology* W.H. Freeman & Company.

MB 316 Molecular Immunology (2 credits)

(Prerequisite: BL 101)

The immune system; structure and function of immunoglobulins; cells of lymphoid systems; response to antigenic stimulation; antigenic determinants; antigen processing and presentation; intercellular interactions; compliment system and its function; biology of the major histocompatibility complex; mechanisms of immunity and hypersensitivity; immunmodulatory products of parasites; diagnostic assays using antibodies; polyclonal and monoclonal antibodies; phage antibody production; imuunochemical methods.

Recommended Texts:

1. Janeway, C. (1999) *Immunobiology: The Immune System in Health and Disease*, Harcourt Health Science group
2. Roitt, I. (2001) *Essential Immunology*, Blackwell Science.
3. Abul K. Abbas, Andrew H. Lichtman (2003) *Cellular and Molecular Immunology* W.B. Saunders Company.
4. Ed Harlow, David Lane (1988) *Antibodies: A Laboratory Manual* Cold Spring Harbor Laboratory.

MB 322 Molecular Biotechnology (2 credits)
(Prerequisites: MB 226, MB 306)
Genetically modified organisms, and their applications; Emergence of Molecular Biotechnology, microbial biotechnology, agricultural biotechnology, medical biotechnology, germplasm assessment and conservation, aquatic biotechnology, bioremediation, effective microorganisms, bioprospecting, regulation of Biotechnology, Biotechnology as a business, career prospects in Biotechnology.

Recommended Texts:

1. Brown, T.A. (2010) Gene Cloning and DNA Analysis: An Introduction, (Sixth Edition). Wiley-Blackwell.
2. Glick, B.R., Pasternak, J.J., Pattern, C.L. (2009) Molecular Biotechnology: Principles and Applications of Recombinant DNA, (Fourth Edition). American Society for Microbiology Press, Washington DC.
3. Dehlinger, C.A. (2014) Molecular Biotechnology, Jones and Bartlett Learning.

MB 326 Bioinformatics (3 credits)
(Prerequisite: MB226)
Molecular databases; bioinformatics and computational biology software; sequence alignment;; phylogenetic analysis; functional genomics; DNA micro arrays; protein structure analysis, motif identification, evolutionary alignments and structure prediction; drug design

Recommended Texts:

1. Baxevanis, A. (1998) *Bioinformatics: a practical guide to analysis of genes and proteins*, John Wiley.
2. Bishop, M. (1994) *Guide to human genome computing*, Academic Press.

MB 331 Fermentation Technology (2 credits)
(Prerequisites: CH 101, CH 102)
Microorganisms used in industrial fermentation; isolation and preservation of pure cultures; mutants, factors influencing rate of mutation; bioreactor design and operation; fermentation kinetics; culture media; sterilization; control of different parameters; process monitoring; isolation of products; current applications, synthesis of secondary metabolites, strain improvement applications of functional genomics in fermentation technology.

Recommended Texts:

1. El-Mansi, E.M.T., Bryce, C.F.A., Dahhou, B., Sanchez, S., Demain, A.L., Allman, A.R. (Ed) Fermentation Microbiology and Biotechnology. CRC Press, Taylor and Francis Group.
2. Dehlinger, C.A. (2014) Molecular Biotechnology, Jones and Bartlett Learning.

MB 333 Molecular Phylogenetics (2 credits)
(Prerequisites: MB 206, MB 226)
Introduction to evolution and systematics; molecular basis of heredity and evolution; genetic maps; general principle of systematics; phylogenetic variations in plant and animal taxa (cladistics and phonetics etc.); molecular phylogenies; speciation and hybridization; applications of molecular methods in biodiversity assessment; in vitro germplasm conservation.

Recommended Texts:

1. Ridley, M. (2003) Evolution, Blackwell.
2. Hall, B.K., Hallgrimsson, B. (2013) Strickberger's Evolution, (Fifth Edition). Jones and Bartlet Publishers.
3. Yang, Z. (2014) Molecular Evolution: A Statistical Approach, (First Edition). Oxford University Press.

MB 335 Molecular Virology (3 credits)

(Prerequisite: MB 226)

History of virology and general characteristics of viruses; virus classification; structure and genomes; virological methods; virus infection cycle; virus receptors and mechanism of virus entry; replication and transcription of RNA viruses; reverse transcription and integration of DNA viruses; replication and transcription of DNA viruses; viral protein synthesis; virus assembly and exit; virus pathogenesis; oncogenic transformation; host resistance to viral infection; antiviral treatment; HIV and AIDS; exploitation of viruses in gene therapy.

Recommended Texts:

1. Flint, S.J., Racaniello, V.R. (2015) Principles of Virology, Vol. 1 and 2 (Fourth Edition). ASM Press.
2. Shors, T. (2011) Understanding Viruses (Second Edition). Jones & Bartlett Learning.
3. Cann, A.J. (2015) Principles of Molecular Virology, (Sixth Edition). Elsevier.

MB 337 DNA and Forensic Medicine Laboratory (2 credits)

(Prerequisite: MB 226)

Principles and methods of DNA profiling; recent examples; biological evidences and serology, distribution and spattering of blood and other useful biological samples, isolation of DNA from forensic samples, techniques in DNA analysis; forensic DNA databases; STR population data analysis, forensic genetics, challenges and case studies, accreditation and quality control, applications such as criminal investigations and paternity analysis, implications in law enforcements, future trends.

Recommended Texts:

1. Dehlinger, C.A. (2014) Molecular Biotechnology, Jones and Bartlett Learning.
2. Rudin, N., Inman, K. (2001) An Introduction to Forensic DNA Analysis (Second edition). CRC Press.
3. Buttler, J.M. (2014) Advance Topics in Forensic DNA Typing: Interpretation. Elsevier.

BT 302 Advanced Microbiology (2 credits)

Population counts, growth cycle of microorganisms. Applied microbiology. Microorganisms in their natural habitats and major activities, microbiology of air (types, diseases transmitted), soil (types, estimation, distribution, role in nutrient cycling), water (types, water pollution, coliform bacteria, sanitary water analysis, water borne diseases, water purification) and food (food microflora, food spoilage, food preservation and food borne diseases). Laboratory exercises based on above topics.

Recommended Texts:

1. Brock, T.D. , Madigan, M.T., Martinko, J.M. and Parker, J. *Biology of Microorganisms* (8^{th} edition), Prentice Hall, USA, 986 pp.

2. Madigan, M.T. Martinko, J.M. Parker . J. Prentice Hall, USA, 986 pp.
3. Giller, K. E. and Wilson, K. F. (1991). *Nitrogen fixation in tropical cropping systems.* CAB. International, UK.
4. McLaren, R. G. and Cameron, K. C. (1996). *Soil Science: Sustainable production and environmental protection*. Oxford University Press, UK.
5. Brady, N. C. (1990). *The nature and properties of soils* (10th edition). Macmillan Publishing Company, UK.

BT 304 Plant Pathology (2 credits)

Introduction, history of Plant Pathology, terminology & definitions, cause of plant disease, infection process, mechanism of symptom development, fungal pathogenesis, plant defense responses – constitutive and inducible defenses, Systemic Acquired Resistance (SAR), principles of plant disease control, diagnosis of plant disease.

Practical exercises: Laboratory examination of diseased specimens covering major field and post-harvest diseases of food, ornamental and plantation crops, plant pathology techniques, study of plant-pathogen interactions.

Recommended Texts:

1. Agrios, G. N. (1997). *Plant Pathology*, 4th Edition, Academic Press, U.K.
2. Abeygunawardena, D.V.W. (1969). *Diseases of cultivated plants*, Their diagnosis and treatment in Ceylon, The Colombo Apothecaries Co. Ltd., Sri Lanka.
3. Mehrotra, R.S. (1994). *Plant Pathology*, 10th Print, Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
4. Persley, Denis M. (1982). *Diseases of vegetable crops*. Department of Primary Industries, Queensland, Brisbane.
5. Beattie, B.B., W.B. McGlasson (1995). Postharvest *diseases of horticultural produce*, Volume 2*:* Tropical fruit. Department of Primary Industries, Queensland, Brisbane.

BT 309 Biodiversity Conservation & Management (2 credits)

Biodiversity – Introduction, Global biodiversity estimates, Measuring Biodiversity, Loss of biodiversity, Threats to Biodiversity, Biodiversity Conservation and Sustainable Development, Setting Conservation principles, Species management, Habitat management, Conservation Education & Ecotourism. Indigenous knowledge and Biodiversity, International conventions on Biodiversity.

Field visits.

Recommended Texts:

1. Groombrige, B. (1992). *Global Biodiversity: status of the Earth's living Resources*. Chapman and Hall. London.
2. Watson, R.T. & Heywood, V.H. (1995). *Global Biodiversity Assessment*. UNEP.

BT 311 Plant Reproductive Biology and Plant Breeding (2 credits)

(Prerequisite: BT 307)

Genetic variation and its estimation, incompatibility and its inheritance. Pollination biology. Plant breeding perspectives, plant reproductive systems, principles of plant breeding, genetic basis of plant breeding, polygenic inheritance, methods of breeding and experimental designs, quantitative inheritance, polyploidy, methods of breeding of self- and cross pollinated crops. Application of molecular marker technologies for genome analysis. Germplasm resources preservation and utilization, hybrid crops, seed

production and maintenance. Field visits to Plant Genetic Resource Centre (PGRC) and Rice Research and Development Institute, Batalagoda.

Recommended Texts:

1. Poehlman, J. M. and Sleper, D. A. (1995). *Breeding Field Crops* 4th Edition,. ISU Press.
2. Agarwal, R. L. *Fundamentals of Plant Breeding and Hybrid Seed Production* .Oxford and IBH Publishing Co.
3. Sharma, J. R. (1994). *Principles and Practice of Plant Breeding*. Tata Mc Graw – Hill Publishing Company Ltd., New Delhi.

CH 341 Analytical Chemistry (3 credits)

(Prerequisite: CH 231)

Advanced Calculations (12 L): Review of statistics in chemical analysis: test of significance, paired t-test, F-test, etc.; Statistics of linear chemical relationships; Performance characteristics of analytical methods; Interlaboratory testing; Sensor characteristics; Advanced calculations as applied to chemical analysis: derivation and error calculations associated with acid-base, redox and complexometric titrations; Iteration methods; metal-complex equilibria; Solubility equilibria and Gran plots.

Analytical Aspects of Spectrophotometry (9 L): Atomic absorption and emission methods, molecular uv and visible absorption spectroscopy.

Electroanalytical Chemistry (12 L): Potentiometric applications; voltammetry including polarographic methods, pulsed techniques, steady-state and flow injection amperometric methods, bulk electrolysis methods, microelectrodes in chemical analysis, electrochemical sensors,

Separation Methods (12 L): Solvent extraction, partition coefficient, distribution ratio, multiple extractions, extraction of metals, introduction to chromatographic techniques and classifications, gas chromatography, van-Deemter equation, ion-exchange chromatography, thin layer and paper chromatography, introduction to liqiuid-liquid chromatography.

Recommended Text:

1. DA Skoog, West and Holler, *Analytical Chemistry*; P Kissinger and WR Heineman (1984) *Laboratory Techniques in Electroanalytical Chemistry*, Marcel Dekker; AJ Bard and L Faulkner (1980), *Electrochemical Methods*.

CH 361 Environmental Chemistry (3 credits)

(Prerequisites: CH 211, CH 221)

Theory Component (20 L): Chemical cycles, aquatic chemistry, water pollution, water treatment, water quality standards. Atmospheric chemistry, particles in the atmosphere Air pollution- inorganic and organic air pollutants, particles in the atmosphere, photochemical smog, global warming, acid rain, depletion of the ozone layer. Municipal and solid waste and their management, hazardous waste, waste as a resource; Pollution prevtion and control, clean production mechanism; Environmental biochemistry; Toxicology; Environmental monitoring and analysis, sampling, classical methods and instrumentation; Analysis of data.

Laboratory Component (20 hr): Analysis of water and wastewater, analysis of air pollutants and particles; detection of pesticides.

Recommended Text:

1. SE Manahan, (1994) *Environmental Chemistry*, Lewis publishers; C Baird (2000), *Environmental Chemistry*

ZL 302 Comparative Anatomy and Animal Physiology (2 credits)
Anatomy and Physiology of Digestion, and Nutrition; Excretion and Homeostasis; Respiration and Gas exchange; Circulation and Blood; Reproduction and hormones; their Action and Regulation; Muscular system and Movement; Nervous system, Sense organs and Coordination. Practicals based on above.

Recommended Texts:

1. *Concepts of Human Anatomy and Physiology*. K.M. De Graff & I.S. Fox.
2. *Atlas and Dissection Guide for Comparative Anatomy.* S. Wischnitzer.
3. *Animal Physiology: Mechanisms and Adaptations*. R. Eckert, D. Randall & G. Augustine.
4. *Animal Physiology: Adaptation and Environment*. K. Schmidt-Nielsen.
5. *Biology*. N.K. Wessels & J.L.H. Hopson.

ZL 303 General Entomology (2 credits)
Insect Structure and Function; Classification and Identification of insects, Methods of Collecting, Preserving and Curating different insect orders; Insect development and Role of hormones; Insects of Agricultural, Medical and Veterinary importance; Principles and Methods of Insect Pest Control.
Practicals and Field work based on above.

Recommended Texts:

1. *A General Textbook of Entomology*. O.W. Richards & R.G. Davies.
2. *An Introduction to the Study of Insects.* D.J. Borror, C.A. Tiplehorn & N.F. Johnson.

ZL 312 Developmental Biology (2 credits)
(Prerequisite: ZL 201)
Introduction to Developmental Biology; Differentiation and morphogenesis in *Dictyostelium*; The cellular basis of morphogenesis; Organizing multicellular embryo; Genomic constancy; Cytoplasmic determinants; Differential gene expression during development; Maternal and zygotic control of gene expression; Maternal specification of embryonic axes; Hox genes and establishment of body plan; Cell-cell interactions; Cell signalling; Cell adhesion; Programmed cell death; Pattern formation; Establishment of segments, hierarchy of segments and segment identity of Drosophila; Sex determination and differentiation; Life cycles and development patterns; Aging and senescence; Regeneration; Teratogenesis; Cloning and transgenic animals.
Practical based on above.

Recommended Texts:

1. *Developmental Biology*. S.F. Gilbert.
2. *Principles of Development*. L. Wolpert, et al.
3. *Evolutionary Developmental Biology*. B.K. Hall.

HR 301 Human Resource Management (2 credits)
Introduction: Defining the Role, Importance and Challenges of HRM; Historical Development of HRM. Approaches of HRM; HRM and Personnel Management, Roles of HR Managers, Strategic Orientation of HRM. Brief Introduction to HRM Functions: Job Design, Job Analysis, HR Planning, Attraction, Selection, Recruitment, Induction, Training and Development, Career Development, Performance Management, Knowledge Management, Salary Administration, Employee Movements, Labor Relations, Discipline Handling, Managing Health and Safety, Grievance Handling and Reward Management.

Recommended Texts:

1. Mathis, R.L., Jackson, J.H., Valentine, S.R. (2013) Human Resource Management, 14th Edition, CENGAGE Learning.
2. Dessler, G. (2012) Human Resource Management, 14th Edition, Pearson.
3. Nkomo, S.M., Fottler, M.D., McAfee, R.B. (2010) Human Resource Management Applications: Cases, Exercises, Incidents, and Skill Builders, 7th Edition, CENGAGE Learning.

400 LEVEL COURSES

MB 401 Molecular Biology of Plant and Animal Diseases (2 credits)
(Prerequisites: MB 201, MB 226)
Genetic disorders; abiotic stresses; infectious diseases; host-parasite interactions; infectiousness of disease causing agents; host response to disease causing agents; diagnosis of disease; treatment; molecular aspects to drug resistance; rational drug design.

Recommended Texts:

1. Agrios, G. N. (1997) *Plant Pathology*, Academic Press
2. Fox, R. T. V. (1993) *Principals of Diagnostic Techniques in Plant Pathology* C & B Intl.
3. I. Roitt, I. (2001) *Essential Immunology*, Blackwell Science Ltd.

MB 412 Biotechnology Industry (2 credits)
(Prerequisite: MB 322)
Pharmacogenomics for personalized medicine, concept of White Biotechnology, industrial production process according to Kyoto objective applications, economic potential and implications for the society, biopharmaceuticals, food and feed, paper and pulp, bio-energy and high-tech food production with GM , Bio-refineries.

Recommended Texts:

1. Soetaert, W., Vandamme, E.J. (2010) Industrial Biotechnology: Sustainable Growth and Economic Success, (First Edition). Willey-UCH.
2. Kamm, B., Grubew, P.R., Kamm, M. (2010) Biorefineries Industrial Processes and Products: Status Quo and Future Directions. Wiley-UCH.
3. Da Silva, S.S., Chandel, A.K. (2014) Bio Fuels in Brazil: Fundamental Aspects, Recent Development and Future Perspectives. Springer.

MB 416 Environmental Biotechnology (2 credits)
(Prerequisites: MB 226, MB 322)
Living organisms as pollution indicators; biodegradation; waste management; pollution treatment; bio-mining; biogas production; microbes in environmental management.

Recommended Texts:

4. R. Barry King, Gilbert M. Long, John K. Sheldon (1997) *Practical Environmental Bioremediation: The Field Guide* (Second Edition) Publisher: CRC Press.
5. Sarina J. Ergas, Daniel P. Y. Chang, Edward D. Schroeder, Juana B. Eweis (Editor) (1998) *Bioremediation Principals*, McGraw-Hill
6. Gareth M. Evans, Judith C. Furlong (2002) *Environmental Biotechnology : Theory and Application* John Wiley & Sons

MB 441 Special Topics in Cell and Molecular Biology (3 credits)
(Prerequisite: MB 311)
Cancer as a micro-evolutionary process; The preventable causes of cancer, Finding the cancer critical genes; The molecular basis of cancer cell behavior; Cancer treatment: present and future. Epidermis and its renewal by stem cells, Renewal by multi-potent stem cells: Blood cell formation; Fibroblasts and their transformations, stem cell engineering. Primordial germ cells and sex determination in mammals; Eggs; Sperm; Fertilization

Recemmended Texts:

1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (2007) *Molecular Biology of the Cell*, Garland Science.
2. Gerald Karp (2003) *Cell and Molecular Biology*. John Wiley & Sons, Inc.

MB 472 Scientific Writing and Research Methodology (3 credits)
Review of research area; introduction to project; types and purposes of project proposals; structure and components of proposal; covering letter and the recipients of the proposal; identifying, justifying and presenting a problem; literature review and development of proposal; time frame, resource identification and budgeting; research philosophy, responsible conduct of research, monitoring project progress, thesis writing, avoidance of plagiarism, indices to measure productivity of scientists and research organizations.

Recommended Texts:

1. Graustein, J.S. (2013) How to Write an Exceptional Thesis or Dissertation: A Step–By–Step Guide from Proposal to Successful Defense. Atlantic Publishing Group.
2. Schimel, J. (2011) Writing Sciences: How to Write Papers that get Cites and Proposal that get Funded. Oxford University press.
3. Locke, L.F., Spirduso, W.W., Silverman, S.J. (2013) Proposals that work: A Guide for Planning Dissertations and Grant Proposals, (Sixth Edition). SAGE publication.

MB 488 Biosafety Issues in Biotechnology (2 credits)
(Prerequisite: MB 322)
Status of molecular biotechnology in the world, use of genetically modified organisms in food industry and medicine, international treaties on biosafety such as Cartagena protocol, potential risks and their assessment, transgene introgression from genetically modified crops to their wild relatives (gene flow issues), the international guidelines for research involving recombinant DNA molecules, the release of genetically modified crops into the environment, food safety, biosafety framework for a country, the role of science in making informed decisions through transparent dialogues, globalization and the international governance of modern biotechnology for safe use.

Recommended Texts:

1. Ludlow, K., Smyth, S.J., Falck-Zepeda J. (2014) Socio-Economic Considerations in Biotechnology Regulation. Springer.
2. Grumet, R., Hancock, J.F., Maredia, K.M., Weebadde, C. (2011) Environmental Safety of Genetically Engineered Crops, Michigan State University Press, USA.
3. Knechtges, P.L. (2011) Food Safety: Theory and Practice. Jones and Bartlett Learning.

MB 489 Quantitative Genomics and Molecular Breeding (3 credits)
Advanced quantitative genetics and genomics, parametrical and non-parametrical statistical methods and related software, genome mapping and molecular markers, QTL theory, haplotype analysis, marker assisted selection as the basis of molecular breeding, association mapping, SNP platforms and GBS data, assessment and estimation of genomic diversity in germplasm conservation and management, definition of core-collections.

Recommended Texts:

1. Xu, S. (2013) Principles of Statistical Genomics, Springer.
2. Khatib, H. (2015) Molecular and Quantitative Animal Genetics, Wiley Blackwell.
3. Xu, Y. (2010) Molecular Plant Breeding, CAB International.

MB 490 Independent Study (1 credit)
The student will work on a selected molecular biology topic of interest under the guidance of a faculty member who agrees to supervise such work. Number of credits registered depends on degree of difficulty.

MB 491 Molecular Developmental Biology (3 credits)
Plant development; Arabidopsis as a model plant for plant molecular genetics, basic strategy and molecular mechanisms of sexual reproduction in flowering plants, germination, involvement of environmental and hormonal signals in coordinating developmental events of the seedlings, switch from meristematic growth to flower formation and cell signaling. Animal development; Basic anatomical features of animals, proteins mediating cell interactions and gene regulation, regulatory DNA, interactions between cells of embryo, inductive signals, asymmetric cell division, positive feedback, signaling pathways controlling developmental patterning, Caernorhabditis elegans as a model for the study of development, Drosophila and the molecular genetics of pattern formation, homeotic selector genes and the patterning of the anteroposterior axis, organogenesis and the patterning of appendages, cell movements and the shaping of the vertebrate body, mammalian development and neural development.

Recommended Texts:

1. Gilbert, S.F. (2013) Developmental Biology, (Tenth Edition). Sinauer Associates, Inc.
2. Moore, K.L., Cersaud, T.V.N., Torchia, M.G. (Eds) (2015). The Developing Human: Clinical Oriented Embryology (Tenth Edition). Elsevier.
3. Henning, L., Köhler, C. (Eds) (2010) Plant Developmental Biology: Methods and Protocols (Methods in Molecular Biology). Human Press.

MB 492 Applications of Nanobiotechnology (3 credits)
(Prerequisite: MB 322)
Nanobiotechnological applications in environment and food, applications in health and disease, lab on a chip concept, protein biomolecular motors, molecular nanosystems, nanobiosensors and their applications, nanoparticle based molecular labels, engineering gene circuits, nanopore methods for DNA detection and sequencing, nanodiamonds and its applications, nanomaterials for cell detection, nanomembranes, nanoparticles as non-viral transfection agents, nanoparticles for electrochemical bioassays, microbial nanoparticle production, Nanobiotechnologies in adult stem cell research, nanotechnology in tissue engineering, enzyme reactors based on nano-structured

materials, nanotoxicity, recent advances in Nanobiotechnology research and development.

Recommended Texts:

1. Mirkin, C.A., Niemeyer, C.M. (2004) Nanobiotechnology: Concepts, Applications and Perspectives, (First Edition). Wiley VCH.
2. Mirkin, C.A., Niemeyer, C.M. (2007) Nanobiotechnology II: More Concepts and Applications, (First Edition). Wiley VCH.
3. Vo-Dinh, T. (2007) Nanotechnology in Biology and Medicine: Methods, Devices and Applications, (First Edition). CRC Press.
4. Xie, Y. (2012) The Nanobiotechnology Handbook, (First Edition). CRC Press.
5. Nicolini, C. (Ed.) (2015) Nanobiotechnology in Energy, Environment and Electronics: Methods and Applications (Pan Stanford Series on Nanobiotechnology). CRC Press.

MB 495 Seminar (1 credit)
The student will present a seminar on a topic assigned by the advisor.

MB 499 Research Project (6-8 credits)
The student will carry out a research project under the supervision of a faculty member. The student is required to give a seminar on the project and submit a report.

SI 401 Industrial training (2 credits)

Each student will undergo full time training in the industry for the prescribed period on projects assigned by the industry. Students are required to have a duly maintained 'Daily Diary' which should be submitted to the Head of the Department within two weeks after completion of the training. In addition, the students are expected to write a report and make a presentation on the work carried out by them.

PHYSICS

100 LEVEL COURSES

PH 101 General Physics I (3 credits)
Mechanics: Laws of Motion, Work and Energy, Impulse, Momentum and Center of mass, Rotational Motion, Gravitation, Fluids, Special Relativity.
Thermal Physics: Kinetic theory and Thermodynamics.
Wave mechanics: Oscillatory and wave motion. Sound waves.
Optics: Interference, Diffraction, Polarization and Scattering of light. Lasers.

Recommended Texts:

1. Serway, R.A., *Physics for Scientists and Engineers* (2000), Saunders College Pub.
2. Resnik, R., Halliday, D.,and Walker, J., *Fundamentals of* Physics (2000), John Wiley & Sons. Inc. New York.
3. Tipler, P.A., *Physics for Scientists and Engineers* (2000), Worth Pub.

PH 102 General Physics II (3 credits)
Electrical and magnetic phenomena: Electric field, Magnetic field, Sources of Magnetic Field, Magnetism in Matter, Electromagnetic Induction, Transient Circuits and Alternative Currents.
Modern physics: Introductory Quantum Physics, Atomic Physics, Nuclear Physics, Elementary particles.
Molecules and Solids: Molecules, Solids, Properties of materials.

Recommended Texts:

1. Serway, R.A., *Physics for Scientists and Engineers* (2000), Saunders College Pub.
2. Resnik, R., Halliday, D.,and Walker, J., *Fundamentals of* Physics (2000), John Wiley & Sons. Inc. New York.
3. Tipler, P.A., *Physics for Scientists and Engineers* (2000), Worth Pub.

PH 103: Elementary Physics Laboratory I (1 credit)
Introduction to measurements and error analysis, Experiments related to mechanics, heat and sound

PH 104: Elementary Physics Laboratory II (1 credit)
Experiments related to electricity, magnetism and optics

200 LEVEL COURSES

PH 200 Mechanics and Fluid Dynamics (2 credits)
Coordinate systems, Inertial Frames, Newton's Laws of Motion, Central Forces, System of Particles, Rotating Coordinate Frames, Motion of Rigid Bodies,
Flow characteristics, Newtonian and Non-Newtonian fluids and Measurement of viscosity.

Recommended Texts:

1. French, A.P., *Mechanics* (1971), Massachusetts institute of Technology, U.K
2. Smith, P. and Smith, R.C., *Mechanics* (1990), John Wiley & Sons, 2nd ed
3. Massey, B.S., *Mechanics of Fuild*, ELBS

PH 205 Thermal and Statistical Physics (2 credits)
First and Second laws of Thermodynamics, Entropy, Thermodynamics potentials, Maxwell relations, First and second order phase transitions, Nernst postulates and its applications to solids, magnetic and electric systems, thermodynamics of dilute solutions, Gaussian reactions, adsorption.
Introduction to and applications of Statistical Methods, Classical Statistical Mechanics and Thermodynamics: Statistical equilibrium of a system, Partition function, Thermal equilibrium, Temperature and Zeroth law of Thermodynamics, Application to the ideal gas. Conservation of energy of a system of particles, Many particle systems, The First law of Thermodynamics, Entropy of a system in statistical equilibrium, Discussion of processes in terms of entropy; Quantum Statistics: Fermi - Dirac, Bose - Einstein Statistics, and their applications.

Recommended Texts:

1. Callen, H.B., *Thermodynamics* (1985), John Wiley & sons, 2nd ed.
2. Reif, F., *Fundamentals of Statistical Thermal Physics* (1965),McGraw-Hill,1st ed.

3. Alonso and Finn, *Fundamental University Physics (VolIII)* (1967), Addision-Wersley

PH 211 Vibrations and AC Theory (2 credits)

Free and Force Vibrations, Normal Modes, Progressive waves. AC generation, Series and Parallel LCR circuits, Mutual inductance and Transformers, Filters.

Recommended Texts:

1. French, A.P., *Vibrations and Waves* (1971), Chapman & Hall,1st ed
2. Pain, H.J., *The Physics of Vibrations and Waves* (2001), John Wiley & sons, 5th ed
3. Yarwood, J., *Electricity and Magnetism*

PH 230 Quantum Mechanics and Atomic Physics (2 credits)

Failure of classical physics, Schrodinger's equation and its applications: ex: proton beam in a cyclotron; electron conduction in metal; alpha emission, electron scattering from negative ion core; quantum well, infrared detectors and neutrons inside nucleus; simple harmonic oscillator: lattice vibrations. Hydrogen atom: Out line of the solution in spherical polar coordinates, spherical harmonics, wave functions, energy levels, selection rules. Hydrogen-like atoms, alkali atoms; spin and angular momentum: L-S coupling, selection rules; fine and hyperfine structure, Effect of external fields: Electric and Magnetic, Applications: stimulated emission, laser, periodic table.

Recommended Texts:

1. Resnik, Robert and Halliday, David, *Basic Concepts in Relativity and Early Quantum Theory* (1992), Macmillan Publising Compund, 2nd ed., USA
2. Constantinescu, F. and Magyari, E., *Problems in Quantum Mechanics* (1971), Pergamon press
3. Thomas, Albert and Fromhold Jr, *Quantum Mechanics for Applied Physics and Engineering*

PH 240 Introductory Solid State Physics (2 credits)

Crystal Structure, Experimental Determination of Structures, Crystal Defects, Lattice vibrations, heat capacity of solids; Electron in solids.

Recommended Texts:

1. Kittel, C., *Introduction to Solid State Physics* (1996), John Wiley & sons, 7th ed
2. Srivastava, J.P., *Elements of Solid State Physics* (N.A), PHI, India
3. Omar, Ali, *Elementary Solid State Physics* (1975),Addision-Wesley publishing

PH 245 Electronics Theory I (2 credits)

Circuit analysis, Diodes and Transistors, Operational amplifier. Digital Electronics, Combinational & Sequentional logic: ROM; PROM; EPROM; EEPROM; PALs and PLAs, registers, RAMs; digital communication basics; sequential ICs, Counters.

Recommended Texts:

1. Horowitz, P. and Hill,W., *The Art of Electronics 2nd ed.* (1989),Cambridge uni. press, 2nd ed
2. Malvino, A. P, *Electronics Principles 5th ed* (1953), McGraw-Hill

PH 261 Medical Physics (2 credits)

Biomechanics of the human body: forces on and in the body, metabolism and energy balance of the body, fluid dynamics of the human circulatory system; Physics of the

cardiovascular system and cardiovascular instruments: mechanics of cardiac contraction, pressure volume curves, ECG, pacemakers, defibrillators; Fiber optics in medicine: physics of fiber optics, endoscopes; Laser in medicine: physics of Laser, Laser treatment, Laser safety; Physics of diagnostic techniques: ultrasound imaging; Nuclear medicine and Radiation physics: properties of nuclear radiation, radioisotopes for nuclear medicine, radiopharmaceuticals, nuclear medicine instrumentation, radiation dosimetry, radiation protection.

Recommended Texts:

1. P. Davidovits (2001) *Physics in Biology and Medicine*, Harcourt/Academic
2. R.K. Hobbie (1997) *Intermediate Physics for Medicine and Biology*, Springer.
3. J.R. Cameron, J.G. Skofronic and R.M. Grant (1999) *Physics of the Body*, Madison: Medical Physics Publishing
4. R.S. Khandpur (2003) *Hand book of Biomedical Instrumentation*, Tata McGraw-Hill.
5. J.G. Webster (1998) *Medical Instrumentation: Application and Design*, Houghton Mifflin.

PH 262 Energy, Weather and Environment (2 credits)

Environmental Pollution: Air, Noise, and Radiation. Energy: socio-economic importance of energy: renewable and non-renewable energy sources, impact on environment. Atmosphere; composition, evolution, thermal structure, radiation; solar and terrestrial, global warming, atmospheric dynamics and circulation, monsoons. Clouds, turbulence, Atmospheric waves, modeling, climate atmospheric measurements.

Recommended Texts:

4. Kraushaar, J. J. and Ristinen , R. A., *Energy and Problems of a Technical Society*.
5. Moran, J. M. and Morgan, M. D., *Meteorology*
6. Haughton, John T., *The Physics of Atmospheres, 2nd Ed.,* (2001), Cambridge uni. press, 2nded

PH 263 Introductory Astronomy (2 credits)

Astronomy before and after Copernicus; gravity; light and telescopes; solar system; properties, formation and evolution of stars; star systems; Milky Way and galaxies; galaxy clusters; cosmology.

Recommended Texts:

1. Fox, John D, *Astronomy: Journey to the Cosmic Frontier* (1995), Mcgraw -Hill
2. Zeilik, Michael and Gregory, Stephen A., *Introductory Astronomy and Astrophysics* 4th Ed. (1998), Saunders college publishing, 4thed

PH 280 General Physics Laboratory I (1 credit)

(Prerequisites: PH 103, PH 104)

Experiments related to the advanced mechanics, elasticity, surface tension and viscosity

PH 281 General Physics Laboratory II (1 credit)

(Prerequisites: PH 103, PH 104)

Experiments related to the rotational motion and properties of materials

PH 285 Electronics Laboratory I (1 credit)

(Prerequisite: PH 245)

Available only for maximum of 60 students who have performed well in PH245

300 LEVEL COURSES

PH 304 Relativity (2 credits)
Background, Postulates of Special Relativity, Derivation of Lorentz Transformation equations, Consequences of LT Equations. Relativistic Dynamics, Relativity and Electromagnetism, Invariance of Maxwell's equations, Possible limitation of special relativity; Special Topics: Geometric representation of space-time; Solutions of twin paradox; Principle of equivalence and General Relativity.

Recommended Texts:

1. Resnick, Robert, *Introduction to special Relativity* (1968), John Wiley & sons
2. French, A.P., *Special Relativity* (1990), Chapman & Hall, 2nd ed

PH 313 Physical Optics and Optical instruments (2 credits)
Interference, Diffraction, Polarization, Lasers. Introduction to optical Instruments: Holography, Opticall spectroscopy, Fibre optics: Optical fibers and their importance, Different types, Inter model dispersion, Fiber modes, signal attenuation, Basics of optical fiber communications; Display devices: Neon displays, Cathode ray tube, liquid crystals, LED's, Electrocrhromic and photochromic, devices, Laser writing and reading.

Recommended Texts:

1. Jenkins, F.A. and White, H.E., *Fundamentals of Optics* (1975), McGraw-Hill, 3rd ed
2. Longhurst, R.S., *Geometrical and Physical Optics* (1967, 1973), Longman, 3rd ed
3. Fowles, G.R., *Modern Optics* (1989), Dover publications, 2nd ed, New York

PH 323 EM Waves and Communication (2 credits)
Summary of vector algebra. Maxwell's equations, Properties of plane e-m waves in free space, Poynting's theorem, Waves in ponderable media, Radio and TV transmission. : polarization of em waves, dipole antennas, wireless communications, transmission line theory and concepts, antennas and equivalent principles.

Recommended Texts:

1. Lorrian and Carson, *Electromagnetic fields and Waves* (1988),W.H. Freeman company, 3rd ed
2. Kong, J.A., *Electromagnetic Wave Theory*, EMW 2000.
3. Griffiths, David J., *Introduction to Electrodynamics* (!989), Prentice Hall, 2nd ed

PH 333 Introductory Nuclear Physics (2 credits)
Compulsory for Special Degree
***Distribution of Nuclear matter*:** α -particle scattering: Rutherford's formula, differential cross-session; other experimental evidence for the nuclear structure; nuclear density variation; nuclear radius; skin thickness; ***Nuclear Binding energy*:** neutron and proton separation energies; features of binding energy curve; liquid drop model; semi empirical mass formula; nuclear stability of isobars; ***Nuclear Reaction*:** reaction energy; threshold energy; exothermic and endothermic reactions; ***Nuclear Decay*:** conservation laws; α -decay: basic α-decay processes, energy release, theory of α-emission; β-decay: basic β-decay process, energy release, β-spectrum, neutrino, electron capture; γ-decay: nuclear excited states, internal conversion, isometric states; ***Nuclear Fission*:** spontaneous fission, activation energy, explanation using semi empirical formula, induced fission, mass distribution of fragments, energy released, neutrons emitted, chain reaction, fission

reactors; ***Nuclear Fusion*****:** basic process, characteristics of fusion thermonuclear fusion, fusion reactors.

Recommended Texts:

1. Krane, K.S., *Introductory Nuclear Physics* (1998), John Wiley & sons
2. Evans, *Introduction to Nuclear Physics*.
3. Burcham, *Nuclear Physics* (1995), Longmn group limited, U.K

PH 341 Semiconductor Physics and Devices (2 credits)

Conductors, insulators and semiconductors, thermal equilibrium, carrier life time, diffusion, mobility and its measurements; Band structure in semiconductors, Semiconductor junctions: theory of p-n junction, capacitance, work function, Schottky barriers, avalanche and Zener breakdown, homo and hetero junctions, ohmic contacts, thermionic emission; Introduction to Simple devices and Fabrication: LED, Solar cell, and LSR. Elemental semiconductors, III-IV, II-VI and ternary compounds; Growth and characterization of semiconductor materials. Bipolar transistor, JFET, and MOSFET. Optical Devices: Photodetectors, Photodiodes, LEDs, Laser diodes, Solar cells and Quantum well devices.

Recommended Texts:

1. Sze, S.M., *Physics of Semiconductor Devices* (1981), John Wiley & sons, 2nded
2. Neamen, D.A.,*Semiconductor Physics and Devices* (1992), Richard D.Irwin,U.S.A
3. Allison, E*lectronic Engineering Materials and Devices*.

PH 345 Electronics Theory II (2 credits)

(Prerequisites: PH245, PH285)

Advanced BJT circuits, Ebers-Moll equation. Differential amplifier; G_{diff}, G_{CM}, CMRR, dc amplifier, current mirrors and applications, power amplifiers; Miller effect; bootstrapping; Field Effect Transistor; JFET; I_C, V_{DS} characteristics, comparison with BJT, FET current source; FET amplifiers; FET as a variable resister; , FET switches; multiplexes, sample and hold, MOSFET logic switches; PMOS, NMOS, CMOS, CMOS inverter, CMOS logic gates, NAND and NOR circuits, MOSFET power switching; Op Amp; logarithmic amplifier, Schmitt trigger, op amp departure from ideal; instrumentation amplifier; power supplies; ac-to-dc conversion, IC regulators, switching regulators, dual power supplies, dc-to-dc conversion; batteries, solar cells; oscillators; relaxation oscillator, sinusoidal , Wien bridge, LC , IC and crystal oscillators, timer chip 555; unwanted oscillations in electronic circuits, phase-locked loops, Integrating logic families.

Recommended Texts:

1. Horowitz, P. and Hill,W., *The Art of Electronics* 2nd ed. (1989),Cambridge Uni. Press, 2nd.
2. Malvino, A.P., *Electronics Principles* 5th ed. (1953), McGraw-Hill
3. Lenk, J.D., *Simplified Design of Linear Power Supplies*.

PH 350 Microstructure and Properties of Materials (2 credits)

(Prerequisite: PH240)

Structure–Property relations, Elastic and plastic behaviour, microplasticity of single crystals, behaviour of polycrystalline materials; fracture and creep theories. Mechanical testing of materials, Microstructure and properties, phase diagrams, phase equilibria, nucleation and growth, non-equilibrium phase transformation, some commercial alloy and ceramic systems.

Recommended Texts:

1. Lovell, M., Avery, A. and Vernon, M., *Physical Properties of Materials*.
2. Moffat, W.G., Pearsall, G.W. and Wulff, J.,*The Structure and Properties of Materials.*
3. Bolton, W., *Engineering Materials Technology* (1998), Butterworth-Heinemann, 3rd ed.

PH 361 Biophysics (2 credits)

Cell: introduction to cell, biopolymers, biomembranes, Biophysics of transport of matter in biosystems: diffusion, Fick's law, diffusion through membranes, compartment systems, flow of fluids, Stokes's law, Hagen-Poiseuill's law, Reynolds number; Thermodynamics of biosystems: equilibrium thermodynamics, Gibbs free energy, chemical potential; Neurobiophysics: neurons, membrane potential, transference equation, electric analog of membrane, nerve excitation, action potential, conduction of action potential; Bioenergetics: photosynthesis; Radiation biology: biological effects of radiation, ionization radiation and biomaterials, radiation safety.

Recommended Texts:

1. W.Hoppe, W. Lohmann (1983) *Biophysics*, Springer-Verlag Berlin Heidelberg.
2. M.J. Cotterill (2002) *Biophysics: An Introduction*, JOHN Wiley & Sons Ltd.
3. P.K. Srivastava (2005) *Elementary Biophysics*, Narosa Publishing House.
4. R. Glaser (1996) B*iophysics,* Springer-Verlag Berlin Heidelberg.

PH 363 Astrophysics (2 credit)

(Prerequisite: PH 263)

Basic Theoretical ideas and observational data on star formation; Nucleosynthesis inside stars; end states of stellar evolution, a brief discussion on extragalactic astronomy, the space time dynamics of the universe; thermal history of the universe.

Recommended Texts:

1. Choudhuri, A.R. (2010). *Astrophysics for Physicists*, Cambridge Press.
2. Carroll, B.W. & Ostlie D.A. (2007) *An Introduction to Modern Astrophysics*, 2nd edition, Addison Wesley.
3. Kippenhahn, R. & Weigert A. (1990) *Stellar Structure & Evolution*, Springer-Verlag, Berlin.

PH 365 Modern Particle Physics (2 credits)

Introduction to Elementary particles, units and interactions in particle physics, Classification of particles: fermions and bosons, Introduction to the Standard model: quarks, leptons and fundamental forces, Quarks and Leptons: properties and quantum numbers of quarks and leptons, Space-time symmetries: Noether's theorem, conservation laws, CPT theorem, Kinematics: introduction to four vectors, kinematics of two-body interactions, Wave equations: Klein-Gordon equation, Dirac equation, interpretation of antiparticle, Feynman diagrams, Feynman rules, Quark Model: the eightfold way, classify hadrons in Y-I_3 diagrams, quark model, hadron masses in quark model, QCD: introduction to QCD, degrees of freedom, colour and colour confinement, perturbation and non-perturbation regimes in QCD, perturbative expansions in QCD, Experimental techniques: particle accelerators and detectors.

PH 366 Physics of Atmosphere, Weather and Climate (2 credits)

The atmosphere: Thermal structure of the atmosphere, Ozone and ozone hole, Atmospheric dynamics: Momentum equation, Hydrostatic equation, Horizontal equation

of motion, Atmospheric radiation: Effect of Earth's curvature, Radiation balance, planetary albedo, Greenhouse effect, Global warming and Climate change, International conventions and protocols on global warming, Atmospheric circulation, General circulation of the larger atmosphere, Atmospheric stability, Lapse rate, Water in the atmosphere, Weather systems and climate, Classification of climates, Effects of continents and oceans on weather, Thunderstorms and lighting: Life cycle of a thunderstorm, Electrification of thunder cloud, Lightning and lightning protection, Local Circulations, Atmospheric boundary layer and air pollution, El-Nino Southern Oscillations (ENSO), Atmospheric Modeling, Weather forecasting

PH 370 Mathematical Methods in Physics (2 credits)
Vectors, coordinate systems, determinants; matrices; infinite series; Ordinary differential equations, Method of Lagrange multipliers; Legendre transformations. Functions of complex variables; Partial differential equations; Legendre, Bessel, Hermite, Laguerrer and Special functions; Fourier series ; Integral transformations: Laplace and Fourier transformations; Green's function; Calculus of variations, Tensors.

Recommended Texts:

1. Arfken, George B., *Mathematical methods for Physicists* (1995),Academic press,2nded
2. Boas, Mary L., *Mathematical Methods in the Physical Science* (1993), John Wiley & sons, 2nded

PH 373 Computational Physics (2 credits)
Basic mathematical operations, ordinary differential equations, boundary value and eigan value problems, special functions of Gaussian quadrature, partial differential equations, Monte Carlo methods.
Recommended Text:

1. Koonin, Steven E.,*Computational physics* (1986), Addision -Weley pub.

PH 374 Experimental Techniques and Material Characterization (2 credits)
Introduction to experimentation, Topics of current interest: High vacuum techniques, cryogenics: Electron microscopy: SEM and TEM, Analytical microscopy; XRD, XRF, SIMS, AES etc. Optical Techniques: Optical reflectivity, Absorption and Modulation techniques, Monochromators and Spectrophotometers. FTIR and Raman techniques; Electrical Techniques: Electrical conductivity, Four probe method, Impedance analysis, I-V, C-V techniques. Thermal techniques.

Recommended Texts:

1. Preston,D.W and Dietz,E.R., *The Art of Experimental Physics*
2. Baird,D.C., *Experimentation: An Introduction to Measurement theory and Experimental Design*
3. Grundy, P.J. and Jones, G.A., *Electron Microscopy and the Study of Materials*

PH 375 Nanoscience (2 Credits)
(Prerequisites: CH 231 or PH 230)
Introduction: Why size matters, Units Review. ***The Scaling Laws:*** How size alters the dynamics of electricity, optics, heat transfer. ***Scanning Probe Microscopy:*** Atomic Force Microscopy, Dipole-dipole interaction, Laser-detecting mechanism, Force-distance curves, Scanning Tunneling Microscopy, Tunneling mechanism, Imaging atoms, Lithography. ***Carbon Nanotubes:*** Fabrication and Characterization, Electronic structure, Optical and mechanical properties, Examples of applications using nanaotubes.

Quantum Dots: Schrodinger's Equation for confined systems, Electronic states and transitions, Density of states, Plasmon resonance in metallic dots, Fabrication methods, Applications of quantum dots in optics, electronics & Biology. ***Self Assembly:*** Thermodynamics of self-assembly, Examples of self assembly on silicon and gold substrates, Soft lithography, Porous materials, Optical anisotropy and its detection. ***Photonic Crystals:*** Maxwell's equations for periodic structures, Dispersion relationship, Growth and Characterization, Opals and inverse-opals, Defect-layer based structures.

Recommended Texts:

1. The Physics and Chemistry of Nanosolids, Frank Owens and Charles Poole, John Wiley, 2008
2. Fundamentals of Nanoelectronics, George Hanson, Pearson, 2008
3. Nano-The Essentials, T. Pradeep, McGraw Hill, 2008

PH 380 General Physics Laboratory III (1 credit)
(Prerequisites: PH 103 & PH 104)
Advanced optics, electricity and magnetism experiments

PH 381 General Physics Laboratory IV (1 credit)
(Prerequisites: PH 103 & PH 104)
Compulsory only for General degree students who are not offering Electronics Laboratory-I
Advanced optics and electricity experiments

PH 383 Advanced Physics Laboratory I (2 credits)
(Prerequisites: PH 280 & PH 281)
Special degree advanced physics experiments. Experiments under special topics in physics

PH 384 Advanced Physics Laboratory II (2 credits)
(Prerequisite: PH 383)
Special degree advanced physics experiments. Experiments under special topics in physics

PH 385 Electronics Laboratory II (1 credit)
(Prerequisites: PH 245, PH 285)

PH 392 Seminar (1 credit)
A student is expected to carry out an extensive literature survey on a topic assigned to him/her by a senior faculty member. At the completion of the project the student is expected to write a report of not less than twenty pages and make a presentation.

PH 395 Industrial Training (1 credit)

HR 301 Human Resource Management (2 credits)
Introduction: Defining the Role, Importance and Challenges of HRM; Historical Development of HRM. Approaches of HRM; HRM and Personnel Management, Roles of HR Managers, Strategic Orientation of HRM. Brief Introduction to HRM Functions: Job Design, Job Analysis, HR Planning, Attraction, Selection, Recruitment, Induction, Training and Development, Career Development, Performance Management, Knowledge

Management, Salary Administration, Employee Movements, Labor Relations, Discipline Handling, Managing Health and Safety, Grievance Handling and Reward Management.

Recommended Texts:

1. Mathis, R.L., Jackson, J.H., Valentine, S.R. (2013) Human Resource Management, 14th Edition, CENGAGE Learning.
2. Dessler, G. (2012) Human Resource Management, 14th Edition, Pearson.
3. Nkomo, S.M., Fottler, M.D., McAfee, R.B. (2010) Human Resource Management Applications: Cases, Exercises, Incidents, and Skill Builders, 7th Edition, CENGAGE Learning.

400 LEVEL COURSES

PH 403 Classical Mechanics (2 credits)

(Prerequisite: PH 200)

Rotating coordinate systems, Motion of rigid bodies, Principle of least action and the derivation of Langrangram equations of motion. Applications. Galilean transformation and Lagrangian for a (i) free particle and (ii) system of particles; Mechanical similarity and viral theorem; conservation laws and symmetries in nature; constraints and method of Lagrange's undetermined multipliers; generalized force and generalized momentum; Hamiltonian and Hamiltonian equations of motion; simple application; Poisson bracket, Ehrenfert's theorem and integrals of motion; canonical transformations; Hamilton - Jacobi equation; adiabatic invariance and canonical variables.

Recommended Texts:

1. Landan, L. & Lifshtz, E M, *Mechanics* (1976), Pergamon press ltd, 3rd ed
2. Goldstein, *Classical Mechanics* (1980), Addision-Wesley publishing, 2nd ed
3. Desloge, *Classical Mechanics* (1982), John Wiley & sons, vol 1,2,3

PH 406 Statistical Physics (2 credits)

(Prerequisite: PH 205)

Introduction and Review: classical & quantum mechanics; thermodynamics; mathematics: probability distribution, binomial and multinomial distributions, Lagrange multipliers, binomial distribution at large numbers; Canonical and other Ensembles, fluctuations. Boltzmann, Fermi-Dirac and Bose-Einstein statistics, ideal monatomic and diatomic gases; Quantum statistics: weakly and strongly degenerate ideal Fermi-Dirac gas; photons;

Crystals: vibrational spectrum of monoatomic crystal; Einestein and Debye theories of heat capacity; phonons; point defects; Imperfect gases: Virial equation, Special Topics: Brownian motion; correlation functions; transport phenomena.

Recommended Texts:

1. Mc Quarrie, Donald A ., *Statistical Mechanics* (1973,1976), Hanper Colling Publishing
2. Reif, F., *Fundamentals of Statistical & Thermal Physics* (1965), McGraw Hill

PH 414 Lasers (1 credit)

Introduction: Properties of lasers, Stimulated emission, Population inversion, Amplification in a medium, Einstein coefficients; Laser Oscillation: Optical resonators, Concave mirrors and Brewster's windows, Resonant cavities, Coherence length, Frequency doubling; Types of Lasers: Gas lasers, He-Ne laser, Argon laser, Molecular

laser, CO_2 laser, Solid state laser, Ruby laser, Nd-glass laser and other lasers; Laser Applications and Laser safety.

Recommended Texts:

1. Lengyel, B.A., *Introduction to Laser Physics* (1966), John Wiley
2. Marshall, S.L., *Laser Technology and Applications*.

PH 422 Magnetic Materials (2 credits)

(Prerequisite: PH 240)

Atomic theory of magnetism, Diamagnetism, Paramagnetism, Ferromagnetism and Antiferromagnetism. Ferromagnetic Domains, Application of ferromagnetic materials: magnetic bubbles and their uses; Magnetic resonance: paramagnetic resonance and the maser; magnetic relaxation; nuclear magnetic resonance (NMR); ferromagnetic resonance and spin waves.

Recommended Texts:

1. Ashcroft, N.W. and Mermin, N.D., *Solid State Physics* (1976), Saunders college publishing
2. Omar, M.Ali., *Elementary Solid State Physics* (1975), Addision-Wesley pubilishing com
3. Crangle, J., *Magnetic Properties of Solids* (1977), Edward Arnold

PH 423 Electromagnetic Theory (2 credits)

(Prerequisite: PH 323)

Electrostatics, Magnetostatics, Maxwell's Equations, Wave equation for Ø and A, Lorentz condition and gauge transformations; Poynting's theorem and Poynting's vector; electromagnetic momentum, Plane Electromagnetic Waves and Wave Propagation, Wave Guides and Transmission Lines, Generation of E.M. Waves.

Recommended Texts:

1. Grants and Phillip, *Electromagnetism* (1975), John Wiley & sons, 3rd ed
2. Griffiths, David J., *Introduction to Electrodynamics* (1989), Prentice Hall, 2nd ed.
3. Jackson, J.D., *Classical Electrodynamics* (1975), John Wiley & sons, 2nd ed

PH 430 Quantum Mechanics I (3 credits)

(Prerequisite: PH 230)

Review of Classical Mechanics, Hilbert space formalism of quantum mechanics. Schordinger, Heisenburg, and Interactive pictures. Wave mechanics in one, two, and three dimensions. Harmonic oscillator and Creation & annihilation operators, Angular momentum and Ladder method, Pauli's theory of spin, Total angular momentum.

Recommended Texts:

1. Weider, Sol., *The Foundation of Quantum Theory(1973)*, Academic Press, Inc.
2. Series, Schaume .,*Quantum Mechanics* (1998), Schaum's outlines
3. Tanuigi, Cohen., *Quantum Mechanics*, (1977), John Wiley & sons, volume I

PH 431 Quantum Mechanics II (2 credits)

(Prerequisite: PH 430)

Methods of Approximation: Time independent and dependent perturbation theory, radiative transitions and Einstein coefficients. Variational technique, WKB approximation. Theory of scattering and many particle systems.

Recommended Texts:

1. Weider, Sol., *The Foundation of Quantum Theory*.
2. Tanuigi, Cohen., *Quantum Mechanics*, (1977), John Wiley & sons, volume I

PH 433 Nuclear and Reactor Physics (3 credits)
(Prerequisites: PH 230, PH 333)
Nuclear Properties; Nuclear force, Nuclear models, Nuclear reactions. Neutron Sources, Neutron Interactions, Energy loss in scattering collisions, Neutron Diffusion and Moderation, Nuclear Reactor Theory, Time-Dependent Reactor: Reactor kinetics: prompt neutron lifetime and mean diffusion time of thermal neutrons. Reactors with and without delayed neutrons; Reactor with delayed neutrons. Reactivity equation. The prompt critical state; the prompt jump (drop). Reactor control: control rods and chemical shims; Rod worth; Temperature effects on reactivity.

Recommended Texts:

1. Krane, K.S., *Introductory Nuclear Physics* (1998), John Wiley & sons
2. Evans, *Introduction to Nuclear Physics*.
3. Burcham, *Nuclear Physics* (1995), Longman group limited

PH 436 Radiation Detection and Measurement (2 credits)
(Prerequisite: PH 333)
Radiation Sources and Interactions, Counting Statistics, General Properties of Radiation Detectors, Radiation Detectors: ionization chambers; proportional counters; Geiger-Mueller counters; G-M survey meter; Scintillation detectors; Semiconductor detectors; Miscellaneous detectors: Cerenkov detector, Superconducting detectors, Photographic emulsions; Thermoluminescent dosimeters; Neutron detection by activation.

Recommended Texts:

1. Knoll, Glenn F. *Radiation Detection and Measurement - 2nd edition (1989),* John Wiley & sons
2. Leo, W.R., *Techniques for Nuclear and Particle Physics Experiments, 2nd edition.*
3. Hemingway, G.G.J., *Practical Gamma-Ray Spectrometry* (1995), John Wiley & sons

PH 440 Solid State Theory (3 credits)
(Prerequisite: PH 240)
Classical and quantum free electron models, Failures of free electron models, Review of crystal lattices and X-ray crystallography, Electrons in a periodic potential, Bloch's theorem, Nearly free electron model, Band gaps, Band structures, Fermi surfaces, Tight binding model, Empty lattice model, Semiclassical model of electron dynamics, Semiclassical motion under external electric and magnetic fields, Effective band mass, Concept of holes, Cyclotron motion, Measuring the Fermi surfaces, Landau levels, de Hass-van Alphen effect, Quantum Hall effect, Lattice Dynamics, Phonon modes, Superconductivity, Type I and Type II superconductors, Cooper pairs and BCS theory.

Recommended Texts:

1. Kittel, C., 7^{th} *edition of Introduction to Solid State Physics* (1996), John Wiley & sons
2. Ashcroft, N.W. and Mermin, N.D., *Solid State Physics* (1976-Saunders College Publishing Co.)
3. Omar, Ali., *Elementary Solid State Physics* (1975), Addision-Wesley Publishing Co.
4. Myers, H.P., 2^{nd} edition of Introductory Solid State Physics (1997), Taylor and Francis Publishers.

PH 445 Electronics Theory III (2 credits)

(Prerequisite: PH 345)

Gates and flip flops combined, Logic pathology, Logic families; RTL, DTL, TTL, CMOS, etc., TTL/CMOS characteristics, TTL/CMOS interfacing, Opto electronics; LED's CCD's, 7-segment, 16-segment and 5x7 dot matrix displays, driving LED displays, opto couplers; Data acquisition; sample and hold, noise and signal processing; A/D and D/A conversions, Digital filters; microprocessors and micro computers; computer architecture, microprocessor support chips, processor example, programmed input/output interrupts, bus signals and interfacing, data communication concepts; Project; design and construction of a practical electronic circuit

Recommended Text:

1. Horowitz, P. and Hill, W., *The Art of Electronics* (1989) , Cambridge uni.press, 2^{nd} ed

PH 454 Solid State Ionics & Devices (2 credits)

Ionic conductivity and solid electrolytes, point defect notation, type of defects, ionic mobility in solids, theoretical explanation of ionic conductivity, Arrhenius relationship, requirements for high ionic conductivity, types of solid electrolytes, some representative examples, composite electrolytes, polymer electrolytes, glassy electrolytes, ionic conductivity measurement, complex impedance technique, transference number and d.c. polarisation, intercalation compounds, solid state batteries, fuel cells, sensors, electrochromic devices

Recommended Texts:

1. West, A.R., *Solid State Chemistry* (1984), John Wiley & sons
2. Chandra, S., *Superionic Conductors* (1981), North-Holland Publishing company

PH 455 Polymer Physics (2 credits)

History of the development of synthetic polymers; chemical nature of polymers; Classification of polymers: Thermoplastic versus thermoset polymers, amorphous versus crystalline polymers molecular sizes and shapes and ordered structures; Distributions of molar mass and their determination, Bonding and the shapes of molecules, Conformations and chain statistics, The single freely jointed chain more realistic chains, the excluded-volume effect, Chain flexibility and the persistence length, Evidence for ordered structures in solid polymers, Morphology: crystallinity, orientation; Mechanical Properties: strength, modulus, elongation, hardness; Thermal properties: glass transition temperature, heat capacity, thermal conductivity, thermal expansion coefficient Optical properties: light transmission, refractive index; Electrical properties: surface and volume resistivity, dielectric constant, electronic conductivity, ionic conductivity, piezoelectric. Differential scanning calorimetry (DSC) and differential thermal analysis (DTA), Density measurement, Light scattering, X-ray scattering, Infrared and Raman spectroscopy, NMR technique, Optical and electron microscopy. Applications of polymers, processing, environmental issues and recycling.

Recommended Texts:

1. Bower, D.I., *An Introduction to Polymer Physics*, Cambridge Univ. Press
2. R.J. Young & P.A. Lovell, *Introduction to Polymers, 2^{nd} Ed*., Chapman & Hall, UK
3. P.C. Painter & M.M. Coleman, *Fundamentals of Polymer Sciences, 2^{nd} Ed*. Technomic Pub. Co. Inc, USA.(1997)
4. J.W. Nicholson, *The Chemistry of Polymers*, Royal Society of Chemistry, UK.

PH 456 Nuclear Magnetic Resonance (NMR) (2 Credits)

***Introduction*:** NMR, NMR Spectroscopy , Units Review ***The Mathematics of NMR*:** Exponential Functions, Trigonometric Functions, Differentials and Integrals, Vectors , Matrices, Coordinate Transformations, Convolutions, Imaginary Numbers, The Fourier Transform, ***Spin Physics*:** Spin, Properties of Spin, Nuclei with Spin, Energy Levels, NMR Transitions, Energy Level Diagrams, Continuous Wave NMR Experiment, Boltzmann Statistics, Spin Packets, T1 Processes, Precession, T2 Processes, Rotating Frame of Reference, Pulsed Magnetic Fields, Spin Relaxation, Spin Exchange, Bloch Equations ***NMR Spectroscopy*:** Chemical Shift, Spin-Spin Coupling, Time Domain NMR Signal, +/- Frequency Convention ***Fourier Transforms*:** Introduction, The + and - Frequency Problem, The Fourier Transform, Phase Correction, Fourier Pairs, The Convolution Theorem, The Digital FT, Sampling Error, The Two-Dimensional FT ***Pulse Sequences*:** Introduction,90-FID,Spin-Echo,Inversion Recovery ***NMR Hardware*:** Hardware Overview, Magnet, Field Lock, Shim Coils, Sample Probe, RF Coils, Gradient Coils, Qadrature Detector, Digital Filtering, Safety ***Practical Considerations*:** Introduction, Sample Preparation, Probe Tuning, Determining a 90^{o} Pulse, Field Shimming, Phase Cycling, 1-D Hydrogen Spectra, Integration, SNR Improvement, Variable Temperature, Troubleshooting, Cryogen Fills ***Carbon-13 NMR*:** Introduction, Decoupling, Population Inversion, NOE, 1-D Spectra ***2-D Techniques*:** Introduction, J-resolved, COSY, Examples ***Advanced Spectroscopic Techniques*:** Introduction, Diffusion, Spin Relaxation Time, Solid State, Microscopy, Solvent Suppression, Field Cycling NMR

Recommended Texts:

1. Principles of Nuclear Magnetic Resonance in One and Two Dimensions, Richard R. Ernst, Oxford University Press, 1990
2. Basic One- and Two-Dimensional NMR Spectroscopy, Horst Friebolin, Wiley-VCH, Weinheim, 2005
3. A Handbook of Nuclear Magnetic Resonance, Ray Freeman, Longman 1997

PH 457 Advanced Nanoscience (2 credits)

(Prerequisites: PH 375)

Photonic Crystals: Theory of Periodic Structures, Dispersing Relationships, Band Structures, Growth, Devices, *Confined Electronic Systems:* Quantum Dots, Plasmon, STM & AFM, *Molecular Electronics:* Wires, Insulators, Diodes, Switches, Measuring Resistance, *Nanoscale Electronics:* Coulomb Blockage, Single Electron Transistors, Nanocapacitors, Quantum Cellular Autamata, *Spintronics:* Spin Transport, Giant Magnetoresistance, Diluted Magnatic Semiconductors, Quantum Computing.

Recommended Texts:

1. The Phisics and Chemistry of Nanosolids, Frank Owners and Charles Pool, John Wiley, 2008
2. Fundermentals of Nanoelectronics, George Hanson, Pearson, 2008

PH 458 General Relativity (2 credits)

(Prerequisites: PH 370)

Tensor calculus on manifolds; the equivalence principle and space time curvature; The gravitional field equations and their structure; The Schwarzschild geometry and experimental tests of general relativity; Linearized gravity and gravitational waves; The Friedman-Robertson-Walker Geometry and cosmological models.

Recommended Texts:

1. Narlikar, J. (2010) *An Introduction to Relativity*, Cambridge Press.

2. Hobson, M.P., Efstathiou, G.P. & Lasenby, A.N. (2006) *General Relativity*, Cambridge Press.
3. Foster, G. & Nightingale, J.D. (2006). *A Short Course in General Relativity*, 3rd edition, Springer-Verlag.
4. Begelman, M. & Rees, M. (2010) *Gravity's Fatal Attraction*, Cambridge Press.

PH 481 Advanced Physics Laboratory III (4 credits)
(Prerequisites: PH 381 & PH 382)

PH 486 Nuclear Physics Laboratory (2 credits)
(Prerequisite: PH 436)
An introduction to the devices and techniques most common in nuclear measurements. Topics include the principles of operation of gas-filled and scintillation detectors for charged particle, gamma ray and neutron radiations. Techniques of pulse shaping, counting, and analysis for radiation spectroscopy. Timing and coincidence measurements.

PH 487 Investigation Laboratory (1 credit)
Advanced physics practicals related to the research areas; solid state ionics, semiconductors, ceramics, nuclear physics and electronics

PH 491 Research Project (6-8 credits)
A student is expected to carry out an independent research project on a topic assigned to him/her under the supervision of a senior faculty member. At the completion of the project the student is expected to write a report and make a presentation.

PH 493 Independent Study (1 credit)

PH 496 Laboratory Teaching course (1 credit)
This teaching course is available for a fourth year Physics Special student selected by the Department of Physics. The course involves laboratory teaching (one laboratory class per week) in an undergraduate laboratory for one semester.

SI 401 Industrial training (2 credits)
Each student will undergo full time training in the industry for the prescribed period on projects assigned by the industry. Students are required to have a duly maintained 'Daily Diary' which should be submitted to the Head of the Department within two weeks after completion of the training. In addition, the students are expected to write a report and make a presentation on the work carried out by them.

STATISTICS

100 LEVEL COURSES

ST 101 Introduction to Statistics (3 Credits)
Basic ideas in Statistics : Representation of data, Histogram, Frequency polygon, Ogive.
Measures of Location : Various Means (AM, GM, HM, TM), Median, Mode, Quantiles, Deciles, Percentiles. Measures of Dispersion : Range, Interquartile range, Variance, Standard deviation, Chebyshev's rule for sample, Shepperd's correction for variance, Coefficient of variance, Moments of higher order, Skewness, Kurtosis.
Representation of data using Stem-Leaf diagrams and Box plots.

Regression and Correlation: Scatter diagrams, Linear Regression, Method of least squares, Correlation, Coefficient of correlation, Rank correlation, Spearman's rank correlation coefficient.
Index numbers: Introduction, Price Relatives, Quantity Relatives and Value Relatives. Link and Chain Relatives, Cost of living Index Numbers, Methods of construction of Index Numbers, Quantity Index Numbers, Tests for Index numbers.

Recommended Texts:

1. *Statistical methods,* J.Medhi.
2. *A Concise course in A-Level statistics with worked examples* (3rd Edition) J. Crawshaw & J. Chambers
3. *A Basic Course in Statistics,*(3rd Edition) G.M.Clarke,and D.Cooke

ST 102 Introduction to Probability Theory (3 credits)
Counting Techniques: Combinations, Permutations, Set partitions,
Elements of Probability: Experiments, Events, Sample space, Laws of Probability, Bayes' Theorem, Independence of events. Random variables: Discrete and continuous r.v.'s, Probability mass function, Probability density function, Cumulative distribution function, Functions of a random variable, Expectation, Moments, Mean and variance, Moment Generating function.
Probability inequalities: Chebyshev's and Markov's etc.
Distributions: Discrete: Uniform, Bernoulli & Binomial, Poisson, Geometric, Negative Binomial, Hypergeometic, Multinomial, Continuous: Uniform, Normal, Gamma, Exponential, Properties and applications of distributions, Probability Generating functions.
Approximation to Binomial using Poisson, Binomial using Normal, and Poisson using Normal.

Recommended Texts:

1. *Applied Probability and Statistical Methods,* G.C.Canovos .
2. *A Basic Course in Statistics,*(3rd Edition) G.M.Clarke,and D.Cooke
3. *A Course in Probability & Statistics,* C.J. Stone

ST 103 Statistics Applications I (1 Credit)
(Prerequisite : ST 101 or any other Basic Statistics course)
Introduction to statistical pakages, Data management: Editing, summarizing, Transforming and Manipulating Data, Graphical methods for describing data, Numerical methods for describing data, Distributions and Random data. Applications of statistical packages

Recommended Texts:

1. MINITAB Reference manual
2. Introductory statistics with R, Dalgaard P.
3. Data manipulation with R, Spector P.

ST 104 Statistics Applications II (1 Credit)
(Prerequisite: ST 101 or any other Basic Statistics course)
Introduction to statistical software for Data analysis and Statistical Computing , Obtaining numerical and graphical summaries, Model fitting, Basics of statistical programming

Recommended Texts:

1. Introductory statistics with R, Dalgaard P.
2. *SAS Reference manual*

MT 105 Real Analysis I (3 credits)

Real number system as a complete ordered field, Complex number system, Topology of the e real line, Neighbourhoods, Sequences and limits, Limit theorems, Monotonic Sequences, Limit Concept of a Real-Valued Function, Algebra of limits, Continuity, Monotonic functions, Differentiability, Rolle's Theorem, Mean-value Theorems, L'Hospital's Rule, Riemann Integral and the basic properties, Fundamental theorem of Calculus, Improper integrals

Recommended Texts:

1. *Elementary Real Analysis*- H.G.Eggleston
2. *Analysis,* S.R.Lay

ST 105/MT 107 Mathematics for Statistics (3 credits)

Vector methods: Introduction to vectors, Linear combinations, Linear dependence and independence, Bases and dimension, Scalar product, Vector product

Differential equations: First order ordinary differential equations, Exact equations, Higher order linear ordinary differential equations with constant coefficients

Linear Algebra: Preliminaries, Determinants, Simultaneous linear equations, Eiganvalues and eiganvectors, Matrix calculations, Special matrices, Range and null space, Decomposition of matrices, Quadratic forms. Differentiation of scalar functions of matrices.

Recommended Texts:

1. *Elementary Vector Analysis,* C.E. Weatherburn,(1982)
2. *A First Course in Differencial Equations,* D.G. Zill, (1998)
3. *Linear Algebra,* K. Hoffman and R. Kunze, (1999)

200 LEVEL COURSES

ST 201 Probability Theory (3 credits)

(Prerequisites **:** ST 102)

Joint distribution of two (or more) discrete or continuous random variables, Marginal distribution, Conditional distribution, Independence of random variables, Expectation, Conditional expectation, Covariance, Correlation coefficient, Transformations involving two or more random variables, Probability density functions of (a) sum and difference, (b) product and quotient of two random variables,

Random samples, Empirical distributions, Order statistics, Distributions of MIN X_i, MAX X_i etc., Distributions of sample mean and sample variance; t, F and χ^2 distributions and their properties, Laws of large numbers, Central limit theorem.

Recommended Texts*:*

1. Canavos G.C. (1984), *Applied Probability and Statistical methods*
2. Freund J.E. (1994) *Mathematical Statistics*, Prentice Hall
3. Wackerly D. Mendenhall W. & Scheaffer R.L. (1995) *Mathematical Statistics with Applications*, Duxbury Press.

ST 202 Applied Statistics (3 credits)

(For students who do not offer Statistics as a major subject. Equivalent to BT 209 offered by the Department of Botany and ZL 205 offered by Department of Zoology.)

Types of data, Data summarization: Histogram, Frequency polygon, Ogive.

Measures of location, Measures of Dispersion, Representation of data using Stem-Leaf diagrams and Box plots. Some Statistical distribution functions and their properties.

Test of hypothesis, Estimation and tests on difference between two means and proportions, Tests on variances.

Simple linear regression and correlation, Lack of fit residual plots, Introduction to Analysis of variance, and analysis of two-way contingency tables.

Recommended Texts:

1. Harper W.M. (1991) S*tatistics*, ELBS
2. Moore D.S. (1995) *The basic practice of Statistics*, W.H. Freeman & Company
3. Bluman A.G. (1997) *Elementary Statistics*, McGraw Hill

ST 203 Theory of Statistics (3 credits)

(Prerequisites**:** ST 201)

Estimation: Point estimation: Properties of estimators; Unbiasedness, Consistency, Relative efficiency, Efficiency, Sufficiency, Factorization theorem, Rao-Blackwell theorem, UMVUE, Exponential families, Cramer-Rao inequality, Methods of obtaining estimators; Method of moments, Maximum likelihood estimators etc.

Interval estimation: Constructing confidence intervals for population parameters under various assumptions, Tolerance limits.

Testing Hypothesis: Tests on population parameters, Tests on independent and paired samples, Neyman-Pearson lemma, Uniformly Most Powerful tests, Likelihood Ratio tests.

Some practical assignments will be given for this course

Recommended Texts:

1. Canavos G.C. *(1984) Applied Probability and Statistical methods, Little, Brown & Company.*
2. Freund J.E. *(1994) Mathematical Statistics, Prentice Hall*
3. Hogg R.V. *(1978) & Craig A.T., Introduction to Mathematical Statistics, Prentice Hall* .

ST 204 Sampling Techniques (2 credits)

(Prerequisites: ST 203)

Principal steps in a Sampling Survey, Probability sampling, Simple random sampling, Sampling proportions and percentages, The estimation of sample size, Stratified random sampling, Methods of allocations, Ratio estimators, Regression estimators, Introduction to Cluster sampling and Systematic sampling, Estimating the population size.

Some practical assignments will be given for this course

Recommended Texts:

1. Cochran W.G. (1977) *Sampling Techniques*, John Wiley & Sons.
2. Scheaffer R.L. (1996) *Mendenhall W., and Ott L., Elementary Survey Sampling*, Duxbury Press.

ST205 Statistical Simulation (2 credits)

(Prerequisites: ST203)

Introduction and overview of simulation analysis, Modeling and estimating input processes, Random-number generation, Generation of random variates, vectors, and processes, Statistical analysis of simulation output, Comparison, ranking, and selection of

simulation models, Variance-reduction techniques, Designing simulation experiments, gradient estimation, and optimization, Monte Carlo simulation
Some practical assignments will be given for this course

Recommended Texts:

1. *Simulation Modeling and Analysis,* Law and Kelton (2003)
2. *Graphical Simulation Modeling and Analysis Using Sigma for Windows,* L.W. Schruben(2001)

MT 202 Real Analysis II (3 credits)
(Prerequisites: MTI05)
Cauchy sequences, Convergence tests, Absolute and conditional convergence, Power series Integration and differentiation of power series, Taylor series, Uniform continuity, Upper and lower Riemann integrals, Characterization of Riemann integral functions, Functions of several variables, Limits and continuity, Partial derivatives, Differentials, Chain rule, Extrema of functions of several variables, Lagrange Multipliers.

Recommended Texts:

1. S. R. Lay {1986), *Analysis An Introduction to Proof,* Prentice-Hall
2. T. M. Apostol (1974), *Mathematical Analysis,* Addison-Wesley

MT 204 Mathematical methods (3 credits)
***Differentiation of Vectors*:** Scalar and vector point functions and their partial derivatives with respect to coordinate variables, Gradient of a scalar point function; Directional derivative, Divergence and curl of a vector point function. ***Integration of Vectors*:** Line integrals and their evaluation using parametric representation, Surface integrals, Green's theorem in the plane Stokes theorem, Circulation and flux of a vector point function, Volume integrals, Divergence theorem, Irrotational and Solenoidal vector fields, Orthogonal Curvilinear Coordinates, Grad, Div, Curl in OCC, Cylindrical polar and spherical coordinate systems, Use of these coordinate systems in evaluation of surface and volume integrals. ***Special Solution of Laplaces Equation*:** Solutions in two-dimensions, Axi-symmetric solutions. ***Integral Transforms*:** Laplace transforms; Elementary Properties, Inverse Laplace transform and its properties, Convolution theorem and its use in evaluation of integrals, Uses of Special functions connected with Laplace transform, Evaluation of integrals using LT, Applications in ODE and integro-differential equations, Applications in PDE, Fourier Transforms; Infinite-Fourier sine/cosine transforms and their inverse formulae, Finite-Fourier sine/cosine transforms, Derivation of inverse formulae, Use of Fourier series, Boundary value problems-Use of Fourier transforms.

Recommended Texts:

1. M.R. Spiegel (1968), *Vector Analysis,* McGraw-Hill
2. M.D. Raisinghania (1997), *Vector Analysis,* S. Chand & Comp. Ltd.
3. M.D. Raisinghania (1995), *Integral Transforms,* S. Chand & Comp. Ltd.

MT 207 Numerical Analysis I (2 credits)
Difference equations, Solutions of equations in one variable: Bisection method, Fixed-point iteration, Newton-Raphson method, Error analysis for iterative methods. Interpolation and Polynomial Approximation: Taylor polynomials, Interpolation and Lagrange polynomial, Iterated interpolation, Divided differences, Hermite interpolation, Cubic spline interpolation. Numerical Differentiation and Integration: Numerical differentiation, Richardson's extrapolation, Elements of numerical integration.

Recommended Texts:

1. Kendall E. Atkinson (2008), *An introduction to numerical analysis*, 2nd Edition. Wiley India Pvt. Limited.
2. Arieh Iserles (2008), *A First Course in the Numerical Analysis of Differential Equations*, 2nd edition. Cambridge University Press.
3. Richard L. Burden, J. Douglas Faires (2011). *Numerical Analysis*, 9th Edition. Brooks/Cole.

MT 209 Graph Theory (2 credits)

Isomorphism of Graphs, Paths, Circuits, Eulerian graphs, Hamiltonian graphs, Shortest path problem, Chinese postman problem, Directed graphs, Graph Colouring, Four colour problem, Proof of five colour theorem, Planar graphs, ***Trees and Searching:*** Properties of trees, Travelling salesman problem, Tree Analysis of sorting algorithms, Hall's Theorem, Transversal theory, Applications to game theory.

Recommended Texts:

1. F. Harary (1988), *Graph Theory*, Narosa Publishing House
2. R. J. Wilson (1996), *Introduction to Graph Theory*, Addison-Wesley Longman

300 LEVEL COURSES

ST 301 Regression Analysis (3 credits)

(Prerequisite: ST 203.)

Simple linear regression, Tests for regression coefficients, Interval estimation, Prediction, Analysis of variance approach, Diagnostic and remedial measures, Matrix approach to simple linear regression, Multiple regression, Polynomial regression. Introduction to logistic regression and nonlinear regression, Introduction to Time series Analysis.
Some practical assignments will be given for this course.

Recommended Texts:

1. Myers R.H. (1990) *Classical and Modern Regression with Applications*, Duxbury Press
2. Neter J. wasserman W. & Kunter M.H. (1990), *Applied Statistical Models*, Irwin Inc.
3. Christensen R. (1998) *Analysis of Variance, Design and Regression*, Chapman & Hall/CRC

ST 302 Quality Control (2 credits)

(Prerequisites: ST 203)

Control charts for mean, variance, range etc, Properties of control charts, Acceptance sampling procedures and consumer risks, Operating characteristic curves, Process capability analysis, Introduction to Quality assurance and acceptance control, Lot-by-Lot acceptance sampling by attributes, Acceptance procedure based on AQL, Other acceptance procedures, Continues acceptance sampling by attributes, Acceptance procedures for variable characteristics.
Some practical assignments will be given for this course

Recommended Texts:

1. Hansen B.L. (1987) & Ghare P.M., *Quality Control and Application*, Prentice Hall
2. Montogomery D.C. (1993) *Introduction to Statistical Quality Control*, John Wiley & Sons.

ST 303 Design and Analysis of experiments (3 credits)
(Prerequisites: ST 203)
Comparison of two samples (independent, dependent), One-way ANOVA: Assumptions, Normal theory, F-tests. Multiple comparisons: LSD method, Tuckey's method, Bon- ferroni method, Scheffe's method, Duncan's multiple range method.
Two-way ANOVA: Normal theory, Randomized block design, The two factor factorial, Multifactor Factorials, Confounding, Introduction to Analysis of covariance, Latin square. Some practical assignments will be given for this course.

Recommended Texts:

1. Jobson J.D. (1991) *Applied multivariate data analysis, Vol. I : Regression and Experimental Design,* Springer
2. Neter J. (1990) Wasserman W. & Kunter M.H., *Applied Statistical Models,* Irwin Inc.
3. Lindman H.R. (1992) *Analysis of Variance in Experimental Design,* Springer Series

ST 305 Multivariate Methods I (2 credits)
(Prerequisites: ST 105, ST 203)
Properties of random vectors and Matrices, The Multivariate Normal distribution, Estimation of parameters in the Multivariate Normal distribution, Wishart distribution, Inferences on multivariate mean, and Hotelling's T^2 tests, Multivariate Analysis of Variance, Cluster Analysis.
Some practical assignments will be given for this course

Recommended Texts:

1. *Multivariate Statistics - A Practical Approach,* Flury B and Riedwel H,l (1998)
2. *Multivariate Statistical inference & Applications,* A.C. Rencher (1982)

ST 306 Data Analysis & Preparation of Reports (1 credit)
(Prerequisites: ST 301, ST 302)
Students will be grouped, and assigned instructors. The skills of data analysis, statistical software development and report writing will be given. Initially the student groups are given case studies. Gradually the students will be assigned small projects taken from Industry. At the end of the course students are expected to write reports of their findings.

Recommended Text:

1. *SAS Reference Manuals*

ST 307 Time Series Analysis (2 Credits)
(Prerequisites: ST203, ST 301)
Introduction; Objectives of time series analysis, Components of time series, Traditional method of time series analysis; Estimation of trend, seasonal effect forecasting; Auto-correlation & Auto-covariance functions Correlogram; Probability models for time series; Stationary processes; Second order stationary processes; Purely random processes; Random walk; Moving average processes; Auto-regressive processes; Mixed models (ARMA, ARIMA); Estimation of parameters; Testing adequacy; Forecasting; Exponentially smoothing forecasting procedure; Non Stationary and Seasonal Time series models (SARIMA); Box-Jenkins forecasting procedure. Introduction to non linear models and Multivariate time series modelling
Some practical assignments will be given for this course

Recommended Texts:

1. *Introduction to Time Series and Forecasting,* P.J. Brockwell and R.A. Davis (2000)
2. *The Analysis of Time Series, An Introduction,* C. Chatfield (1998)

ST 308 Bayesian Statistics I (2 credits)

(Prerequisites: ST203)

Introduction: Statistical and Non-statistical decisions, Profit, Loss, Risk and utility, Expected Value, Bayes' Theorem, Prior Distribution, Bayesian Inference; Non-statistical Decisions: Maximin, Maximax, Minimax Regret and Hurwicz.

Recommended Texts:

1. *Statistical Decision Theory and Bayesian Analysis,* J.O. Berger (1985)
2. *Bayes and Empirical Bayes methods for Data analysis,* B.P. Carlin and T.A. Louis (1996)
3. *Bayesian computation with R (2nd Edition)* , Jim Albert Springer Science,, USA, 2009

ST 309 Non-Parametric & Categorical Data Analysis (3 Credits)

(Prerequisites: ST203)

Non-Parametrics : One sample sign test, Binomial test, Two sample sign test, Wilcoxon paired samples, Signed rank test, Wilcoxon and Mann Whitney test, Correlation tests, Tests of independence, Wald- Wolfowitz runs test, Kruskal-Wallis test, Friedman test. Categorical Data Analysis : Multinomial distribution and Goodness of fit tests, The Kolmogorov-Smirnov test, Inference on two-dimensional contingency tables, Models for binary response variables and generalized linear models: Logistic regression, logit models, probit models, Model diagnostics

Log-linear models: Log-linear models for two or more dimensions, testing goodness of fit, estimation model parameters, Strategies in model selection, Analysis of deviance, Log-linear models for ordinal variables,

Some practical assignments will be given for this course

Recommended Texts:

1. *Nonparametric Statistical Inference,* Gibbons J.D. & Chakrabortic S.,
2. *Categorical Data Analysis,* Alan Agresti
3. *Generalised Linear Models,* McCullagh and Nelder

ST 325 Seminar (1 Credit)

(Prerequisites: ST 306, ST 307)

A student is expected to carry out an extensive literature survey on a topic assigned to him/her by a senior staff member. At the completion of the course the student is expected to write a report of not less than ten pages, and make a presentation.

MT 302 Real Analysis III (3 credits)

(Prerequisites: MT 202)

Jacobian, Inverse and Implicit Functions Theorem, Multiple integrals, change of variables (transformations) in multiple integrals, Function of Bounded Variation, Total variations, Rectifiable curves, Uniform convergence of infinite series, Infinite products, Special Functions (Gamma, Beta, Bessel, Legendre etc), Riemann Stieltjes Integral.

Recommended Texts:

1. W. Rudin (1976), *Principles of Mathematical Analysis*, McGraw-Hill
2. T. M. Apostol (1974), *Mathematical Analysis*, Addison-Wesley Longman

MT 304 Partial Differential Equations (2 credits)
(Prerequisites: ST 105)
First order partial differential equations: Linear equations, Non-linear equations, Characteristics.
Second order partial differential equations: Equations with constant coefficients, Equations with variable coefficients, Laplace equation, Wave equation, Diffusion equation, Boundary value problems, Use of Fourier series.
Numerical methods of solving partial differential equations.

Recommended Texts:

1. R. V. Churchill & J.W. Brown (1987), *Fourier Series and Boundary Value Problems*, McGraw-Hill
2. E.T. Copson (1975) *Partial Differential Equations*, Cambridge University Press

MT 308 Combinatorics (2 credits)
(Prerequisite: MT 209)
***Recurrence relations and generating functions*:** Computing solutions to recurrence relations, The principle of Inclusion and Exclusion, Latin squares, System of distinct representatives, Extremal set theory.
***Steiner triple systems*:** Direct construction, Recurrence construction, Tournaments and Kirkman's school girls problem, Further Graph Theory, Networks, Matroids, Designs, Hadamard matrices.
***Error-Correcting codes* :** Linear Codes and Hadamard codes.

Recommended Text:

1. P. J. Cameron (1994), *Combinatorics: Topics, Techniques, Algorithms*, Cambridge University Press

HR 301 Human Resource Management (2 credits)
Introduction: Defining the Role, Importance and Challenges of HRM; Historical Development of HRM. Approaches of HRM; HRM and Personnel Management, Roles of HR Managers, Strategic Orientation of HRM. Brief Introduction to HRM Functions: Job Design, Job Analysis, HR Planning, Attraction, Selection, Recruitment, Induction, Training and Development, Career Development, Performance Management, Knowledge Management, Salary Administration, Employee Movements, Labor Relations, Discipline Handling, Managing Health and Safety, Grievance Handling and Reward Management.

Recommended Texts:

1. Mathis, R.L., Jackson, J.H., Valentine, S.R. (2013) Human Resource Management, 14th Edition, CENGAGE Learning.
2. Dessler, G. (2012) Human Resource Management, 14th Edition, Pearson.
3. Nkomo, S.M., Fottler, M.D., McAfee, R.B. (2010) Human Resource Management Applications: Cases, Exercises, Incidents, and Skill Builders, 7th Edition, CENGAGE Learning.

400 LEVEL COURSES

ST 401 Actuarial Statistics (2 credits)
(Prerequisites: ST 203)
Economics of uncertainty. Risk theory and utility. Jensen's inequality. Sums of random variables and convolutions. Applications to individual risk models. Failure rates and the

force of mortality. Mixtures of random variables and mixtures of distributions. Loss distributions, Reinsurance. Risk models, Estimating distribution by simulation. Actuarial applications of statistical inference. Compound distribution. Collective risk models. Ruin theory. Lundberg's Inequality, Introduction to credibility theory. Compound stochastic processes. Applications of risk theory in insurance problems. No claims discounting. Run off triangles.

Recommended Texts:

1. *An Introduction to the Mathematics of Finance (Chapters 1-4),* J.J. McCutcheon and W.F. Scott.,(1998)
2. *Life Contingencies (Chapters 1-6),* A. Neill.(1999)
3. *Actuarial Mathematics (Chapters 3-8),* N.L. Bowers Jr, ... [et al.].(2001)
4. *Mathematical Models for the Growth of Human Populations,* .H. Pollard (1997)

ST 402 Statistical Data Mining (3 credits)

(Prerequisites: CS 409)

Introduction: Basic Data Mining Tasks, Database / OLTP Systems, Data Warehousing, OLAP Systems, Related Concepts (Statistics, Fuzzy Sets and Fuzzy Logic, Information Retrieval, Decision Support Systems, Dimensional Modeling, Machine Learning, Pattern Matching). Data Preprocessing, Exploratory Data Analysis, Statistical Approaches to Estimation and Prediction. Association Rule Mining. Classification and Prediction: Introduction, Decision Tree Induction Methods, Bayesian Classification, Rule Based Algorithms, Neural Network Based Algorithms. Cluster Analysis: Introduction, Similarity and Distance Measures, Partitioning Methods, Hierarchical Methods, Outlier Analysis. Web Mining: Web Content Mining, Web Structure Mining, Web Usage Mining. Applications and Trends in Data Mining.
Some practical assignments will be given for this course

Recommended Texts:

1. *Data Mining Introductory and Advanced topics,* M.H. Dunham (2003)
2. *Predictive Data Mining,* Weiss SM & Indurkhya N, Morgan Kaufmann (1997)
3. *Principles of Data Mining, Hand DJ et al,* MIT Press (2001)

ST 403 Statistics for Bioinformatics (2 credits)

Review of the following in the context of bioinformatics: Basic probability, statistical inference, stochastic processes, computer intensive approaches to statistical inference, applications. Mathematical models and computational methods of statistical genetics including mendelian genetic traits, population genetics, pedigree relationships and gene identity, meiosis and recombination, linkage detection, multipoint linkage analysis. Course work involves some computation in a Unix environment.

Recommended Texts:

1. *Biological Sequence Analysis,* R. Durbin, S. Eddy, A. Krogh and G. Mitchison (1998)
2. *Statistical Methods in Bioinformatics, An Introduction,* W. J. Evans, G.R. Grant (2001)

ST 404 Stochastic Processes (2 credits)

(Prerequisites: ST201, ST 203)

Introduction to Stochastic processes: Markov Chains, Markov Processes with Discrete state space, Markov Processes with Continuous state space, Stationary processes, Branching Processes, Stochastic processes in Queueing and Reliability

Recommended Text:

1. *Stochastic Processes*, J. Medhi (1996)

ST 405 Multivariate Methods II (2 credits)

(Prerequisites: ST 305)

Discriminant analysis of two group and multiple groups, Principal component analysis (PCA). Interpretation using illustrative examples. Factor analysis. Comparison with PCA, factor loadings, rotations, Interpretation, Canonical correlation, Covariance structure models.

Some practical assignments will be given for this course

Recommended Texts:

1. *Multivariate Statistical inference & Applications,* A.C. Rencher(1990)
2. *Applied Multivariate Statistical Analysis,* R.A. Johnson and D.W. Wichern (1982)

ST 406 Bayesian Statistics II (2 credits)

(Prerequisites: ST 308)

Decision Rules; Making Decisions when data is not available: Specifying a prior distribution, Making decisions with only prior information; Making Decisions when data is available: Decision trees, Expected Value of Perfect Information (EVPI), Expected Value of Sample Information (EVSI), Non-informative and natural conjugate prior, Bayesian confidence intervals.

Recommended Texts:

1. *Statistical Decision Theory and Bayesian Analysis,* J.O. Berger (1985)
2. *Bayes and Empirical Bayes methods for Data analysis,* B.P. Carlin and T.A. Louis (1996)

ST 407 Linear Models (3 Credits)

(Prerequisites: ST 105, ST 203)

Elementary Theorems on Linear and Matrix Algebra, Partitioned Matrices, Nonnegative Matrices; Generalized Inverses of Matrix; Solutions of Linear Equations; Idempotent Matrices, Trace of Matrices; Derivatives of Quadratic Forms, Expectation of Matrix, Multivariate Normal Distribution, Distribution of Quadratic Forms; General Linear Model, Optimal Estimation and Hypothesis Testing Procedures for the General Linear Model, Applications to Regression Models. Application of Optimal Inference Procedures for the General Linear Model to Multifactor Analysis of Variance, Experimental Design Models, Analysis of Covariance, Split-Plot Models, Repeated Measures Models, Mixed Models, Variance Component Models.

Recommended Texts:

1. *Matrices with Applications in Statistics,* F.A.Graybrill, Wadsworth
2. *Theory and Applications of the Linear Model,* F.A.Graybrill, Wadsworth

ST 408 Reliability Theory and survival analysis (3 Credits)

(Prerequisites: ST 203)

Reliability Theory: General introduction, Reliability concepts, Classical model, Weibull distribution: Censored observation, Parameter estimation, Asymptotic results.

Survival analysis: Introduction, Survival curves, Parametric modeling, Cox's proportional hazards model, Extensions.

Recommended Texts:

1. *Survival Analysis: A practical approach,* D Machin, Y.B. Cheung,M. Parmar, Wiley
2. *Statistical Methods for Reliability Data,* Meeker M. Q. and Escobar L. A, Wiley

CS 401 Artificial Intelligence and Expert Systems: (3 credits)
(Prerequisite: CS 311)
Artificial intelligence: Intelligent Agents, Search Techniques, Game Playing, Knowledge and Reasoning, First order logic, Logical reasoning systems, Uncertainty, Probabilistic Reasoning, Simple and complex Decisions, Learning. Expert systems: Characteristics and components of Expert systems, Machine learning, Knowledge base and bank, Rule Knowledge, Inference engine, transit fare rule, Rule interpreter, Inference tree.

Recommended Text:

1. Russell, S.J; Norvig, P.; *Artificial Intelligence: A Modern Approach*; Prentice-Hall; 1995

CS 409 Neural networks and Fuzzy logics (3 Credits)
(Prerequisities: CS 401)
Fuzzy system models, Fuzziness and certainty, fuzzy sets, basic properties and characteristics, Domains, Alpha- level sets and support sets, Linear representation, Fuzzy set operators, Conventional (crisp) set operations, basic Zadeh type operations, intersection, union and complement of fuzzy sets, General algebraic operations, Fuzzy set hedges, Fuzzy reasoning, linguistic variables, Fuzzy models, Fuzzy systems and modeling, Design methodologies, modeling and utility software. Parallel and distributed processing, Neuron, Connectivity, Activation function, propagation rule, Learning rules, pattern Preparation, Perceptron, Multilayer perceptron, Associative memory, Hopfield neural networks, Self organizing map (SOM), Adaptive Resonance theory, topologies, Training methods, supervised and unsupervised learning

Recommended Text:

1. *Artificial Intelligence: A Modern Approach* (Second Edition) by Stuart Russell and Peter Norvig.

ST 423 Industrial Training (3 Credits)
Each student will undergo full time training in the industry for the prescribed period on projects assigned by the industry. Students are required to have a duly maintained 'Daily Diary' and 'Students Record Book' which should be submitted to the Head of the Department within two weeks after completion of training. In addition, the students are expected to write a report and make presentation on the work carried out by them.

ST 426 Research Project (6-8 Credits)
Students are expected to carry out an independent research project on a topic assigned to him/her under the supervision of a senior staff member. At the completion of the project students are expected to write a report and make a presentation.

Students, who do not offer Statistics as a major subject, can take the following course units after following the
Applied Statistics (ST 202) course. Note that ST 103 course can be followed concurrently with ST 202.

ST 103 Statistics Applications I
ST 104 Statistics Applications II
ST 204 Sampling Techniques
ST 301 Regression Analysis

ST 303 Design and Analysis of experiments ST 302 Statistical Quality Control
ST 304 Non- parametrics and Categorical Data Analysis

Note: Students opting to follow the Special Degree course in Statistics are required to select courses from the following course units in addition to fulfill their credit requirements.
GL316(2 credits) Remote Sensing and GIS
MT311(3 credits) Linear Programming
MT407 (3 credits) Optimization Theory

ZOOLOGY

100 LEVEL COURSES

BL 101 Basic Biology (2 credits)
Cell Biology - Chemical nature of life, origin of life, scientific method, prokaryotic and eukaryotic cells, cell types, structure and function of cell membranes and organelles, cell division, structure and function of genetic material.
Classification of organisms - Early and current systems of classification.
Genetics and evolution - Chromosome theory of inheritance, Mendelian genetics and deviation, linkage and recombination, mutations, Hardy-Weinburg principle, sources of variation, natural selection, origin of species. Laboratory exercises based on above topics.

Recommended Texts:

1. Campbell, N. A., Reece, J. B. and Mitchel, I. G. (1996). Biology 4th Edition. The Benjamin/Cummings Publishing Company, Inc.
2. Marder, S. S. (2001). Biology 7th edition. McGraw – Hill Book Company Inc., USA.
3. Raven, P. H. and Johnson, G.B. (1996). Biology. 4th Edition. Wm. C. Brown Publishers.
4. Tauro, P. Kapoor, K. K. and Yadav, K. S. (1986). An Introduction to Microbiology. Wiley Eastern Limited, New Delhi.
5. Winter, P. C., Hickey, G. T. and Fletcher, H. L. (2000). Genetics. 2nd Edition. Vivo Books Private Ltd., New Delhi.

BL 102 Plant and Animal Form & Function (2 Credits)
Plant Form & Function: Tissue types; Internal structure of plants and organs; Photosynthesis; Transport systems; Plant nutrition. **Animal Form & Function**: Levels of body organization, body form and symmetry; Major animal groups and their basic needs for survival; How different animal groups solve problems of survival and challenges of the environment through form and function; Functional adaptations of animals under extreme environmental conditions.
Practicals based on above.

Recommended Texts:

1. *Biology.* Peter H. Raven and George B. Johnson. 6th Edition. McGraw Hill, Boston.

2. *Diversity of Organism.* Caroline M. Pond. (1999). Hodder & Stoughton.
3. *Biology.* N.A. Campbell, J. B. Reeve, I.G. Mitchel. 8th Edition. Benjamin-Cummings Publishing Company.
4. *Plant Physiology.* F.B. Salisbury and C.W. Ross. (1996). Wadsworth Publishers, London.
5. *Plant Physiology.* Taiz, L. and Zeiger, E. (1996). Benjamin-Cummings Publishing Company.

BL 103 Basic Ecology (2 Credits)

Ecological levels (individuals, populations, communities, habitats, ecosystems, biomes, biosphere); Components of the physical environment (energy, water, atmospheric gases, wind, fire, gravity, topography, geologic substratum and soil); Energy flow in ecosystems (trophic levels, food webs, productivity); Cycles of materials (hydrological cycle, carbon cycle, biogeochemical cycles).
Practicals based on above.

Recommended Texts:

1. *Biology, Principles and Processes*. Michael Roberts, Michael Reiss, Grace Monger. (1993) Thomas Nelson & Sons, Ltd. UK.
2. *Biology.* Peter H. Raven & George B. Johnson, 6th Edition. McGraw Hill, Boston.
3. *Biology.* N.A. Campbell, J. B. Reeve, I.G. Mitchel. 8th Edition. Benjamin-Cummings Publishing Company.
4. *Elements of Ecology*. R. L. Smith and T. M. Smith (2000). Benjamin/Cummings Science Publishing.
5. *Ecology of World Vegetation.* O.W. Archibold (1995) Chapman and Hall.
6. *Tropical Rain Forest Ecology.* D. J. Mabberley, (1992) Blackie and Son Ltd.

BL 107 Basic Microbiology (2 credits)

Introduction to microorganisms, history, discovery and diversity. Classification and major groups of microorganisms - Mollicutes, Bacteria and Protozoa. Viruses, Viroids, Prions. Distribution and role of microorganisms in different environments. Microbial cell structure and function. Microorganisms in biotechnology and disease. Microbiological equipment and safety procedures. Sterile techniques - culturing, isolation, purification, characterization and identification of microorganisms.
Laboratory exercises based on the above topics.

Recommended Texts:

1. Atlas, R.M. (1995). Principles of Microbiology. Mosby.
2. Madigan, M.T., Martinko, J.M. and Parker. J. (2002). Brock Biology of Microorganisms. 10th edition. Prentice Hall.

BL 115 Biomolecules (2 Credits)

Essential classes of biomolecules - nucleic acids, proteins, fatty acids & lipids and carbohydrates; structure and function; chemistry, properties and interactions of biomolecules; applications of biomolecules in agriculture, medicine, forensics and industry (15 L).
Laboratory exercises based on above topics (30 P).

Recommended Texts:

1. Buchanan, B.B., Guissem, W. and Jones, R.L. (2000). *Biochemistry & Molecular Biology of plants*. American Society of Plant Physiologists.
2. Callow, J.A., Ford – Lloyd, B.V. and Newbury, H.J. (1997). *Biotechnology and Plant Genetic Recourses. Conservation and use*. Biotechnology in Agriculture Series, No.19.
3. Meuser, F., Manners, D.J. and Seibel, W. (1993). *Plant Polymeric Carbohydrates. The Royal Society of Chemistry*.
4. Nelson, D. L. and Cox, M. M. (2009). *Lehninger Principles of Biochemistry* (5^{th} Edition), W.H. Freeman and Company.
5. Stryer, L. (1995). *Biochemistry* (4^{th} Edition). W.H. Freeman and Company.
6. Wilson, K. and Walker, J. (2005). *Principles and techniques of Biochemistry and Molecular Biology* (6^{th} Edition). Cambridge University Press.

BL 116 Introductory Environmental Biology (2 Credits)

Basic concepts in environmental biology; Hydrosphere; Lithosphere; Atmosphere; Biosphere; renewable & nonrenewable resources and cycling of energy & matter; Climate & life; human population growth & problems of overpopulation; Atmospheric pollution and global changes: impacts of atmospheric pollution on biota- plants, animals, humans, carbon footprint; World food resources & green revolution; Effect of agriculture on environment; Water resources: pollution and treatment methods; Solid and hazardous wastes; Environmental health & toxicology; Sustaining terrestrial biodiversity and urban biodiversity. Global resources and associated problems.
Practicals based on above.

Recommended Texts:

1. *Living in the Environment: Principles, Connections and Solutions*. Tyler, G. and Miller Jr. (2004).Thompson books.
2. *Biology.* Peter H. Raven & George B. Johnson, 6^{th} Edition. McGraw Hill, Boston.

BL 117 Biotic Interactions (2 Credits)

Neutralism verses interactions among plants, animals and microbes; kinds of biotic interactions with examples, interspecific interactions and intraspecific interactions – symbiotic relationships, protection and defense, competition & allelopathy. The role of trophic interactions in community initiation, maintenance and degradation. Biotic interactions affecting the sizes of species populations and diversity. Community consequences of biotic interactions and co-evolutionary dynamics. Biotic interactions in human dominated landscapes. Application aspects of biotic interactions (15 L). Laboratory exercises based on above topics (30 P).

Recommended Texts:

1. Begon, M., J.L. Harper, and C.R. Townsend (2000). *Ecology: Individuals, Populations and Communities***.** 3rd Edition. Sinauer Associates, Sunderland, Mass.
2. Campbell, Neil A. and Jane B. Reece (2002). *Biology*. 6th Edition. Pearson Higher Education.
3. David F.R.P. Burslem, Michelle A. Pinard and Sue E. Hartley (Eds.) (2005). *Biotic interactions in the tropics: their role in the maintenance of species diversity*. Cambridge University Press, UK.

BL 118 Introductory Evolutionary Biology (2 Credits)
Introduction; Evidence for evolution; Mechanisms of evolution; Micro and macroevolution; Speciation; Co-evolution; Adaptation; Adaptive radiation; Phylogenetics; Phenotypic plasticity; Kin selection; Parent offspring conflict; Human evolution; Health and evolution; Evolution of photosynthesis, angiosperms and crop plants.
Practicals based on above.

Recommended Texts:

1. *Biology*. Neil A. Campbell; Jane B. Reece; Robert B. Jackson; Michael L. Cain; ; Steven A. Wasserman; Peter V. Minorsky, 8th Edition. Benjamin-Cummings Pub Co.
2. *An Introduction to Biological Evolution.* Kenneth V. Kardong. (2007). McGraw-Hill
   Science.

BL 120 Introduction to Biotechnology and its Applications (2 credits)
Introduction to Molecular Biology and Biotechnology, historical development, land mark discoveries and pioneering scientists, diverse applications of Biotechnology in medicine, food production and environmental protection. World Wide Web Resources on Biotechnology and their reliability, the fraudulent nature of bioterrorism and how to circumvent it through proper and safe use of Biotechnology. In the contexts of humanitarian and environmental catastrophes, the use of Biotechnology as a developmental tool to face the challenges in the present and future.

Recommended Texts:

1. Thieman, W.J., and Palladino, M.A. (2012) Introduction to Biotechnology, (Third Edition). Benjamin Cummings.
2. Walker, S. (2006) Biotechnology Demystified, (Fifth Edition). The McGraw-Hill Companies.
3. National Center for Biotechnology Information, U.S. National Library of Medicine, 8600 Rockville Pike, Bethesda, MD, 20894, USA. Website: http://www.ncbi.nlm.nih.gov/ .
4. International Service for the Acquisition of Agri-biotech Applications (ISAAA), Operated in USA, Kenya and Philippines. Website: http://www.isaaa.org/.
5. GMO Compass, the task of GMO Compass is to collect objective, science-based information on the use of genetic engineering in the agri-food industry and present it to the public in a way that is easy to understand and readily accessible. Maintained at Genius GmbH, Robert-Bosch-Str. 7, 64293 Darmstadt, Germany. Website: http://www.gmo-compass.org/eng/.

200 LEVEL COURSES

ZL 201 Animal Embryology (2 credits)
Historical development of embryology; Gametogenesis, structure and function of gametes; Process of fertilization; Principles and concepts of different embryonic stages and processes: cleavage, blastula, gastrulation, gastrula, neurulation, neurula and organogenesis; Early embryonic development of Amphioxus, frog, chick, human and selected invertebrates.
Practicals based on above.

Recommended Texts:

1. *Animal Biology*. A. J. Grove and G. E. Newell. (1969).University Tutorial Press, UK.
2. *An Introduction to Embryology*. 5th Edition. B. I. Balinsky. Holt Rinehart and Winston Publishers, USA.
3. *Langman's Medical Embryology*. T. W. Sadler. Lippincott Williams and Wilkins, 12th Edition. Wolters Kluwer Business, USA.

ZL 205 Biostatistics (2 credits)

This course cannot be offered by students who offered ST 101 or ST 201. Some practical assignments will be given for this course.
(Equivalent to BT 209 and ST 202)
Types of data, Data summarization: Histogram, Frequency polygon, Ogive.
Measures of location, Measures of Dispersion, Representation of data using Stem-Leaf diagrams and Box plots. Some Statistical distribution functions and their properties.
Test of hypothesis, Estimation and tests on difference between two means and proportions, Tests on variances.
Simple linear regression and correlation, Lack of fit residual plots, Introduction to Analysis of variance, and analysis of two-way contingency tables.

Recommended Texts:

1. Harper W.M. (1991) S*tatistics*, ELBS
2. Moore D.S. (1995) T*he basic practice of Statistics*, W.H. Freeman & Company
3. Bluman A.G. (1997) *Elementary Statistics*, McGraw Hill

ZL 206 Invertebrate Diversity (3 credits)

Classification and life history of Protozoa; Introduction to Metazoa; Characteristic features, diversity, ecology, life history and phylogenetic relationships of the following invertebrate phyla: Porifera, Cnidaria, Ctenophora, Platyhelminthes, Nematoda, Annelida, Onychophora, Arthropoda, Mollusca, Echinodermata, Hemichordata, Tardigrada, Bryozoa, Brachiopoda.
Practicals based on above.

Recommended Texts:

1. *Invertebrates*. Richard C. Brusca, Gary J. Brusca and Nancy J. Haver. 2nd Edition. Sinauer Associates, Inc. Publishers, USA.
2. *Invertebrate Zoology*. E. E. Ruppert, R. S. Fox, and R. D. Barnes. 7th Edition. Saunders College Publishing, USA.

ZL 215 Zoogeography and Sri Lankan Fauna (2 credits)

Theories of Continental Drift and Plate Tectonics; Earth's mantle and core; Tectonic plates and their motion; Supercontinent cycle; Geological time scale; History of zoogeography; Patterns of zoogeography; Biological processes in zoogeography; Ecological zoogeography: dispersal of animals, barriers for dispersal; Zoogeographic regions: terrestrial and oceanic regions and inland waters; Centers of origin and divergence of species; Island biogeography; Sri Lankan fauna.
Practicals based on above.

Recommended Texts:

1. *Zoogeography: The Geographic Distribution of Animals.* P.J. Jr. Darlington (1957).
2. *Biogeography.* J.H. Brown & M.V. Lomolino (1998).

3. *The Changing Earth: Exploring Geology and Evolution.* J.S. Monroe and R. Wicander (2001).

ZL 216 Vertebrate Diversity (3 credits)
Origin and evolution of protochordates and vertebrates; Diversity, distribution, and classification of protochordates (urochordates and cephalochordates) and vertebrates: jawless fishes, cartilaginous fishes, bony fishes; amphibians, reptiles (including major extinct groups), birds and mammals.
Practicals based on above.

Recommended Texts:

1. *The Life of Vertebrates.* Young, J.Z. 3rd Edition. Oxford University Press, Oxford.
2. *Vertebrate Life.* Pough, F.H., Janis, C.M., and Heiser, J.B. 9th Edition. Pearson, Boston.

ZL 217 Coastal Ecosystems and Coral Reefs (2 credits)
Introduction to the coastal environment; Biology and ecology of communities in rocky intertidal zone, estuaries, salt marshes, mangroves, coral reefs, sea grass beds; Human impact on the coastal zone; Disturbances and restoration; Coastal zone management; Regulations and laws.

Recommended Texts:

1. Marine Biology: An Ecological Approach (2004) J.W. Nybakken. 6th Ed. Benjamin Cummings.
2. Status of Coral Reefs of the World (2002) Ed. Clive Wilkinson. Australian Institute of Marine Science.

ZL 218 Histological and Museum Techniques (1 credit)
Tissue processing and microtomy; Slide mounting and staining of whole specimens, tissues and embryos; Histochemistry; Taxidermy and preparation of skeletons; Curation of vertebrate and invertebrate specimens.

Recommended Texts:

1. The Microscopic Anatomy of the White Rat: A Photographic Atlas (1968) E.M. Smith and M.L. Calhoun. 1st Ed. Ames: Iowa State University Press.
2. Taxidermy: Step by Step (1977) W.F. McFall. Winchester Press.
3. Advanced Taxidermy (1983). P.A. Connor 1st Ed. P.A. O'Connor & Learnex Ltd.

MB 226 Molecular Genetics (3 credits)
(Prerequisites: BL 101, CH 101, CH 102)
Organization of prokaryotic and eukaryotic genomes; genes and chromosomes; mitochondrial and chloroplast DNA; mobile genetic elements; genome replication; genetic recombination; DNA repair; RNA synthesis, processing and metabolism; the genetic code; protein synthesis; regulation of gene expression; DNA cloning and microarrays; genetic disorders and gene therapy.

Recommended Texts:

1. David L. Nelson, Michael M. Cox (2000) *Lehninger Principles of Biochemistry* (third edition), Worth Publishers, Inc.
2. Robert F. Weaver (2005) *Molecular Biology* (third edition) McGraw-Hill.

300 LEVEL COURSES

ZL 302 Comparative Anatomy And Animal Physiology (2 credits)
Comparative anatomy and physiology of digestive, respiratory, excretory, circulatory, nervous, musculoskeletal, reproductive and endocrine systems in selected invertebrates and vertebrates; Homeostasis in vertebrates.
Practicals based on above.

Recommended Texts:

1. *Animal Physiology*. R. W. Hill, G. A. Wyse and M. Anderson. 3rd Edition.
2. *Eckert Animal Physiology: Mechanisms and Adaptations*. R. Eckert, D. Randall and G. Augastine. 5th Edition.
3. *Animal Physiology: Adaptation and Environment.* K. Schmidt-Nielsen. 5th Edition.

ZL 307 Fish Biology (2 credits)
Morphological, physiological and ecological diversity of fishes; Behavior, growth, life history strategies; Composition of major fish assemblages; Fishes and their habitats; Fish community structure, food webs and pollution dynamics.
Practicals based on above.

Recommended Text:

1. *The Diversity of Fishes: Biology, Evolution and Ecology*. Gene S. Helman, Bruce B. Collette, Douglas E. Kacey and W. Brian. 2nd Edition. Bowen Blackwell –Wiley.

ZL 314 Evolutionary Biology and Systematics (2 credits)
Conceptual and philosophic issues in evolutionary theory; Molecular evolution; Phylogenetics; Evolution and development; Limits on adaptation; Life history evolution; Phenotypic plasticity; Assessing the factors that affect rates of speciation and extinction; Causes of geographic variation in genetic diseases; Evolutionary applications in biomedicine, disease biology, biotechnology, climate change, conservation biology, aquaculture fisheries and wildlife management, forestry and agriculture. Course will consist of interactive lectures and discussions of scientific papers.
Practicals based on above.

Recommended Texts:

1. *Evolution*. Mark Ridley. 2nd Edition. Oxford University Press.
2. *Evolutionary Biology*. Futuyama D, 3rd Edition. Sinauer Associates, Sunderland, Massachusetts.
1. *From DNA to diversity: Molecular Genetics and the Evolution of Animal Design*.
2. Sean B. Carroll, Jennifer Grenier and Scott Weatherbee. (2013). John Wiley & Sons.

ZL 322 Insect Pest Management (2 credits)
(prerequisite ZL 206)
Introduction to insect pests; Insect population dynamics and pest status; Insect pests of agriculture, stored products, plantation crops, forestry, horticultural and export crops; household insect pests; Insect pest control; physical, biological, chemical and integrated

pest management. Insecticide resistance and mechanisms of resistance. Success stories of pest control.

Recommended Texts:

1. Agricultural Insect Pests of the Tropics and Their Control (1983) D.S. Hills. Cambridge University Press
2. Fundamentals of Applied Entomology (1985) R.E. Pfadt. 4th Ed. Macmillan Publishing Co.

ZL 323 Vector Borne Diseases (2 credits)

(prerequisite ZL 206)

Taxonomy, morphology, distribution and life cycle of medically and veterinary important vector borne pathogens; Emergence and resurgence of vector borne diseases; Dynamics of transmission; Detection and control; Integrated strategies to address vector borne diseases; Environmental and ecological relations, Outbreaks and geographic spread of vectors and pathogens; Vectors of medically and veterinary importance, and their control; Case study on currently important vector borne disease in Sri Lanka.

Recommended Texts:

1. Parasitology and Vector Biology (2000) W. C. Marquardt, R.S. Demaree and R.B. Grieve. 2nd Ed. Harcourt/Academic Press.
2. Infectious diseases (2000) B.A. Bannister, N.T. Begg and S.A. Gillespie 2nd ed. Blackwell Science Ltd.
3. Parasitic and Infectious Diseases: Epidemiology and Ecology (1994) M.E. Scott and G. Smith Eds. Academic Press Ltd.

ZL 324 Inland Fisheries and Aquaculture (2 credits)

(prerequisite ZL 307)

Island fisheries of Sri Lanka, its importance and potential: species involved, fishing gear and methods, techniques of natural stock enhancements in inland fisheries: fishery regulation and management.

Scope and role of aquaculture present status: Different types of aquaculture systems, species selection: Site selection, environmental demands, Pond Construction: Propagation; reproductive cycles of cultured aquatic animals and brood stock management, spawning induction: larval rearing of fin fish and shell fish: Aquaculture Management; water quality management in fish ponds, aeration, aquatic weed management, predators in aquaculture, fish handling and transport.

Recommended Texts:

1. Aquaculture: Principles and Practices (2005) T.V.R. Pillay and M.N. Kutty. 2nd Ed. Blackwell Publishing.
2. Aquaculture Training Manual (1993) Donald R. Swift. 2nd Ed. Fishing News Books.
3. Sri Lanka Fisheries Year Book (2012) National Aquatic Resources Agency.
4. Fisheries Sector in Sri Lanka (2009) Compiled by the Ceylon Chamber of Commerce.

ZL 326 Animal Behaviour (2 credits)

An evolutionary approach to animal behaviour; Proximate and ultimate causes of behaviour; Development of behavior; Heredity and environment; Economic decisions; Evolutionary arms race; Competition for resources; Living in groups; Fighting and assessment; Sexual conflict; Parental care and mating systems; Selfishness and altruism.

Recommended Texts:

1. An Introduction to Behavioural Ecology (1981) J.R. Krebs and N.B. Davies. 3rd Ed. Blackwell Science.
2. Animal behavior (2001) Alcock John. 8th Ed. Sinauer Association, Inc.

ZL 327 Animal Genetics and Molecular Biological Techniques (2 credits)
(similar to MB 226/ BT 307)
Genetic variation; Chromosomal and extra-chromosomal inheritance; Variation in chromosome number and structure; Organization of prokaryotic and eukaryotic genomes; DNA replication, transcription and translation; Genetic code; Regulation of gene expression; DNA and RNA extraction; Genomic DNA and Complimentary DNA, Agarose and Polyacrylamide gel electrophoresis; DNA manipulative enzymes; Polymerase Chain Reaction and Gene Cloning; Repetitive DNA sequences; DNA fingerprinting and barcoding; DNA microarrays and RNA interference (gene silencing); DNA sequencing; Genetic disorders and gene therapy.

Recommended Texts:

1. Principles of Genetics (2012) D.P. Snustad and M.J. Simmons. 6th Ed. John Wiley and Sons.
2. Molecular Biology (2011) R.F. Weaver. 5th Ed. McGraw-Hill.
3. Gene Cloning and DNA Analysis (2010) T.A. Brown. 6th Ed. Wiley-Blackwell.
4. Understanding DNA Technology (2012) S.H.P.P. Karunaratne and S.D.S.S. Sooriyapathirana. Science Education Unit, Faculty of Science, University of Peradeniya.

ZL 328 Herpetology (3 credits)
(prerequisite ZL 216)
Transition from water to land; Evolution and adaptive radiation of amphibians and reptiles; Biology of herpetofauna; Communication and behavior of amphibians and reptiles; Parental care and reproductive strategies; Herpetofauna as bio-indicators; Global and local threats to herpetofauna; Conservation and management of amphibians and reptiles; K/T extinction of dinosaurs.

Recommended Texts:

1. Herpetology: an introductory biology of amphibians and reptiles (2001) G.R. Zug, L.J. Vitt & J.P. Caldwell. 4th Ed. Academic Press.
2. Biology of Amphibians (1994) W.E. Duellman. JHU Press.
3. Reptiles and Amphibians, their care and behaviour (1964) Z. Vogel. London. Studio Vista Press.
4. Vertebrates: Comparative Anatomy, Function, Evolution (2006) K.V. Kardong . 4th Ed. Boston: McGraw-Hill.
5. The Life of Reptiles (Vol. 1). (1970) A.D.A. Bellairs. New York: Universe books.

ZL 329 Avian and Mammalian Biology (3 credits)
(prerequisite ZL 216)
Origin and evolution of birds; Form & function: feathers and dynamics of bird flight; Vocalizations; Social behavior; Annual cycles of birds; Migration and navigation; Avian life histories: mates, breeding systems, nests and incubation; Population dynamics; Adaptive radiation of birds: Darwin's finches and Hawaiian honeycreepers; Origin and

evolution of mammals; Mammalian characteristics; Biology of prototherians (egg-laying mammals), metatherians (marsupials), and eutherians (selected groups including elephants, primates, rodents, bats, carnivores, artiodactyls, and cetaceans).

Recommended Texts:

1. Ornithology (2007). Gill, F.B. 3rd Ed. W.H. Freeman and Company, New York.
2. Manual of Ornithology: Avian Structure and Function.. (1993). N.S. Proctor and P.J. Lynch. Yale University Press, New Haven and London.
3. A Manual of Practical Mammalian Cranial Morphology (2000) C. Santiapillai. Science Education Unit, University of Peradeniya, Peradeniya.
4. An Illustrated Guide to the Endemic Birds of Sri Lanka (2002) C. Santiapillai and C. Wijesundara. Science Education Unit, University of Peradeniya, Peradeniya.
5. Mammalogy (2011). T.A. Vaughan, J.M. Ryan and N.J. Czaplewski. 5th Ed. Jones and Bartlett Publishers, Sudbury, Massachusetts.

ZL 330 Ecotourism and Nature Conservation (2 credits)

Historical perspective of ecotourism; Ecotourism vs mass tourism; Socio-cultural impacts; Regional economic development; Zoos, wildlife parks and other ecotour attractions; Ecotourism resorts and tour companies; International and domestic ecotourism; National and international policies and accreditation programs; Future trends; Constraints and pitfalls; Ethics in ecotourism; Case study analysis.

Recommended Texts:

1. Tourism, Ecotourism and Protected Areas: The State of Nature-Based Tourism around the World and Guidelines for Its Development. (1996). Ed. H. Cebellos Lascurdin. World Conservation Union. Island Press.
2. Ecotourism: An Introduction. (2007) D.A. Fennell 3rd Ed. Routledge London.

ZL 331 Limnology and Wetland Ecology (2 credits)

Physics, chemistry and biology of freshwater systems; Emphasis on: morphometry; Light and temperature; Water chemistry in relation to nutrients; Physiological requirements; Composition and interaction of algal and invertebrate populations; Eutrophication; Pollution; Environmental change of freshwater systems.

Recommended Texts:

1. Limnology: Lake and River Ecosystems (2001) R.G. Wetzel 3rd Ed. Academic Press.
2. Wetland Ecology: Principles and Conservation (2000) P.A. Keddy. Cambridge University Press.

ZL 332 Quantitative Ecology (2 credits)

(prerequisite BL 103)

Ecological data; Hypothesis testing in ecology; Estimating abundance in animal populations; Line transects, quadrat counts, mark-recapture techniques; Population growth and carrying capacity; Population regulation; Age structure; Life history strategies; Survivorship curves and life tables; Interspecific interactions: Investigating food habits of terrestrial vertebrates; Niche overlap and diet analysis; Species diversity measures.

Recommended Texts:

1. Research Techniques in Animal Ecology (2000) L. Boitani and T.K. Fuller. Columbia University Press, New York.
2. Practical Statistics for Field Biology (1998) J. Fowler, L. Cohen and P. Jarvis. Wiley, New York.
3. Ecological Methodology (1999) C.J. Krebs. 2nd Ed. Benjamin/Cummings, Menlo Park, California.
4. Fundamentals of Ecology (2009) E.P. Odum and G.W. Barret. 5th Ed. Thomas Brooks/Cole, Belmont, California.

400 LEVEL COURSES

ZL 404 Applied Parasitology (3 credits)

(prerequisite ZL 323)

Epidemiology of parasitic diseases with special reference to Sri Lanka; Drug resistance of parasites; Zoonoses; Emerging and re-emerging infectious diseases; Epidemiology and control of helminthes in livestock; Parasite behaviours; Parasite-induced alterations in host behavior, reproduction and survival; Evolution of parasitism; Impact of parasites on wild animal health and population declines; Medically and veterinary important arthropods and vector borne diseases; Diagnostic techniques of parasitic diseases; Assignments and discussions on current research articles.

Practicals based on above.

Recommended Texts:

1. *Parasitology and Vector Biology*. W. C. Marquardt, R.S. Demaree and R.B. Grieve.(2000).
2. *Atlas of Human Parasitology*. L.R. Ash and T.C. Orihel.
3. *Human Parasitology*. Burton J. Bogitsh & Thomas C. Cheng .3rd Edition.
4. *Parasitology in Focus*. Heinz Mehlhorn (1988).

ZL 406 Environmental Biology (3 credits)

Adaptation to environment and adapting environment: man's position and his impact on earth, overpopulation and environmental degradation, worldwide population trends; Atmosphere; Greenhouse effect and global warming; Ozone depletion; Types, Sources and Effects of air pollution: acid rain, photochemical smog; organic pollution; Carcinogenic and mutagenic effects of chemicals; Agrochemicals and their problems; Aquatic pollution; Algal toxins; Heavy metal pollution; Thermal pollution; Sound and noise pollution; Biological effects of radiation: health effects on humans and other animals; Land use; Urbanization; Sewage; Soil and land pollution; Industrial pollution; Introduction to Climatology: El Nino and southern oscillation; Earthquakes; Volcanism & Tsunamis; Resource development and Environmental Impact Assessment (EIA) in Sri Lanka; Government and environmental policy; International conventions and protocols related to environment.

Practicals based on above.

Recommended Texts:

1. *Living in the Environment: Principles, Connections and Solutions*. Tyler, G. and Miller Jr. (2004). Thompson books.
2. *Environmental Science and Engineering*. J.G. Henry and G.W. Heinke. 2nd Edition. Prentice Hall.

3. *Guidelines for Baseline Ecological Assessment*. Ed. Institute of Environmental Assessment.
4. *El Nino and the Southern Oscillation*. Eds. H.F. Diaz & V. Markgraf.
5. *Environmental Science with Infotrac: Working with the Earth*. G.T. Miller.

ZL 407 Immunobiology (3 credits)
Adaptive and innate immunity; cells and soluble mediators of immune system; Antigens and antigen presentation; inflammation; Antibodies; T-cell receptors; Major histocompatibility complex; Cytokines and cytokine receptors; Evolution of immunity; Vaccination; Tumor immunology; Immunodeficiency; Transplantation and rejection; Autoimmunity and autoimmune diseases; Hypersensitivity; immunological techniques.
Practicals and discussions based on above.

Recommended Texts:
1. *Immunology*. David Male, Jonathan Brostoff, David Roth and Ivan Roitt, 7th Edition.
2. *Immunology*. Roitt I., Brostoff J., Male D., 6th Edition.

ZL 410 Marine Biology and Fisheries (3 credits)
The ocean as a habitat: circulation, tides and waves; properties of sea water; Marine habitats and biodiversity; deep sea, open ocean, coastal sea; The intertidal zone; primary productivity in the sea: phytoplankton and macro-algae; Major invertebrate groups; Fishes, reptiles, birds and mammals; Larval dispersal and Migrations; Coral and other reefs; Human impacts: over-exploitation of marine resources; pollution, introduced marine pests, tourism; Sri Lankan marine flora and fauna;; Inshore and offshore fishery; Fishing gear; Marine fishery resources of Sri Lanka; Mariculture of shellfish.
Practicals based on above.

Recommended Texts:
1. *The Effects of Fishing on Marine Ecosystems and Communities*. S.J. Hall.
2. *Marine Pollution*. R.B. Clark.
3. *Marine Biology: An Ecological Approach*. J.W. Nybakken.

ZL 411 Wildlife Management (3 credits)
Wildlife Census Techniques; Population: Growth and Regulation; Carrying capacity; Sustainable Yield Harvesting; Effective Population Size (EPS); Minimum Viable Population (MVP); *In-situ* and *Ex-situ* conservation; Extinction; Vertebrate pest control; Management of Threatened Wildlife; Island Biogeography and Principles of Reserve Design; Categories of Protected Areas; Protected Areas of Sri Lanka; Wildlife and Society; International Conventions.
Field studies and assignments.

Recommended Texts:
1. *Wildlife Ecology and Management.* Bolen, E.G. and Robinson, W.L. (2003). Prentice Hall, Inc., New Jersey.
2. *Wildlife Ecology, Conservation, and Management.* Sinclair, A.R.E., Caughley, G., and Fryxell, J.M. (2006). Blackwell Publishing.

ZL 412 Biodiversity and Conservation Biology (3 credits)
Ecosystem- and genetic diversity; Global patterns and Values of biodiversity; Effective population size, Inbreeding and Gene flow; Overexploitation; Demography and Extinction processes, Population viability analysis; Endangered species and their

protection; Exotic introductions and Invasive species; Ecosystem degradation, Habitat fragmentation and Edge effects; Habitat pollution; Modified ecosystems, Ecosystems management and Restoring ecosystems; Protected areas; Captive breeding and reintroduction; Zoos and Gardens; Human population growth ; Human impact; Sustainable development; Law and politics; Social factors in conservation; Economics of conservation; Conservation politics.

Recommended Texts:

1. *Principles of Conservation Biology*. G.K. Meffe & C.R. Carroll. 1997.
2. *A Primer of Conservation Biology*. R.B. Primack
3. *Global Biodiversity Assessment*. ed. V.H. Heywood.

ZL 421 Scientific Writing and Presentation (2 credits)

History and origin of scientific writing; Types of scientific journals and articles and their characteristics; Scientific method; Information retrieval methods (Print & electronic); Format and content of a research paper; Guidelines for making an effective scientific presentation (oral and poster); Guidelines for writing a project proposal, research report and thesis; Ethics in research and scientific writing; Plagiarism; Critical examination and presentation of a scientific paper; Interactive discussions of scientific papers.
Assignments based on above.

Recommended Texts:

1. *How to Write and Publish a Scientific Paper*. Robert A. Day (1998). Vikas Publishing House, India.
2. *How to Write Dissertations and Project Reports*. Kathleen McMillan & Jonathan Weyers (2011). Prentice Hall.
3. *Developing a Research Proposal*. Pam Denicolo & Lucinda Becker (2012) SAGE Publications.

ZL 424 Research Methods and Data Analysis (2 credits)

(prerequisite ZL 205)

Designing and conducting research; Data collection; Concepts of probability and probability distributions and how they are applied in statistical testing; developing and testing hypothesis; Errors in hypothesis testing; Parametric and nonparametric statistics; Univariate and multivariate data analysis; Applications of statistical packages.

Recommended Texts:

1. The Analysis of Biological Data (2009) M.C. Whitlock & D. Schluter. Greenwood Village, Colorado: Roberts and Company Publishers.
2. Multivariate Statistics for Wildlife and Ecology Research (2002) K.S. McGarigal, S. Cushman and S. Stafford. 2nd Ed. Springer, New York.
3. Ecological Diversity and Its Measurement (Vol. 168) (1998) A.E. Magurran & A.E. Magurran. Princeton: Princeton university press.
4. Statistical Methods: An Introductory Text (1992) J. Medhi. 2nd Ed. New Age International.
5. Fundamental Statistics for Behavioral Sciences (1990) B.M. Robert 5th Ed. Harcourt Brace Jovanovich, New York.

ZL 425 Entomology (3 credits)
(prerequisite ZL 322)
Insect systematics; Anatomy and physiology of insect organ systems; Development and growth; Sensory perception; Communication and behavior of insects; Insect adaptations to live in different environments, Social insects; Apiculture; Insect pollination; Predatory and parasitic insects; Insects of forensic importance.

Recommended Texts:

1. The Insects Structure and Function (2012) R. F. Chapman 5th Ed. Cambridge University Press.
2. Forensic Entomology. The Utility of Arthropods in Legal Investigations. (2010) Jason H. Byrd & James L. Castner. Taylor and Francis, CRC Press.
3. Imms' General Textbook of Entomology: Volume 1: Structure, Physiology and Development (1977) O.W. Richards and R. G. Davies. Springer Science & Business Media.
4. Imms' General Textbook of Entomology: Volume 2: Classification and Biology (1977) A.D. Imms, O.W. Richards and R. G. Davies. Springer Science & Business Media.

ZL 426 Developmental Biology (2 credits)
(prerequisite ZL 201)
Fate, potency, cell specification and differentiation, morphogenesis, cell adhesion in embryonic development; Genome equivalency and differential gene expression; Stem cells, regeneration, animal cloning, maternal and zygotic control of gene expression; Cell-cell communication during development: inductive events, signal transduction cascades, cell death pathways; Patterning the embryonic body plan: embryonic axes and germ layers, tetrapod limb development.

Recommended Texts:

1. Developmental Biology (2014) S. F. Gilbert 10th Ed. Sinauer Associates, Inc., Publishers.
2. Principles of Development (2007) J. Smith, P. Lawrence and L. Wollpert. 3rd Ed. Oxford University Press.
3. Evolutionary Developmental Biology (1999). B. K. Hall (1999). 2nd Ed. Kluwer Academic Publishers
4. An Atlas of Embryology (1978) W. H. Freeman and B. Bracegirdle. 3rd Ed. Heinemann Educational Books, UK.
5. Langman's Medical Embryology (2011). T.W. Sadler Lippincott Williams and Wilkins, 12th Ed. Wolters Kluwer Business, USA.

ZL 428 Independent Study and Seminar (2 credits)
Make a presentation of an assigned topic after literature survey and produce a written article on the topic critically analyzing primary literature. Write two essays in the class on given topics after due preparation and literature survey.

Recommended Texts:

1. Primary Literature relevant to the topic.
2. The Craft of Scientific Presentations; Critical Steps to Succeed and Critical Errors to Avoid (2003) Michael Alley Springer-Verlag New York, Inc. (Available online).
3. Designing Science Presentations: A Visual Guide to Figures, Papers, Slides, Posters, and More (2013). Matt Carter 1st Ed. Elsevier Inc.

ZL 491 Research Project (6-8 credits)

A research project on a given zoological topic shall be carried out under the supervision of staff members. The student is expected to write the Research Proposal and present it, carry out a literature survey and, on completion of the project, make an oral presentation of the work and submit a written report.

SI 401 Industrial training (2 credits)

Each student will undergo full time training in the industry for the prescribed period on projects assigned by the industry. Students are required to have a duly maintained 'Daily Diary' which should be submitted to the Head of the Department within two weeks after completion of the training. In addition, the students are expected to write a report and make a presentation on the work carried out by them.

SUPPLEMENTARY COURSES

ECONOMICS

EC 201 Introductory Economic Theory (3 credits)

Introduction to microeconomics : Scopes, subject matter and concepts, economical problems; scarcity and choice, opportunity costs, different economic systems. Theory of price: theories of Demand and Supply, the price determination, theory of elasticity. Government role in the economy: Government intervention, taxation and expenditure. Theory of production: short run and long run production functions

Theory of costs: short run and long run costs, law of diminishing marginal productivity, law of returns to scale

Theory of the firm: perfect competition, monopoly and monopolistic competition

Factor markets and price determination. Introduction to macroeconomics: problems and issues: inflation and economic growth. Macroeconomic modeling: circular flow of income, aggregate demand and supply: macroeconomic equilibrium, determination of National Income and output, fiscal and monetary policies.

Money supply and demand; definition of money, creation of money, real GNP and price level.

The global economy: international trade, balance of payment and determination of exchange rate 6hrs

Recommended Texts:

1. Lipsey, R.G and K. Alec Chrystal, 1995, *Introduction to Positive Economics*, 8th Edition, Oxford: Oxford University Press.
2. Samuelson P.A and William D. Nordhaus, 1998, *Economics*, 16th Edition, New York: The McGraw Hill.
3. Parkin M, Powel M and Kent Matthews, 1997, *Economics*, 3rd Edition, Addison Wesley Longman Limited
4. Shapiro E and William J. Baumol, 1970, *Macroeconomic Analysis*, Harcourt, Brace & World.
5. Dornbusch R and Stanley Ficsher, 1980, *Macroeconomics*, 2nd Edition, New York: McGraw Hill.
6. Ghosh B.N and Rama Ghosh, 1993, *Modern Macroeconomics*, 1st Edition, Bombay, Himalaya Pub House.

EC 301 The Sri Lankan Economy (2 credits)

(Prerequisite EC 201)

An introduction to the Sri Lankan economy, Economic progress in independent Sri Lanka: an overall assessment, Sri Lanka's position in the world economy. Primary sector performance, issues and prospects, Industrial sector issues and prospects, services sector, issues and prospects. Government activity, External trade and balance of payments.

Foreign direct investment, Financial institutions and capital markets. Population, poverty and unemployment, Economic development and natural environment. Regional cooperation and economic integration.

Recommended Texts:

1. Athukorala,P. and Jayasuriya, S.(1994) *Macroeconomic Policies, Crises and Growth in Sri Lanka, 19601990*, The World Bank, Washington.
2. Central Bank (1998) *Economic progress of Sri Lanka*, Central Bank, Colombo.
3. Karunathilake, H.N.S. (1987) *The Economy of Sri Lanka*, Centre for

Development studies, Colombo.
4. Lakshman, W.D. (ed.) (1997) *Dilemmas of Development: Fifty years of Economic Change in Sri Lanka*, Sri Lanka Association of Economists, Colombo.
5. Lake House (1986), *Facets of Development in Independent Sri Lanka*, Lake House, Colombo.

MANAGEMENT STUDIES

MG 201Management Studies I (2 credits)

Business Organizations and Environment: Why Organization Exists, Vision, Missions, Goals .An introduction to the Type of Businesses. The Business and Its Environment
Evolution of Management:Managerial Roles And Skills. Model of effective management
Planning: Plan, Goal Setting, Assess Alternatives, Selecting Best Path, Implementation of Plan
Organizing: Division of Labor, Co-ordination, and Guideline for organizing, Staffing: HR Planning, Job Analysis & Design, Recruitment and Selections, Motivation, Communication, Team Building, Trades Unions, Industrial
Relations, Inter-personnel Relations, Conflict Management. Directing: Leadership.
Controlling Accounting: Introduction to Financial Statements. Preparation & Analysis of Financial Statements

Recommended Texts:

1. Beardwell Ian and Len Holden, 1997. *Human Resource management*,*2nd edition*, Pitman London.
2. George,Clande S. Jr. 1974. *The History of Management, Trought*. New Delhi: Prentice Hall
3. Jennings, A.R. 1997, *Financial Accounting*, *2nd edition*, ELBS, London.
4. Koontz, Harold and Heninz Weihrich, 19993. *Management: A Global Perspective*, *10th edition*, McGraw-hill, New York
5. Stoner, James A.F. and Freeman Edward K, 1995. *Management*, Prentice Hall, New Delhi
6. Wood, Frank, 1984. *Business Accounting*, *Vol.1 & 2, 4th edition*, Pitman, London.

MG 301 Management Studies II (2 credits)

Operation Management: The Process, Planning and controlling, scheduling & Loading and Designing, Quality control, Quality Circle. Industrial Engineering: Plat location & layout, Material handling, Work & Method Study, MIS for operation, Equipment Replacement Management. Design Project and Project management Inventory & Ware-House Management. Productivity and 5 S' system
Marketing Management :The role of Marketing organization and society .Fundamentals of Marketing. Marketing Mix and Production Mix. Product Life Cycle & Consumer Behavior. Issues in Market Segmentation and Target Market. Corporate Marketing Strategies.
Financial Management: Evolution of Financial Management. Goals of FM. Financing, Investing and Dividend Decisions. Capital Budgeting, Working Capital Management,
Financing and Financial Institutions
Management Quantitative Techniques: Business Mathematics and Decision-Making, Business Forecasting. Project Evaluation, Linear Programming, Quality Control,

Inventory model, Network Analysis, Queuing theory, Regression Analysis, Transportation Model.

Recommended Texts:

1. Jain, K.C.& Aggraval, 1990. *Production Planning and control and Industrial Management* , Khanna Publishers, Delhi.
2. Karunarathne, K.M.R.T.1995. *Quantitative Methods For Management*: *with applications in planning and decision making,* Author Published, Moratuwa.
3. Kotler , Philip, 1999. *Marketing Management: Analysis, Planning and control*, Prentice-Hall, USA
4. Kooper , V.K. 1994. *Operations Research, (for Managerial decision making*),New Delhi. Sultan Chand.
5. Lucey, T. 1992, *Quantitative Techniques*, D.P.Publications ,London.
6. Schall , L.D. and Haley C.W. 1991. *Introduction to Financial Management, 6th edition,* McGraw-Hill, New York.
7. Woolf, Emile, 1985, *Financial Management, 3rd edition*, Prentice-hall, Delhi.

SCIENCE EDUCATION

SE 101 Science and Society (3 credits)

(Only for the students who follow the Computational Management programe)

The Scientific Method; Induction and Deduction; Scientific Revolutions: Ancient and Modern Science; Science of Non-Western Societies; Colonial Science; Science and Ethics; Values in Scientific Research and Results; Indigenous Knowledge systems; Technology and Science; Science and Technology in Development; Important Discoveries of Modern Science and their Development; Institutionalization of Science and Technology; Modern Scientific Research and its Funding; Role of Multinationals; Science and Warfare; Scientists and Social Responsibility; Risk and Uncertainty in Science; Science and the Media; Food and Population; Energy; Environment; Oceans; Outer Space; Technology and Trade; Science and Developing Countries

Recommended Texts:

1. Okasha, S. 2002, *Philosophy of Science, A Very Short Introduction*, Oxford: OUP
2. Bird, A, 1998, *Philosophy of Science*, Montreal: McGill-Queen's University Press
3. Kuhn, T, 1962, *The Structure of Scientific Revolutions*, Chicago: University of Chicago Press
4. Harre, R., 1981, *Great Scientific Experiments*, New York: Dover Publications
5. Moore, P 2002, $E=mc^2$, *The Great Ideas that shaped our World*, London: Quintet Publishing
6. Barnes, B (ed.), 1972, *Sociology of Science*, Penguin, London
7. Barnes, B *et al*., 1996, *Scientific Knowledge: A Sociological Inquiry*, Athalone, London

SE 201 Foundations in Science Education (2 credits)

How science and science education has progressed in Sri Lanka and globally. Philosophical background that supported to develop science as a discipline. Scientific inquiry and scientific thinking. Nature of science, Scientific method and applications. Cognitive and psycho-social development of the child. Socialisation process in the

classroom, school and community.

Recommended Text:

1. W.Harlen, *Teaching, learning and assessing science*.

SE 202 Educational Philosophy and Educational Management (2 credits)

(Prerequisite: SE 201)

What is philosophy? Need of philosophy in science teaching. Contributions of Dewey, Plato and Rousseau and their relevance to education in a modern society.

School amd classroom management. Functions of an educational manager. Monitoring, mentoring, supervision and inspection of school contexts.

Recommended Texts:

1. RB Sund and LW Torbridge, *Teaching science by inquiry in the secondary school*,
2. M.Braine, D.Kerry and M.Piling ,*Practical classrroom management*

SE 301 Methodology in Teaching Science (2 credits)

(Prerequisite: SE 201)

Preparation to be a science teacher. How to teach science using different methods and strategies to encourage active student learning with special reference to cooperative and collaborative learning and constructivism. A learning model towards meaningful learning. Teaching practice. Currculum design. How to plan a science lesson, laboratory activity, demonstration.

Recommended Texts:

1. K.Barry and L.King ,(1998)Beginning teaching, Social sciences Press
2. W.Harlen, (2000) *Teaching, Learning and assessing Science* , Paul Chapman publishing Ltd.

SE 302 Teaching practice (2 credits)

(Prerequisite: SE 201)

Lesson planning to teach a unit or two units in Grades 6-10 science/mathematics syllabus and implement those plans in classroom teaching.

Recommended Texts:

1. K.Barry and L.King ,(1998)*Beginning teaching,* Social sciences Press
2. JE Kemp, (2000) *Instructional design, A plan for unit and course development*, John Wiley .

SE 303 Assessing students in the learning process (2 credits)

(Prerequisite: SE 201)

Scales of measurement (nominal, ordinal, interval & ratio). Measures of central tendency (mean, median & mode) frequncy distributions, noraml and skewed distributions. Taxonomy of educational objectives in cognitive domain. Different types of assessments. On going assessments and assessing practicals. School-based assessment (SBA). Constructing a test and checking for validity and reliability. Marking answer scripts and awarding a grade using formal and non-formal assessments.

Recommended Texts:

1. K.Barry and L.King ,(1998)*Beginning teaching,* Social sciences Press
2. W.Harlen, (2000) *Teaching, Learning and assessing Science* , Paul Chapman publishing Ltd.

SE 310 Introduction to Scientific Writing (1 credit)

Identification of different subtopics in a scientific report. Type of information presented under different subtopics. Avoiding plagiarism. Methods of quoting references in the text. Methods of referencing in different bibliographic styles. Deciding on information to be included in the abstract.

Recommended Texts:

1. Gustavi, B. (2008) How to write & illustrate a scientific paper. Cambridge University Press
2. Rubens, P. ed. (2002) Science & technical writing: a manual of style. Taylor and Francis, NY
3. 3. Day R.A. (2006) How to write and publish a scientific paper (6^{th} Ed.) Cambridge University Press

APPLIED SCIENCES SUBJECT AREA

An additional 30 credits at 400 level from the course units in the Applied Sciences subject area, as stated below.

- All the compulsory courses, which are of multidisciplinary in nature (11 Credits)
- Industrial training component (8 Credits)
- At least 11 credits of optional courses selected from at least three subject categories among six subject categories based on biology, chemistry, geology, mathematics, physics and statistics & computer science.

AS 400 Industrial Management (2 credits - Compulsory)

Approaches to Management: Introduction to Management; Organizations and importance towards effective work; The scientific, the human relation, the quantitative and the systems approach.

Group Dynamics: Formal and informal organizations, teamwork & teambuilding; self managing teams; Motivation; motivational drives, models of motivation, behaviour modification, contemporary motivational approaches; Productivity and worker satisfaction.

Communication in Organizations: The Two-Way communication process, communication barriers, upward, downward and lateral communication. public speaking.

Managing Conflicts Stress and Counseling: Nature and level of conflict, sources of conflict, effects of conflict, conflict resolution, change management; Work change, resistance to change, implementing change successfully; Stress and job performance, approaches to stress management, employee counseling; Effect of culture on organizational behavior and its impact on management.

Recommended Texts:

1. Jain, K.C. and Aggraval, S. (1990) *Production Planning and Control, and Industrial Management*, Khanna Publishers, Delhi.
2. Karunarathne, K.M.R.T. (1995) *Quantitative Methods for Management: with applications in planning and decision making*, author published, Moratuwa.

AS 401 Industrial Placement (8 credits)

Train students with work experience in an industrial environment and to produce a model science graduate to be competent to work in the industrial sector through variety of activities as specified by Sri Lankan industries. Students will specifically gain knowledge in the following areas during this period: Type of raw materials; Industrial process; Problems associated with the process; Quality control; Research & Development aspects; Management aspects.

This course will be graded based on evaluation by industries, report

AS 402 Research methodology and scientific writing (2 credits)

***Methods of Research*:** To provide skills of survey and quantitative research methods.

***Scientific Writing*:** Literature survey – traditional and modern methods; Improve scientific report writing skills: writing abstracts, summary of research papers, proposal writing, etc.

Recommended Texts:

1. Kumar, R.,(2005) *Research Methodology: A Step-by-Step Guide for Beginners, 2nd edition.*
2. Yin, R. K., (2003) Case Study Research: Design and Methods, 3rd edition.

AS 403 Seminar (1 credit)

Under this course undergraduate students will give oral presentations and listen to presentations by various people in Departments and by other speakers. Each student enrolled in the course will give one oral presentation which will be evaluated by a team of members of the Faculty. Learning from and with each other is one important aspect of this course. Participation includes punctual attendance, engagement with topics being discussed, answering the posed relevant questions etc.

20-minute Student Seminar: Students are encouraged to choose a topic with the guidance of a faculty member assigned. After preparation of a 20-minute presentation based on material in the published literature (journal articles or websites), it should be then submitted to the lecturer assigned by the coordinator for approval. This will be then presented to a selected audience according to a roster.

These seminars will be graded based on continuous attendance, performance/speaking ability, grasp of material, use of appropriate visual aids, answers to questions, and an overall presentation.

AS 404 Data Integrity Management & Data Analysis (2 credits-Compulsory)

***Data Integrity Management*:** Good laboratory practice (GLP); Facilities and equipment (including computer systems); Use of equipment; Managing test and reference items and reagents; Design of experiments to obtain variable data; Record keeping; Storage and retention of records and materials; Maintenance and calibration of equipment; Standard operation procedures; Multi-site and multi-laboratory studies.

***Errors of Measurements*:** Concept of significant figures; Uncertainty of measurements; Statistical averages and deviations such as mean, median, standard deviation, relative deviation; Statistical tests such as Q test, Z test, t test, F test, and confidence intervals; propagation of errors; Errors in instrumental methods; Linearization and graphical analysis; Method of least squares.

***Data analysis*:** Data preparation and applications of statistical techniques using statistical software.

Recommended Texts:

1. Priyantha, N., (1999) *Measurements and Errors in Chemical Analysis*, Printing Unit, Faculty of Science, University of Peradeniya.
2. Myers, R.H., (1990) *Classical and Modern Regression with Applications*, Duxbury Press.
3. Jobson, J.D., (1991) *Applied Multivariate data Analysis, Vol I: Regression and Experimental Design*, Springer.
4. MINI TAB Reference Manual.

AS 409 Industry and the Environment (2 credits-Compulsory)

Chemical Aspects: Effect of industrial activities on the environment; Guidelines for discharge of industrial effluents; Water quality and air quality: chemical aspects, classical and instrumental methods for determination of water quality and air quality parameters, analytical aspects; Treatment of water and waste water: chemical and biological methods, low-cost and modern methods.

***Sound Pollution*:** Sound pollution due to various industrial activities in Sri Lanka; Pollution parameters of sound and measurements of sound pollution.
***Air Pollution*:** Air pollution and climate change; Biomonitoring of environmental pollution: concepts, active and passive monitoring, bioindicator parameters, control of air pollution by plants, green belt design.
Field Visits: Industrial /Field visits to various industries.

Recommended Texts:

1. Manahan, S.E., (1994) Environmental Chemistry, Lewis Publishers.
2. Ileperuma, O.A., (1995) *Environmental Pollution and the Future of Mankind*, Science Education Unit, Faculty of Science, University of Peradeniya.
3. Alloway, B.J., and Ayres, D.C., (1993) *Chemical Principles of Environmental Pollution*, Blackie Academic Professional.

AS 410 Industrial Applications Laboratory (2 credits)
Analysis of Industrial Effluents: Determination of parameters, such as DO, BOD, COD, TDS, SS, floatables, conductivity, hardness, anions, etc.
Analysis and quality control of industrial materials: Operation of modern instrumentation used in the industrial sector such as X-ray fluorescence spectrometer, X-ray diffractometer, atomic absorption spectrophotometer, gas chromatograph, thermogravimetric apparatus & differential thermal apparatus, etc; Selected experiments using above instruments as applied to quality control processes of industries; Analysis of industrial raw materials and products such as cement clinker, ceramics, clay, dolomite, apatite, mineral sands, etc.

Recommended Texts:

1. Shoemaker, D.P., Garland, C.W. and Nibler, J.W., (1996) *Experiments in Physical Chemistry*, McGraw Hill
2. Skoog, D.A., Holler, F.A. and Crouch, S.R. (2007) *Principles of Instrumental Analysis*, Thomson

AS 414 Industrial Microbiology (2 credits)
Microorganisms with industrial and environmental use and their products; Growth and product formation in industrial processes; Large scale fermentations: proteins, antibiotics, organic acids, amino acids, enzymes, vitamins, food, alcoholic beverages, fuel and energy, microbial quality of water; Setting up a microbiological laboratory. [Selected titles from the above course content will be offered each year]

Recommended Texts:

1. Glazer, A.N., and Nikaido, H., 1995. Microbial biotechnology. Fundamentals of Applied Microbiology. New York: W.H. Freeman & Company
2. Madigan, M.T., Martinko, J.M. and Parker. J., 2000. Brock Biology of Microorganisms. 9 th ed. Prentice Hall

AS 415 Biodiversity Conservation and Sustainable Development (2 credits)
Impart Knowledge and Develop Skills on Biodiversity Conservation and Management: Changes of biodiversity over space and time; Assessing and Monitoring biodiversity; Conservation of biodiversity; Managing species and habitats
Sustainable Use of Biodiversity: Timber and non timber forest products; Medicinal plants and lesser known timber species in Sri Lanka, Indigenous knowledge; Ecotourism
Production Forestry and Biodiversity Conservation: Forest management; Impacts of forestry practices in the conservation of biodiversity, Sustainable forestry practices; Soil fertility management for the conservation of biodiversity;

Computer Aided Data Analysis and Management of Biodiversity: Identification and classification of vegetation types/habitats using the computer programmes PC ORD, XL stat, Estimates.

Laboratory and Field Work: Assessing and monitoring biodiversity, Estimating the plant species diversity in a forest, data analyses and identifying different vegetation types

Recommended Texts:

1. Meffe, G.K. and Carroll, C.R. (1997). *Principles of Conservation Biology*
2. Primack, R.B. *A, Primer of Conservation Biology*
3. Kent, M and Coker, P. (1992). Vegetation description and analysis- a practical approach. Jhon Wiley & Sons, New York

AS 416 Fisheries and Aquaculture (2 credits)

Inland Fisheries in Sri Lanka: Brief history and the recent developments in the industry, species involved and the gear used. Fishery regulation, sustainable utilization and potential for future developments.

Aquaculture: General principles and economics of aquaculture, culturable fish and shellfish species, design and construction of aquafarms, fish nutrition and feeding, farm management, integration of aquaculture with crop and livestock farming, marketing of aquaculture products and aquarium fish trade.

Laboratory studies: Identification of fish species, fish parasites and diseases, preparation of aquarium tanks

Field visits: visits to brackish water prawn farm, cage culture facility, fish processing unit, freshwater aquarium fish farm, reservoir with well organized fishery.

Recommended Texts:

1. Agarwal, A.C. 1994. A hand book of fish farming. Narendra Publishing House, Delhi, India.
2. Santhanan, R., Sukumaran, N, and Natarajan, P. *A Manual of Freshwater Aquaculture.*
3. Baluyut, E.A. *Aquaculture Systems and Practices: A Selected Review.*
4. Vadapalli Satyanarayana. 1996. A symposium on fish culture. Narendra

AS 417 Food and Fresh Produce Technology (2 credits)

Training on research & development and quality control aspects of fresh produce handling; food processing and safety; packaging and analysis; floriculture.

Recommended Texts:

1. Kirk, R.S. and Sawyer, R. (1991) *Pearson's Composition and Analysis of Food*, Longman.
2. Vanderwerf, C.A. (1960) *Food Chemistry, Reinhold Organic Chemistry and Biochemistry Textbook Series*.

AS 418 Ecotourism (2 credits)

Impart knowledge and develop awareness on non-detrimental tourism; develop skills as ecotourism guides and operators.

Recommended Texts:

1. Fennell, D.A. Ecotourism: An Introduction
2. Ashton, P.S. and Ashton, R.E. Jr. *Ecotourism: Sustainable Nature and Conservation Based Tourism.*

AS 431 Chemical Technology (2 credits)

Introduction: Chemical engineering stoichiometry; Chemical plant technology: safety, services, storage, etc; fluid flow; Industrial chemical engineering equipments: reactors (batch, flow, semi batch);

Chemical engineering economics and planticides: cost, investments, fixed charges etc.

Chemical Technology: Raw materials, raw materials for the chemical industry; New development in chemical technology; Automation and some selected examples.

Chemical Kinetics: Chemical kinetics in plant design for isothermal, constant volume batch reactions, isothermal variable volume batch reactions, plug flow reactions continuous stirred tank reactants (Industrial reactants).

Catalysis: Homogenous, heterogeneous catalysis, pack bed reactors, fluid dye pack reactors; Electrochemical industries.

Recommended Text:

1. Panel on the Applications of Biotechnology to Traditional Fermented Foods, (1992) *Applications of Biotechnology in Traditional Fermented Foods,* National Research Council.

AS 432 Cleaner Production for Industry (2 credits)

Introduction: Introduction to cleaner production, cleaner production tools; Assessment and audits; Introduction of cleaner production in an enterprise and cleaner production methodology; Prerequisite for success of cleaner production.

Industrial Aspects: Cleaner production assessment, cleaner production team, process mapping and process flow diagram, data sources, material balance, energy balance, costing of waste; alternating option generations; Better process control, equipment and product modification, technology change, onsite recovery/reuse; Implementation of cleaner production options and pay back period.

ISO Standards: ISO standards in industrial processes.

Case Studies and Group Exercises:

Recommended Texts:

1. National Cleaner Production Centre (2006) *Proceedings: Seminar on Introduction to Cleaner Production into University Curriculum*, Colombo
2. National Cleaner Production Centre (2005) *Cleaner Production: A Way to Improve Your Enterprise*

AS 433 Industrial Waste Management (2 credits)

Characterization of Industrial Waste: Types of waste; Toxic substances in different types of waste; Chemical and physical methods of determining pollution parameters of industrial waste.

Minimization of Waste and Management of Waste: Traditional and modern concepts, advantages and disadvantages of different waste management strategies.

Development of Industries Using Waste as a Resource: Value addition methods for waste for reuse.

Recommended Text:

1 Pichtel, J. (2005) *Waste Management Practices*

AS 434 Industrial Organic Chemistry (2 credits)

Industries Which Use Organic Materials: To impart a theoretical and practical knowledge of industries in Sri Lanka which use fats & oils, phospholipids and waxes

with emphasis on soap making and surface active compounds, manufacture of biodiesel and the food industry.

Essential Oils in Sri Lanka: Overview of the essential oil industry in Sri Lanka, including the methods of extraction, analysis and quality standards utilized.

Tea Industry in Sri Lanka: Tea industry and the processing technology and the importance of tea flavours.

Recommended Texts:

1. Oils and Fats in Industry. Publication no. 25. Science Education Unit Publication 2006. D.N. Karunaratne.
2. Textbook of chemical Technology Vol. 11 Shukla SD and Pandey GN
3. Food Chemistry L.H. Meyer
4. Industrial Chemistry E.R Riegel.

AS 444 Industrial and Economic Minerals (2 credits)

Introduction to Gemmology: Introduction to gems and gemstones, basic physical properties of gem minerals-crystallography, colour, hardness (durability), lustre, cleavage, general optical properties-reflection, refractive index, pleochroism, special properties-special optical properties, luminescence, fluorescence, dispersion, Introduction to fashioning.

Industrial Minerals: Mechanisms of formation and distribution of metallic and non metallic ore deposits; Classification of industrial minerals and rocks; Geology and origin of industrial minerals and rocks; Deposits of industrial minerals and rocks (quartz, feldspars, carbonates, asbestos, clay, phosphates).

Exploration and Mining Techniques: Introduction to mine planning, mining methods, mine plant design and mineral processing

Recommended Texts:

1. Read, Peter G. (1995). *Gemmology, , Butterworth & Heineman*
2. Huralburt, C.S Jr. and Switer, G.S. (1979) *Gemology*
3. Maning, D.A.C. (1995*) Introduction to Industrial Minerals*, Chapman & Hall

AS 445 Remote Sensing and Geographic Information Systems (2 credits)

Remote Sensing: Overview and concepts of Remote Sensing technology, basics of photogrametry, practical uses of aerial photographs in various disciplines, fundamental characteristics of electromagnetic radiation, remote sensing platforms, satellite system and sensors, active and passive sensing systems, concepts of spatial, spectral, radiometric and temporal resolution, overview of RS applications.

GIS (Geographic Information System): Introduction to GIS, definition, concepts of GIS, scope and application areas, purpose and benefits of GIS, functional elements of GIS, required hardware and software for GIS, installation of GIS, map projection, data structures [WINDOWS-1252?]– raster and vector data structures, input of geospatial data, sources of data and input devices, spatial database data acquisition and management techniques, data manipulation and analysis, map output generation.

Laboratory Sessions: Visual interpretation of aerial photographs for land use, land pattern analysis, hands-on practical sessions on GIS, data input, linking non-spatial and spatial database, database editing and updating, GPS data integration in GIS, data manipulation and pre-processing, spatial analysis, map generation, mini-project for GIS application.

Recommended Texts:

1. Thomas M. Lillesand, Ralph W. Kiefer, (1999) Remote Sensing and Image Interpretation, 4th Edition
2. Burrough, P.A. and McDonnell, R.A. (1998) Principles of Geographical Information Systems, Oxford University Press

AS 451 Industrial Mathematics (2 credits)

Mathematical Modelling: Linear programming, integer programming and non-linear programming models.

Network Modelling: The transshipment problem, the shortest path problem, the equipment replacement problem, transportation/assignment problems, generalized network flow problems, maximal flow problems, special modeling considerations and minimal spanning tree problems.

Project Management: Introduction, creating the project network, critical path method, project crashing, project evaluation and review technique, simulating project networks and Microsoft project.

Recommended Texts:

1. Spreadsheet Modelling and Decision Analysis (Fourth Edition), Cliff T. Ragsdale *Thomson Press*
2. Data Analysis and Decision Making with Microsoft Excel, Albright, Winston, Zappe, *Duxbury Press*
3. Simulation Modeling using @RISK, Wayne L. Winston, *Duxbury Press*
4. Operations Research (An Introduction – Seventh Edition), Hamdy A. Taha, Eastern Economy Edition

AS 452 Financial Mathematics (2 credits)

Introduction to mathematical models that comes under finance. Introduction of MATHEMATICA software package at an advanced level and prepares students to use software to solve mathematical problems related to finance through practical sessions.

AS 461 Semiconductor Device Technology and Application (2 credits)

To provide knowledge on the physics behind semiconductor devices and the fabrication of semiconductor devices and IC circuits.

Recommended Texts:

1. Sze, S.M. (1981) *Physics of Semiconductor Devices*, *2nd ed*, John Wiley & sons,
2. Neamen, D.A. (1992) *Semiconductor Physics and Devices*, Richard D. Irwin,

AS 462 Science and Technology of Ceramic Materials (2 credits)

Introduction: Traditional and modern ceramics (Technical ceramics), ceramic industry in Sri Lanka,

Raw Materials: Clays, talc, refractories, fluxes, enamels, glazes. purification of clays, value addition to the raw materials.

Power Processing: Crushing, grinding, sizing, chemical methods

Shape Forming: Pressing, isostatic pressing, casting, mould preparation, tape casting, extrusion, injection molding, binders.

Densification: Theory of sintering, Control of sintering parameters, firing and kilns, hot pressing (HP), hot issostatic pressing (HIP), sintering problems, densification by chemical processes.

Glass and Glass Ceramics (5L*):* structure of glass materials, concept of glass-ceramics,

properties and application of glass-ceramics. glass ceramic composites
Quality assurance (2L): non destructive testing, environmental issues related to ceramic industry;
Practical Classes and industrial visits

Recommended Texts:

1. Gingery, W.D. Bowen, H.K. and Human, D.R. (1976) *Introduction to Ceramics*, John Wiley & sons
2. Richardson, D.W. (1992) *Modern Ceramic Engineering* Marcel Dekker

AS 463 Energy; Sources, Use and Conservation (2 credits)
Energy resources:
a. Fossil Fuels; Coal (electricity generation from coal, coal for industry), petroleum (refining, different products and their usage)
b. Alternative energy resources; nuclear energy (nuclear energy from fission, nuclear power plants, advantages and problems, nuclear energy from fusion), solar energy (direct use of solar energy; Solar collectors, solar chimneys)(indirect use of solar energy; PV cells; Efficiencies, limitations), wind energy (wind blow, power dependence, efficiency with wind speed), tidal energy (origin, tidal fences, tidal turbines/offshore turbines), geothermal energy (high temperature resources, moderate/low temperature resources), biomass energy (direct use, through conversion; biofuel; ethanol, bio-diesel), batteries (fuel cells)
Energy Picture of Sri Lanka: Main sources available, Energy consumption pattern, Use of biomass, Petroleum requirement, Electricity generation, Alternative sources, New power projects
Conservation of Energy: Different methods to conserve energy; Advantages and disadvantages of different methods

AS 464 Workshop Practice (2 credits)
Introduction: Introduce technical drawing methods, measuring instruments, handling of basic hand tools and portable machines used in sheet metal works.
Use of a Machines**:** machines of lath, milling and drilling machines, etc
Wood and Plastic Machining: Practice basic wood and plastic working methods in wood and plastic machines of portable bench types
Glass Work: ***Practice glass cutting methods and blowing methods***

AS 465 Industrial Applications (Electronics/Hardware) Laboratory (2 credit)
Digital Electronics: Logic gates, combinational and sequential logics, flip flops; counters, 7-segment display and driver circuits; Stepper motors, sensors, DAC and ADC, interfacing exercises.
Analogue Electronics: Power supplies and amplifier circuits, opamps.
Repair of instruments: Repair of simple instruments such as colorimeters, ph meters, uv-vis spectrophotometers, etc.
Recommended Text:

1 Horowitz, P. and Hill, W. (1989) *The Art of Electronics*, Cambridge University Press.

AS 471 Design and Development of Software Systems (2 credits)
Software process and advantages of software process; Feasibility study; Requirement analysis ; Requirement specification; Software design; Implementation; Testing and maintenance.

Recommended Text:

1 Pressman, R. S. and Ince, D.(2000) *Software Engineering*: *A practitioner's Approach*, McGraw-Hill

AS 472 Management of Computers and Computer Networks (2 credits)

PC management; PC trouble shooting; Computer networks; Network configuration; Device interfacing; Data acquisition and data processing; Micro – controllers; Instrument control.

Recommended Text:

1. Tanenanbaum, A.S. (1996) *Computer Networks*, Prentice Hall

AS 473 Visualizing Statistical Concepts using Java and Software Development (2 credits)

To provide experience to undergraduates in development of statistical software.

Recommended Texts:

1. Wesley, T. A. (1998) *Addition Data Structures in Java*, Standish.
2. Ditel, H.M. and Hall, P. P.J. (1999) *Java How to Program.*

AS 474 Statistical Applications in Industry and Project Presentation (2 credits).

To provide experience in handling statistical problems in industry and to improve project presentation skills and report writing.

Online PowerPoint Tutorials:

http://www.actden.com/pp/,
http://einstein.cs.uri.edu/tutorials/csc101/powerpoint/ppt.html
http://presentationism.com/

AS 481 Enzymes in Industry (2 credits)

Proteins and Protein Purification: Amino acids and proteins, protein structure and function, protein purification and characterization, chromatography and electrophoresis.

Enzyme; The Agents of Life: Enzymes as catalysts in biological systems, enzyme classification, enzyme kinetics, enzyme assay methods, regulatory enzymes.

Application of Enzymes Technology in Industry: Bakery industry, food and dairy industry, textile industry, enzymes as detergents, enzymes in biotechnology.

Laboratory work: Laboratory experiments relevant to above aspects.

Recommended Texts:

1. Lehninger A.L., Nelson D.L and Cox M.M (1993) *Principles of Biochemistry, 2nd edition, Worth Publishers*
2. Scope, R.K. (1993) *Protein Purification: Principles and Practice, 3rd edition*, Springer.
3. Fersht, A. (1998) *Structure and Mechanism in Protein Science: A Guide to Enzyme Catalysis and Protein Folding, 3rd edition*, Freeman.

AS 482 Biochemistry and Molecular Laboratory Instrumentation (1 credits)

Introduction, preparation of biochemical laboratory solutions, pH and buffers;Absorption spectroscopic methods in biochemical applications; Chromatography methods; Electrophoresis; DNA isolation and analysis; Immunochemical methods (immunoblotting and ELISA); DNA isolation and analysis; Polymerase chain reaction.

Recommended Texts:

1. Sanbrook, J. Fritsch, E.F. and Maniatis, T. (1989) *Molecular Cloning – A Laboratory Manual*, Cold Spring Harbor Laboratory Press
2. Keith Wilson and John Walker (2000) *Priniples and Techniques of Practical Biochemistry.* Cambridge University Press
3. Alexander J. Ninfa, David Ballou (1998) *Fundamental Laboratory Approaches for Biochemistry and Biotechnology*. Fitzgerald Science Press, Inc

AS 483 Bioinformatics (2 credits)

Introduction to Bioinformatics; Structure and function of DNA; Collecting and storing sequence data; Biological databases and retrieval of information; Sequence alignment; Database searching for similar sequences; Phylogenetic analysis; Prediction of genes and regulatory sequences; Protein structure prediction.

Recommended Texts:

1. Baxevanis, A. (1998) Bioinformatics: *A practical Guide to Analysis of Genes and Proteins*, John Wiley
2. David W. Mount (2004) *Bioinformatics: Sequence and Genome Analysis*, Cold Spring Harbor Laboratory Press

COMPUTATION AND MANAGEMENT SUBJECT AREA

Year One

All students: EN 100 - Basic English (2 credits), CS 100 – Computer Applications (2 Credits)
GCE (A/L) Arts, Biological Science & Commerce students: MT 120 - Foundation Course in Mathematics (2 credits)
GCE (A/L) Physical Science students: FND 114 – Law and Ethics (2 credits)

CS 101 Introduction to Computer Science (3 credits) CS 102 Programming Techniques (3 credits) CS 104 Structured oriented Programming practical (1 credit) CS 105 Object oriented Programming practical (1 credit)	ECN 101 Introductory Microeconomics I (3 credits) MT 105 Real Analysis I (3 credits) MGT 101 Principles of Management (3 credits) ECN 102 Introductory Macroeconomics II (3 credits)
Arts and Biological Science Stream: MGT 103 Introduction to Business Accounting (3 credits) MT 121 Mathematics for Arts/Commerce I (3 credits) **Commerce Stream:** MT 121 Mathematics for Arts/Commerce I (3 credits) and PSC 101 Introduction to State & Government (3 credits) or SE 101 Science and Society (3 credits) **Physical Science Stream**: MGT 103 Introduction to Business Accounting (3 credits) and PSC 101 Introduction to State & Government (3 credits) or SE 101 Science and Society (3 credits)	**Arts, Biological Science and Commerce Stream**: MT 122 Mathematics for Arts/Commerce students II (3 credits) **Physical Science Stream**: FNA102 Introduction to Art History and Aesthetics (3 credits)

Year Two

CS 201 Data structures (2 credits) CS 202 Data Structures Practical (1 credits) CS 203 Database Management Systems (2 credits) CS 204 Programming using DMS Packages (1 credit) ECN 201 Intermediate Microeconomics I (3 credits) ECN 202 Intermediate Macroeconomics II (3 credits) MGT 206 Human Resource Management (3 credits)	MGT 207 Operations Management (3 credits) MGT 208 Business Statistics (3 credits) MGT 209 Project Management (3 credits) MGT 211 Business Accounting for Decision Making (3 credits) MT 221 Mathematics for Management Studies I (3 credits)

Year Three

CS 303 Operating Systems Concept (3 credits) CS 305 Computer Networks (2 credits) CS 309 Object Oriented Analysis and Design (3 credits) CS 310 Server side web programming CS 311 Software Engineering (2 credits) CS 315 Design and Analysis of Algorithms (2 credits) ECN 304 Econometrics I (3 credits)	MGT 301 Marketing (3 credits) MGT 304 Entrepreunership (3 credits) MGT 305 Cost and Management Accounting (3 credits) MGT 307 Business Law (3 credits) MT 321 Mathematics for Management Studies II (3 credits)

Year Four

MGT 421 Project involving Internship (6 credits) MGT 423 Seminar (1 credit)	MGT 424 Strategic Management (3 credits) MGT 438 Management Information Systems (3 credits)
3 more credits from CS 4xx and 2 from MGT 4xx	9 credits chosen from CS4xx or MGT 4xx of which at least 3 must be from CS4xx and 3 from MGT4xx

100 LEVEL COURSES

SE 101 Science and Society (3 credits)

The Scientific Method; Induction and Deduction; Scientific Revolutions: Ancient and Modern Science; Science of Non-Western Societies; Colonial Science; Science and Ethics; Values in Scientific Research and Results; Indigenous Knowledge systems; Technology and Science; Science and Technology in Development; Important Discoveries of Modern Science and their Development; Institutionalization of Science and Technology; Modern Scientific Research and its Funding; Role of Multinationals; Science and Warfare; Scientists and Social Responsibility; Risk and Uncertainty in Science; Science and the Media; Food and Population; Energy; Environment; Oceans; Outer Space; Technology and Trade; Science and Developing Countries

Recommended Texts:

1. Okasha, S. 2002, *Philosophy of Science, A Very Short Introduction*, Oxford: OUP
2. Bird, A, 1998, *Philosophy of Science*, Montreal: McGill-Queen's University Press
3. Kuhn, T, 1962, *The Structure of Scientific Revolutions*, Chicago: University of Chicago Press
4. Harre, R., 1981, *Great Scientific Experiments*, New York: Dover Publications
5. Moore, P 2002, $E=mc^2$, *The Great Ideas that shaped our World*, London: Quintet Publishing
6. Barnes, B (ed.), 1972, *Sociology of Science*, Penguin, London
7. Barnes, B *et al*., 1996, *Scientific Knowledge: A Sociological Inquiry*, Athalone, London

MGT 101 Principles of Management (3 credits)
This is an introductory course in Management. It covers various definitions of Management as well as the evolution and social responsibility of Management. The main components of the course are the functions of Management: Planning, Organizing, Staffing, Leading and Controlling. The course will introduce and discuss case studies in business in order to provide students with a sound knowledge of Real World Management.

MGT 103 Introduction to Business Accounting (3 credits)
This course provides the basic knowledge in financial accounting, which ensures that the students are able to understand the issues in financial accounting relating to business entities.
The course includes: objectives, use & users, underlying assumptions, qualitative characteristics and the elements of financial statements; the understanding of the recording of transactions; the adjusting entries; the preparation of financial statements of Sole Proprietorships and Partnerships and the underlying systems, procedures & controls in preparation of such statements.

Recommended Texts:

1. Wood, F., 1984, *Business Accounting*. Vol. 1 and 2 (4^{th} ed.) London: Pitman Publishing
2. Jennings A. R. 1997, *Financial Accounting* (2^{nd} ed.) London: ELBS
3. Randall, H. Advanced Level Accounting, ELBS ed.
4. Relevant Journals and Books published by *CIMA*

PSC 101 Introduction to State and Government (3 credits)
This course introduces the basic concepts related to the state and government. The course commences by introducing the nature and scope of political science and the main approaches to its study. The course then focuses on the emergence, development, and the nature of the nation state and the key theories related to it. Particular attention is paid to study the position the nation state occupies in the contemporary international system, its relationship with the citizens, and how the process of globalization impacts upon the modern state. Some key political concepts such as sovereignty, separation of power, power and authority, civil society and governance will also be introduced to the students. Finally, the course will provide a basic understanding of public policy, policy formulation, and the process of policy implementation.

FNA 102 Introduction to Art History and Aesthetics (3 credits)
This course entails introductions to the study of art from historical and philosophical perspectives.
The historical approach to art will be studied in relation to the critical approach. The significance of art as a source of the history of human society will be examined under the topic history in art. The concept of aesthetics and its basic tenets will be introduced.

MT 105 Real Analysis I (3 credits)
Real number system as a complete ordered field, Complex number system, Topology of the real line, Neighborhoods, Sequences and limits, Limit theorems, Monotonic Sequences, Limit Concept of a Real-Valued Function, Algebra of limits, Continuity, Monotonic functions, Differentiability, Role's Theorem, Mean-Value Theorems, L'Hospital's Rule, Riemann Integral and the basic properties. Fundamental theorem of Calculus, Improper integrals.

Recommended Texts:

1. *Elementary Real Analysis,* H.G. Eggleston
2. *Analysis,* S.R. Lay

MT 121 Mathematics for Arts/Commerce I (3 credits)

Algebraic inequalities, Basic set theory, Permutations and Combinations, Mathematical Induction, Binomial Theorem, Vectors, Systems of Linear equations, Continuity and Differentiability, Applications of derivative, Curve sketching, Applications of definite integral, Convergence of sequences and Summation of series.

MT 122 Mathematics for Arts/Commerce II (3 credits)

Probability: Tree diagrams, Sample space and events, Axioms of probability and basic laws, Probability in discrete sample space, Conditional probability and multiplicative law, Baye's theorem,
Independent events.
Descriptive Statistics: Graphical representation of statistical data, Mean, Median, Mode. Quartiles, Deciles, Inter quartile range, Standard deviation. Shapes of distributions
Linear and non-linear market models, Marginal functions in economics.

CS 100 Computer Applications (2 credits)

Introduction to Computer and operating Systems,
Micro Computer Applications : Use of Software Packages- Spread Sheet applications, DBMS applications, Utility programs and Word processing.
Data Protection Techniques: Data security techniques, Computer Viruses and prevention.
Data Communication: Email, Internet and Networking of Computers.
Introduction to a Programming Language: Procedures, Functions, File handling, Application of a DB management.
(This course includes both theory and practicals)

Recommended Texts:

1. Computer Science, C.S.French
2. Programmer's Guide to Foxpro 2.0, D. Howard
3. Computer viruses, Robert Slade

CS 101 Introduction to Computer Science (3 credits)

Introduction and overview : Intelligent machines and systems applications, Business, Communications, Educational, Engineering, Environmental, Medical and Scientific applications.
Introduction to computing concepts : Basics of computer programming : data types, declarations, assignments, basic input and out put ASCII files, built-in functions.
Structured programming ideas: selection statements: sequence, iteration (counting loops, while loops, file pointers), conditional (if-then-else statements, case statements), matrix manipulations (addition, subtraction, multiplication, transposition).
Modular programming: functions, procedures with actual and formal parameters, simple sort algorithms, dynamic memory allocation and addressing.
Numerical methods: Linear interpolation, linear regression, pseudo random, roots of functions, solutions of simultaneous linear equations by Gaussian elimination, numerical integration.

Recommended Texts

1. The Thinking Ape: Evolutionary Origins of Intelligence, R. Byrne.

2. Intelligent Multimedia System : A Handbook for Creating Applications, R.M.Kaplan
3. Artificial Intelligence, E.Rich and K. Knight

CS 102 Programming Techniques (3 credits)
Basic concepts, basic components of programming languages, binding, simple algorithms operating on non-structured data, modularity in program construction.
Basics of constructing larger programs :abstraction and instantiation of program components, structured data (lists, stacks, queues, ordered binary trees), storing and accessing data structures, operations on mutable data, working with mutable data, object-based programming, data encapsulation

Recommended Texts:
1. *Data Structures, Algorithms, and Object-oriented Programming*, G.L. Heileman.
2. *Structured programming concepts*, K. Labudde

CS 104 Structured oriented Programming practical (1 credit)
(Prerequisites: CS101, CS102 which shall be taken concurrently)
Language constructs: data declarations, loops, decision structures, input/output, files, subprograms / procedures, numeric and non-numeric data. Design and construction of software: top-down and bottom-up design, decomposition, structuring, design for reuse, documentation, study of examples, writing software as a team, using software from others. Programming assignments: A variety of progressively more complex assignments

Recommended Text:
1. *The C Programming Language*, 2nd Edition, by Brian W. Kernighan and Dennis M. Ritchie, Prentice Hall, Inc., 1988.

CS105 Object oriented Programming practical (1 credit)
(Prerequisites: CS101, CS102)
Implementation of programs with object oriented language constructs: classes, objects, inheritance, aggregation, composition and polymorphism.

Recommended Texts:
1. *Developing Java Software*, 3rd Edition, by Russel Winder and Graham Roberts, published by John Wiley and Sons, 2006
2. *Java Programming: From the Beginning*, K. N. King, *Georgia State University*

ECN 101 Introductory Microeconomics (3 credits)
This course is an introduction to microeconomic theory. No prior knowledge of economics is required.
Course topics include: Demand and supply. Theories of consumer behavior and cost. Market failure and Market structure (perfect competition. monopoly, monopolistic competition and oligopoly). No prerequisites.

ECN 102 Introductory Macroeconomics (3 credits)
The course is an introduction to macroeconomic theory. No prior knowledge of economics is required
Course topics include: National income accounting. Circular flow of income: the Keynesian income/output determination model: Fiscal policy, Deficit and debt: Money supply and demand: Monetary policy: Unemployment and inflation: Debates in macroeconomics: and an introduction to international trade and finance No prerequisites.

200 LEVEL COURSES

MGT 206 Human Resource Management (3 Credits)

The course aims at providing students with a complete theoretical and operational approach to Human Resource Management. The course provides a full length analysis of the importance of HRM, organization and functions of HR department, HRM and environmental factors, historical development of HRM and current trends, human resource planning (projection of HR needs, labour market analysis, analyzing demand and supply, job analysis and job design, job description and employee specification, attraction, selection, recruitment and placement, process of selection, selection methods), HR development (technological change and employee development, compensation and protection, employee relations), and other functional areas of HRM.

MGT 207 Operations Management (3 Credits)

This course provides students with a knowledge in manufacturing and service sector operations.

Course topics include: Nature and importance of operations management; Production engineering; Systems approach to operations management; Input-output relationship; Types of production; Introduction to work study; Production planning and control (PPC); Product design and development; Planning and control techniques; Critical path analysis and simulation models; Production control (control of value, quality control and inspection); Total quality management (TQM); Inventory controls models; Just-in-Time system; Plant location analysis; Plant and process layout; Plant housekeeping; Occupational health and safety; and Productivity and the 5's system.

MGT 208 Business Statistics (3 Credits)

This is an introductory course in statistics. It will introduce computer applications to selected topics, and each student will spend a minimum of ten computer hours.

Course topics include: Introduction to business statistics; Types of data; Presentation of data; Analysis and interpretation of data; Exploratory data analysis; Theory of probability; Sampling techniques; and Index numbers.

MGT 209 Project Management (3 Credits)

This course is complementary to Operations Management (MGT 207) but there are no prerequisites for it. This course aims at presenting a framework for evaluating and managing capital expenditure proposals, which have been developed by financial economists.

The subject area of the course consists of four phases: 1) Planning—feasibility study, elementary investment strategies, generation and screening of project ideas; 2) Analysis—market and demand analysis, technical analysis, financial analysis; 3) Selection—project cash flows, time values of money, cost of capital appraisal criteria, social cost benefit analysis, multiple projects and constraints, quantitative factors, strategic aspects, organization considerations; and 4) Management—project management, project review and administrative aspects.

MGT 211 Business Accounting for Decision Making (3 credits)

This course enhances students the practical and functional nature of business decisions based on financial accounting. It provides a solid foundation for studies in both accounting and non-accounting disciplines.

The course includes: Regularity framework within which financial statements are

produced with a special reference to SLASs and the Companies Act, preparation of financial statements of limited liability companies, financial statements analysis and computerized accounting systems covering the practical use of accounts in an information system and the financial control.

Recommended Text:

1. Wood, F., 1984, *Business Accounting*. Vol. 1 and 2 (4th ed.) London: Pitman Publishing
2. Jennings A. R. 1997, *Financial Accounting* (2nd ed.) London: ELBS
3. Relevant Journals and Books published by *CIMA*
4. The Institute of Chartered Accountants of Sri Lanka, Sri Lanka Accounting Standards Act No. 15 of 1995 together with subsequent amendments, Gazette, Democratic Socialist Republic of Sri Lanka
5. The Institute of Chartered Accountants of Sri Lanka web site: *icasrilanka.com*

MT 221 Mathematics for Management Studies I (3 credits)

Algebra and Advanced Calculus: Matrices, Determinants, Eigenvalues and Eigenvectors, Quadratic forms, Functions of several variables, Partial derivatives, Vector-calculus, Multi-variable Optimization.

Statistical Quality Control: SQC tools, Shewhart charts (Attributes and variables), Regression analysis.

Network Analysis: Graph theory, Minimum cost problem, Maximum flow problem, Critical path analysis.

Queuing Theory: Characteristics of queues, Simple queues, Queuing costs, Multiple-server queues.

CS 201 Data Structures (2 credits)

(Prerequisites: CS 101, CS 104, CS 105)

Introduction: 1. Arrays, records, pointers, indices, 2. Recursion 3. Objectives: (I) Timing comparisons, (ii) Memory comparisons, Implementation: array/linked; ordered/unordered Searching: introduction to set abstract data type, Stacks and queues, Trees; Pointer implementation, traversal, Binary search; Definition, Searching, Creation and insertion, Good and bad trees, Deletion, B-trees, Hashing: initial hash, collisions, separate chaining, Graphs; Implementation of depth first search, breadth first search, topological numbering, connected, Sorting; Insertion sort, Quick sort, Heap as priority queue; Heap sort

Recommended Texts:

1. Standish T. A.; *Data Structures in Java*; Addison-Wesley; 1998
2. Deitel, H. M.; Deitel, P. J.; *Java how to Program*; Prentice Hall; 1999

CS 202 Data Structures Practicals (1 credits)

(Prerequisite: CS 201)

Implementation of data structures studied in CS 201 using C, C++ and Java.

Recommended Texts:

1. Standish T. A.; *Data Structures in Java*; Addison-Wesley; 1998
2. Deitel, H. M.; Deitel, P. J.; *Java how to Program*; Prentice Hall; 1999

CS 203 Database Management Systems (2 credits)

(Prerequisites: CS 101, CS 104, CS 105)

Introduction, The entity-relationship model, Logical organization of databases; The relational model, Relational algebra, SQL, Physical organization of databases;

Characteristics of disks and disk blocks, Storage of relations, Query processing and optimization, Concurrency control; Transactions, Serializability, Locking, Recovery, Distributed databases, Functional dependencies and normal forms.

Recommended Texts:

1. Date, C. J.; *An Introduction to Database Systems*; Addison-Wesley; 2000
2. Loney, K.; Koch, G.; *Oracle 8i: The complete reference***;** McGraw Hill ; 2000

CS 204 Programming using Database Management Packages (1 credits)

(Prerequisites: CS 104, CS 105, CS 202, CS 203)

Computer programming using database management packages such as Informix, Sybase, Oracle and FoxPro on PCs and workstations. Programming assignments: A variety of progressively more complex assignments.

Recommended Text:

1. Loney, K.; Koch, G.; *Oracle 8i: The complete reference*; McGraw Hill ; 2000

ECN 201 Intermediate Microeconomics (3 credits)

This is an intermediate-level course in Microeconomic Theory. The basic approach will be partial equilibrium analysis. It is expected that during the course students would gain an understanding of the behaviour of individual economic agents such as consumers, producers and firms.

Course content: Theory of consumer behaviour; The cardinal utility theory. The indifference curves theory: The revealed preference hypothesis: applications of consumer theory: Theory of production and cost: Concept of production function: Types of production function: Production contours: Equilibrium of the firm: Laws of production (Theory of variable proportions and Theory of returns to scale): Modern theory of cost: Applications: Derivation of cost functions from production functions: Production function of a multi-product firm: Theory of firm: Perfect competition (a review): Dynamic changes and industry equilibrium: Monopoly (a review): Price discrimination: Monopolistic competition: Theories of oligopoly: Game theory applications to theory of firm: Factor markets (pricing and employment of resources): Factor price determination: Wage determination and Theory of profit.

ECN 202 Intermediate Macroeconomics II (3 credits)

The main objective of this course is to offer a broad outline of the development of economic thought from the sixteenth century to the present. It relates the history of social and economic thought and the paradigm shifts and the coexistence in economics of intellectual trends of the different periods. Student who follow this course are expected to detect the genesis and development of the different categories they learn in economic theory so that they will be able to trace the evolution of different policy strands. The course will emphasize the simultaneous presence of diverse theoretical positions on which empirical analyses and policy formulations are based. It will also examine the different epistemological approaches to social and economic theory.

Course content: Classical political economy; Economic thought before Adam Smith; Adam Smith's *Wealth of Nations;* Robert Malthus; David Ricardo; Post-Ricardian economics; J.B. Say; J.R. McCulloch; The currency vs banking school; Nassau Senior; Sismondi; Contradiction in the system; John Stuart Mill Contradictions of modernity; Karl Marx and Max Weber; Post-Marxian economics; Neo-classicism and its critique; Marginalism; Jevons, Walras, and Menger; The Austrian school; Marshallian partial equilibrium analysis; Crisis of neo-classical theory and a paradigm shift; the political economy of development; Development economics; Modernization theory; Big push

theories; Dependency theory; Neo-Marxian theories of development; Development economics-an opposite view: Bauer, Little and Deepak Lal.

300 LEVEL COURSES

MGT 301 Marketing (3 Credits)
The objective of this course is to provide students with a broad understanding of the concept of marketing, and a basic knowledge in total marketing. The course integrates key marketing concepts and marketing tools. The course will also consider ways of creating and maintaining a positive total marketing effort in business.
Course topics include: An introduction to marketing; Analysis of marketing opportunities; Planning marketing strategies and making marketing decisions; and Marketing management and the total marketing effort.

MGT 304 Entrepreneurship (3 Credits)
This is an intermediate course in Management specially designed to provide students eligible to take 300 or 400 level courses in Management with theoretical knowledge and academic training in the new entrepreneurship. It is expected that graduating students will find this course useful in formulating new ventures. While there are no prerequisites for this course, students with management, economics, or information technology backgrounds are encouraged to enroll.
Topics taught in the course include: The meaning and importance of the concept of entrepreneurship; Models for new ventures; Commercial opportunities and new ventures; Marketing research for new ventures; Organizing new ventures; Financing new ventures; and Managing growth and finance.

MGT 305 Cost and Management Accounting (3 Credits)
Cost accounting is a tool in Management. It provides management information regarding cost of products, operations, and services. It also provides data for special decisions to be made by management regarding planning and controlling the operations of the enterprise. As a subject, cost accounting is technical in nature, requiring an understanding of its complex concepts, methods, and techniques. Management Accounting is the application of accounting techniques to provide information designed to help all levels of management in planning and controlling the activities of a business enterprise and decision making. The objective of this course is to provide students with a sound knowledge of cost and management accounting theories and their use in problem solving.
Course topics include: Cost accounting—basic nature and concepts, elements of cost, costing methods and accounting systems, cost analysis for planning control and decision making; Management accounting-concepts and applications.

MGT 307 Business Law (3 Credits)
This course provides a basic knowledge of the nature, constitution, and legal background of varied forms of business units and contracts such as sole trade ventures, partnerships, and companies.
Course topics include: General principles of the law of contract; Law of agency; Sale of goods; Carriage of goods by sea and air; Partnership; Insurance law; Hire purchasing; Banking; Customer relationships and negotiable instruments; and Company law.

MT 321 Mathematics for Management Studies II (3 credits)

Game theory: Pure strategies, Mixed strategies, Zero-sum games, Dominance, $2 \times n$ game, Graphical solutions, $m \times n$ game, Games with optimal pure strategies, Games with optimal mixed strategies.

Linear Programming: LP in two dimensional space, Graphical solution methods, General LP models, Primal simplex method, Big-M method, Two-phase simplex method, revised simplex method, Applications of duality, Dual simplex method.

Transportation model, Assignment model.

Quadratic Programming: QP algorithms, Applications of QP.

CS 303 Operating Systems Concepts (3 credits)

(Prerequisite: CS 203)

Introduction, Distributed OS Techniques; Naming, Inter-process communications and remote procedure calls Data and process migration, transactions, file systems, Parallel OS Techniques; Process management, scheduling, synchronization, Data management, caching, coherency, consistency, file systems, Load balancing, Advanced OS Concerns; Memory management, virtual memory, garbage collection, Fault-tolerance, reliability, replication, Protection, authentication, security, cryptography, I/O models, Performance, benchmarking, and monitoring, Client - Server Model.

Recommended Text:

1. Tanenanbaum, A.S.; *Modern Operating Systems* ; Prentice Hall; 1992

CS 305 Communication Networks (2 credits)

(Prerequisite: CS 303)

Overview; Examples and concepts of layered architecture; overview of higher layer protocols. LAN - Network Topologies, Medium Access Control Methods, LAN Standards, WAN - Introduction to ISO/OSI Model, Introduction to Internet & TCP/IP Protocols, Transport layer; Internet addressing and Internet protocols; socket interface, Network layer, Taxonomies; relevant parameters of network and traffic, Multiple-access methods for broadcast networks, Taxonomies of multiple access methods; contention, methods; polling methods; reservation methods, Switched networks Architectures of switches; scheduling and admission control; routing, flow control, and congestion control, Interconnections of networks Logical data link protocols.

Recommended Text:

1. Tanenanbaum, A.S.; *Computer Networks*; Prentice Hall; 1996

CS 309 Object Oriented Analysis and Design (3 credits)

(Prerequisite: CS 102, CS 201)

Fundamental of Object-oriented design: Encapsulation, classes and objects, information hiding, operator overloading, inheritance, overriding, delegation; Analyze problems, determine objects that are necessary to model the system, determine what attributes the objects need to have, determine what behaviors the objects need to exhibit, develop conceptual models, generate designs from the models, and implement the models.

Recommended text:

1. An Introduction to Object-Oriented Analysis and Design and the Unified Process Second Edition. Craig Larman, 2002.

CS 310 Server Side Web Programming (3 credits)
(Prerequisites: CS104, CS 105, CS203, CS204)
Introduction to HTML, Introduction to Client Side Scripting ***Java Script***: JavaScript syntax, JavaScript object model, JavaScript objects, Static objects, Forms object (Submit () and Reset () methods), Event handling - Mouse related events, Keyboard events, Document events, Output in JavaScript, Introduction to VB Script, ***ASP.net*;** Implement ASP.net with VBScript, Use SQL & ADO to Interact with ASP.net Databases, Write Cookies on the Client Using ASP.net ***J2EE - Java Enterprise Edition*;** JDBC, JSP, Servlet, ***Hypertext Preprocessor* ;**Program structure, Use php to process html forms, Regular expressions for form validation and other applications, Read and write files, Database applications. ***XML*;** Understand the role of XML, Write XSL Documents to Describe how XML Documents are to HTML, Create Simple DTD & Schema Files to Describe the Grammar of XML, Differences between DTD's & Schema, Differences between Cascading Style Sheets & XSL, ***Other new trends in Web development*;** Eg. SOAP, WSDL

Recommended Texts:

1. Benoit Marchal (1999/2001). *XML by Example* (1st or 2nd Edition).Que Publishers
2. *Java 2 with Swing*: Deitel and Deitel
3. *Internet & World Wide Web How to Program* (Second Edition) 2002

CS 311 Software Engineering (2 Credits)
(Prerequisites: CS 201)
Overview of software engineering: software process; classic life cycle model, iterative models, incremental model. Project planning; Fundamentals of project and system planning, Requirements analysis, Software design fundamentals; Stepwise refinement, bottom-up approach, modularity, Design techniques; Use of UML and design patterns, Testing: Testing objectives, test case design, white box vs. black box testing, overview of testing strategies, Maintenance; Overview of maintenance issues and software configuration management

Recommended Texts:

1. Ian Somerville, *Software Engineering*, 6th edition, Addison Wesley, 1999.
2. *Design Patterns*, 1st edition, Addison Wesley, 1996.

CS 315 Design and Analysis of Algorithms (2 Credits)
(Prerequisites: CS 202 ,CS 301)
Analysis of algorithms: time complexity, big O notation. Sorting algorithms: bubble sort, selection sort, insertion sort, quick sort, heap sort, merge sort and external sorting methods. Hashing: hash functions and collision resolution: separate chaining, linear probing and double hashing. Classification of Algorithms by Implementation and Design Paradigm: Divide & Conquer Algorithms, Dynamic Programming, Greedy Algorithms, Recursive Algorithms, Backtracking, Alfa-Beta pruning, Branch & Bound Search; Analysis of Algorithms, NP- completeness; Classification by Field of Study: Searching, Sorting, String matching, Graph, Machine Learning; Genetic algorithms

Recommended Texts:

1. Sara Baase, Allen Van Gelder (2000), *Computer Algorithms - Introduction to Design & Analysis*, Addison-Wesley
2. Thomas H. Cormen, Charles E. Leiserson & Ronald L. Rivest (2000), *Introduction to Algorithms*, McGraw-Hill

ECN 304 Econometrics I (3 credits)
This course is designed as an introduction to the econometric method and to econometric estimation. Its objectives are, first, to impart a sound theoretical background of the classical linear regression model (CLRM) and second, to enable students to estimate and interpret such models.

The course will begin with a discussion of what constitutes "econometrics". It will then move on to the concept of a "regression". And discuss the estimation and interpretation of simple linear regression models. Students will be introduced to the assumptions of the CLRM and to properties of OLS estimators. Initial coverage of Interval Estimation. Testing of Hypotheses, R^2, and Prediction Error will be within the context of the simple linear regression model. These topics will then be studies with respect to the multiple linear regression model, which will also be extended to cover Dummy Variables. The course will conclude with (a) a preview of some violations of assumptions of the CLRM, i e, Multicollinearity, Heteroscedasticity and Autocorrelation. and (b) a brief discussion of Specification Error.

400 LEVEL COURSES

MGT 421 Project involving internship (6-8 credits)

MGT 423 Seminar (1 credit)

MGT 424 Stratergic Management (3 credits)

MGT 438 Management Information Systems (3 credits)
The aim of this course is to provide knowledge in building and maintaining an information system essential for making strategic decisions in a dynamic business environment through a learning organization/
The course consists of: Organizational, ethical, technical fundamentals of information systems; Building information and organizational support systems; Organizational Information System; Geographical Information System for business; Database management.

Recommended Texts:
1. Davis G.B., 1984, *"Management Information Systems; Conceptual Foundations: Structures & Developments"* McGraw Hill International
2. Gerald V. Post, David L. Anderson, 1999 *"Management Information Systems; Solving Business Problems with Information Technology"* Tata McGraw Hill
3. Kendall K.E., 1998 *"Emerging Information Technologies"*, Sage Publications
4. Laudon K.C, Laudan J.P., 2000, *"Management Information Systems"*, Prentice–Hall, India (7^{th} edn)
5. McLeod R .Jr, 1998 *"Management Information Systems"*, Prentice–Hall Intntl. (7^{th} edn)
6. Wendy Robson, 1998 *"Strategic Management Information Systems"*, Pitman Publishing (2^{nd} edn)

STATISTICS & OPERATIONS RESEARCH SUBJECT AREA

Year One

All students: BL100 – Basic Life Sciences (2 credits), CS 100 – Computer Applications (2 Credits), EN 100 - Basic English (2 credits)

ST 101 Introduction to Statistics (3 credits)*	CS 104 Structured oriented Programming practical (1 credit)*
ST 102 Introduction to Probability Theory (3 credits)*	CS 105 Object oriented Programming practical (1 credit)*
ST 103 Statistics Applications I (1 credit) #*	MT105 Real Analysis I (3 credits)*
ST 104 Statistics Applications II (1 credit)#*	MT 107 Mathematics for Operations Research (3 credits)*
CS 101 Introduction to Computer Science (3 credits)*	MT 108 Operations Research I (2 credits)*
CS 102 Programming Techniques (3 credits)*	MT 109 Linear Programming (3 credits) # *

Year Two

ST 201 Probability Theory (3 credits)*	CS 204 Programming using Database Management Systems (1 credit)*
ST 203 Theory of Statistics (3 credits) #*	MT 202 Real Analysis II (3 credits)
ST 204 Sampling Techniques (2 credits) #*	MT 204 Mathematical Methods (3 credits)
ST 205 Statistical Simulation (2 credits) #*	MT 209 Graph Theory (2 credits)
CS 201 Data Structures (2 credits)*	MT 210 Advanced Linear Programming (3 credits) # *
CS 202 Data Structures Practicals (1 credit)*	MT211 Integer Programming (3 credits) #*
CS 203 Database Management Systems (2 credits)*	MT 212 Operations Research II (2 credits)*

Year Three

ST 301 Regression Analysis (3 credits) #*	ST 325 /MT325 Seminar (1 credit) #*
ST 302 Statistical Quality Control (2 credits) #*	CS 315 Design and Analysis of Algorithms (2 credits)#*
ST 303 Design and Analysis of Experiments (3 credits)#*	MT 304 Partial Differential Equations (2 credits)
ST 305 Multivariate Methods I (2 credits) #*	MT 313 Convex Analysis (2 credits)
ST 306 Data Analysis & Preparation of Reports (1 credit) #*	MT 314 Network Optimization Theory (3 credits) *
ST 307 Time Series Analysis (2 credits) #	MT 315 Operations Research III (2 credits)*
ST 308 Bayesian Statistics I (2 credits)*	MT 316 Non-Linear Programming (3 credits) *
ST 309 Non Parametrics & Categorical Data Analysis (3 credits) #*	

Year four

ST 401 Actuarial Statistics (2 credits)	CS 409 Neural networks and Fuzzy logics (3 credits) #
ST 402 Statistical Data Mining (3 credits) #*	ST 425/MT 425 Project work /Industrial training (3 credits) #*
ST 403 Statistics for Bioinformatics (2 credits)	MT 409 Selected Topics in Applied Operations Research (2 credits)
ST 404 Stochastic Processes (2 credits)	MT 411 † Optimization Modeling (2 credits)*
ST 405 Multivariate Methods II (2 credits) #*	MT 410 Optimization for Engineering Design (3 credits)*
ST 406 Bayesian Statistics II (2 credits)	MT 412 Financial Mathematics (3 credits) *

† Equivalent to AS 451
** : Compulsory courses # : Courses including practical*

The following existing courses cannot be offered by the students who follow this degree programme.
MT 101, MT 103, MT 311, MT 407, CS 201, CS 203

The following course units maybe of interest to the students:
Numerical Analysis, Economics, Environmental Science, Genetic Engineering, Geographical Information Systems, Management studies.

100 LEVEL COURSES

ST 101 Introduction to Statistics (3 credits)
Basic ideas in Statistics : Representation of data, Histogram, Frequency polygon, Ogive.
Measures of Location : Various Means (AM, GM, HM, TM), Median, Mode, Quantiles, Deciles, Percentiles. Measures of Dispersion : Range, Interquartile range, Variance, Standard deviation, Chebyshev's rule for sample, Shepperd's correction for variance, Coefficient of variance, Moments of higher order, Skewness, Kurtosis.
Representation of data using Stem-Leaf diagrams and Box plots.
Regression and Correlation: Scatter diagrams, Linear Regression, Method of least squares, Correlation, Coefficient of correlation, Rank correlation, Spearman's rank correlation coefficient.
Index numbers: Introduction, Price Relatives, Quantity Relatives and Value Relatives. Link and Chain Relatives, Cost of living Index Numbers, Methods of construction of Index Numbers, Quantity Index Numbers, Tests for Index numbers.

Recommended Texts:
1. *Statistical methods*, J.Medhi.
2. *A Basic Course in Statistics*, G.M.Clarke, and D.Cooke

ST 102 Introduction to Probability Theory (3 credits)
Counting Techniques: Combinations, Permutations, Set partitions,
Elements of Probability: Experiments, Events, Sample space, Laws of Probability, Bayes' Theorem, Independence of events. Random variables: Discrete and continuous r.v.'s,

Probability mass function, Probability density function, Cumulative distribution function, Functions of a random variable, Expectation, Moments, Mean and variance, Moment Generating function.
Probability inequalities: Chebyshev's and Markov's etc.
Distributions: Discrete: Uniform, Bernoulli & Binomial, Poisson, Geometric, Negative Binomial, Hypergeometic, Multinomial, Continuous: Uniform, Normal, Gamma, Exponential, Properties and applications of distributions, Probability Generating functions.
Approximation to Binomial using Poisson, Binomial using Normal, and Poisson using Normal.

Recommended Texts:

1. *Applied Probability and Statistical Methods*, G.C.Canovos .
2. *Basic Course in Statistics*, G.M.Clarke and D. Cooke
3. *A Course in Probability & Statistics*, C.J. Stone

ST 103 Statistics Applications I (1 credit)
(Prerequisite: ST 101 or any other Basic Statistics course)
Introduction to MINITAB, Data management: Editing, summarizing, Transforming and Manipulating Data, Graphical methods for describing data, Numerical methods for describing data, Distributions and Random data. Applications.

Recommended Text:

1. *MINI TAB Reference manual*

ST 104 Statistics Applications II (1 credit)
(Prerequisite: ST 101 or any other Basic Statistics course)
Introduction to the SAS Display manager system, Structure of a SAS program, Editing, rearranging, displaying and summarizing data using PROC PRINT, PROC SORT, PROC FREQ, PROC MEANS, PROC UNIVARIATE, PROC FORMAT, PROC CORR PROC TABULATE, PROC STANDARD, PROC RANK etc. Creating Graphics using PROC PLOT, PROC CHART etc.
SAS Expressions, SAS Functions, Some SAS statements (ARRAY, DELETE, DO, DROP, FORMAT, GO TO, IF, INFILE, INFORMAT, INPUT, KEEP, LABEL MERGE, OUTPUT, PUT, SET, ID, VAR, TITLE, LIBNAME ETC.) Applications.

Recommended Text:

1. *SAS Reference manual*

CS 101 Introduction to Computer Science (3 credits)
Introduction and overview: Intelligent machines and systems applications, Business, Communications, Educational, Engineering, Environmental, Medical and Scientific applications.
Introduction to computing concepts: Basics of computer programming: data types, declarations, assignments, basic input and out put ASCII files, built-in functions.
Structured programming ideas: selection statements: sequence, iteration (counting loops, while loops, file pointers), conditional (if-then-else statements, case statements), matrix manipulations (addition, subtraction, multiplication, transposition).
Modular programming: functions, procedures with actual and formal parameters, simple sort algorithms, dynamic memory allocation and addressing.

Numerical methods: Linear interpolation, linear regression, pseudo random, roots of functions, solutions of simultaneous linear equations by Gaussian elimination, numerical integration.

Recommended Texts:

1. The Thinking Ape: Evolutionary Origins of Intelligence, R. Byrne.
2. Intelligent Multimedia System : A Handbook for Creating Applications, R.M.Kaplan
3. Artificial Intelligence, E.Rich and K. Knight

CS 102 Programming Techniques (3 credits)

Basic concepts, basic components of programming languages, binding, simple algorithms operating on non-structured data, modularity in program construction.
Basics of constructing larger programs :abstraction and instantiation of program components, structured data (lists, stacks, queues, ordered binary trees), storing and accessing data structures, operations on mutable data, working with mutable data, object-based programming, data encapsulation

Recommended Texts:

1. *Data Structures, Algorithms, and Object-oriented Programming*, G.L. Heileman.
2. *Structured programming concepts*, K. Labudde

CS 104 Structured oriented Programming practical (1 credit)

(Prerequisites: CS101, CS102)
Language constructs: data declarations, loops, decision structures, input/output, files, subprograms / procedures, numeric and non-numeric data. Design and construction of software: top-down and bottom-up design, decomposition, structuring, design for reuse, documentation, study of examples, writing software as a team, using software from others. Programming assignments: A variety of progressively more complex assignments

Recommended Text:

1. *The C Programming Language*, 2nd Edition, by Brian W. Kernighan and Dennis M. Ritchie, Prentice Hall, Inc., 1988.

CS105 Object oriented Programming practical (1 credit)

(Prerequisites: CS101, CS102)
Implementation of programs with object oriented language constructs: classes, objects, inheritance, aggregation, composition and polymorphism.

Recommended Texts:

1. *Developing Java Software*, 3rd Edition, by Russel Winder and Graham Roberts, published by John Wiley and Sons, 2006
2. *Java Programming: From the Beginning*, K. N. King, *Georgia State University*

MT 105 Real Analysis I (3 credits)

Real number system as a complete ordered field, Complex number system, Topology of the real line, Neighborhoods, Sequences and limits, Limit theorems, Monotonic Sequences, Limit Concept of a Real-Valued Function, Algebra of limits, Continuity, Monotonic functions, Differentiability, Role's Theorem, Mean-Value Theorems, L'Hospital's Rule, Riemann Integral and the basic properties. Fundamental theorem of Calculus, Improper integrals.

Recommended Texts:

1. *Elementary Real Analysis,* H.G. Eggleston
2. *Analysis,* S.R. Lay

MT 107 Mathematics for Operations Research (3 credits)

Vector methods: Introduction to vectors, Linear combinations, Linear dependence and independence, Bases and dimension, Scalar product, Vector product
Differential equations: First order ordinary differential equations, Exact equations,
Higher order linear ordinary differential equations with constant coefficients
Linear Algebra: Preliminaries, Determinants, Simultaneous linear equations, Eiganvalues and eiganvectors, Matrix calculations, Special matrices, Range and null space, Decomposition of matrices, Quadratic forms. Differentiation of scalar functions of matrices.

Recommended Texts:

4. *Elementary Vector Analysis,* C.E. Weatherburn,(1982)
5. *A First Course in Differencial Equations,* D.G. Zill, (1998)
6. *Linear Algebra,* K. Hoffman and R. Kunze, (1999)

MT 108 Operations Research I (2 credits)

Introduction to Operations Research, Operations Research methods: Probabilistic and Deterministic.

Recommended Texts:

1. *Operations Research,* Kanti Swarup.(1987)
2. *Operation Research* Panner Selvam. (2006)
3.

MT 109 Linear Programming (3 credits)

(Prerequisites: MT 107, MT 108)
Introduction, Convex sets and functions, The Simplex method, Big-M method, Revised simplex method, Dual simplex method, Sensitivity analysis, Introduction to LINGO.
Some practical assignments will be given for this course.

Recommended Texts:

1. *Linear and Nonlinear Programming,* David G. Luenberger,(1997)
2. *Operations Research,* Kanti Swarup.(1987)
3. *Integer Programming,* Harold Greenberg. (1971)
4. *Linear programming,* Mukund N Thapa. (1997)
5. *Linear Programming,* Katta G. Murty. (1983)

200 LEVEL COURSE

ST 201 Probability Theory (3 credits)

(Prerequisite: ST 102)
Joint distribution of two (or more) discrete or continuous random variables, Marginal distribution, Conditional distribution, Independence of random variables, Expectation, Conditional expectation, Covariance, Correlation coefficient, Transformations involving two or more random variables, Probability density functions of (a) sum and difference, (b) product and quotient of two random variables,

Random samples, Empirical distributions, Order statistics, Distributions of MIN X_i, MAX X_i etc., Distributions of sample mean and sample variance; t, F and χ^2 distributions and their properties, Laws of large numbers, Central limit theorem.

Recommended Texts:

1. Canavos G.C. (1984), *Applied Probability and Statistical methods*
2. Freund J.E. (1994) *Mathematical Statistics*, Prentice Hall
3. Wackerly D. Mendenhall W. & Scheaffer R.L. (1995) M*athematical Statistics with Applications*, Duxbury Press.

ST 203 Theory of Statistics (3 credits)

Some practical assignments will be given for this course. (Prerequisite: ST 201)

Estimation: Point estimation: Properties of estimators; Unbiasedness, Consistency, Relative efficiency, Efficiency, Sufficiency, Factorization theorem, Rao-Blackwell theorem, UMVUE, Exponential families, Cramer-Rao inequality, Methods of obtaining estimators; Method of moments, Maximum likelihood estimators etc.

Interval estimation: Constructing confidence intervals for population parameters under various assumptions, Tolerance limits.

Testing Hypothesis: Tests on population parameters, Tests on independent and paired samples, Neyman-Pearson lemma, Uniformly Most Powerful tests, Likelihood Ratio tests.

Recommended Texts:

1. Canavos G.C. (1984) *Applied Probability and Statistical methods*, Little, Brown & Company.
2. Freund J.E. (1994) M*athematical Statistics*, Prentice Hall
3. Hogg R.V. (1978) & Craig A.T., *Introduction to Mathematical Statistics*, Prentice Hall .

ST 204 Sampling Techniques (2 credits)

Some practical assignments will be given for this course. (Prerequisite: ST 203)

Principal steps in a Sampling Survey, Probability sampling, Simple random sampling, Sampling proportions and percentages, The estimation of sample size, Stratified random sampling, Methods of allocations, Ratio estimators, Regression estimators, Introduction to Cluster sampling and Systematic sampling, Estimating the population size.

Recommended Texts:

1. Cochran W.G. (1977) *Sampling Techniques*, John Wiley & Sons.
2. Scheaffer R.L. (1996) Mendenhall W., and Ott L., E*lementary Survey Sampling*, Duxbury Press.

ST 205 Statistical Simulation (2 credits)

(Prerequisites: CS 102, CS 104, CS 105, ST 203)

Introduction and overview of simulation analysis, Modeling and estimating input processes, Random-number generation, Generation of random variates, vectors, and processes, Statistical analysis of simulation output, Comparison, ranking, and selection of simulation models, Variance-reduction techniques, Designing simulation experiments, gradient estimation, and optimization, Monte Carlo simulation

Some practical assignments will be given for this course

Recommended Texts:

1. *Simulation Modeling and Analysis*, Law and Kelton (2003)
2. *Graphical Simulation Modeling and Analysis Using Sigma for Windows*, L.W. Schruben(2001)

CS 201 Data Structures (2 credits)
(Prerequisites: CS 101, CS 104, CS 105)
Data Structures: linear and non linear data structures. Arrays, lists: linked list, ordered linked list, and doubly linked list; push down stacks; queues: FIFO queue and deque. Tree structures – trees in general, binary search tree (BST), root insertion to BST, splay tree, 2-3-4 trees, radix tree and red-black tree; Graphs; Implementation of depth first search, breadth first search; Hashing: initial hash, collisions, separate chanining.

Recommended Texts:

1. Sedgwick R., Algorithms in C, Addition Wesley, 1998
2. Standish T. A.; *Data Structures in Java*; Addison-Wesley; 1998
3. Gregory L., Heilemen; Data Structures, Algorithms, & Object-Oriented programming; McGraw-Hill

CS 202 Data Structures Practicals (1 credits)
(Prerequisites: CS 104, CS105, CS 201)
Implementation of data structures studied in CS 201 using C, C++ and Java.

Recommended Texts:

1. Standish T. A.; *Data Structures in Java*; Addison-Wesley; 1998
2. Deitel, H. M.; Deitel, P. J.; *Java how to Program*; Prentice Hall; 1999

CS 203 Database Management Systems (2 credits)
(Prerequisites: CS 101, CS 104, CS 105)
Overview: What is a database? Data and metadata. *Conceptual Modeling:* Entities, attributes, associations, functional determination, 3-level structure, graphical representation. *Relational Databases:* Relational algebra, Relational databases and tables, Query languages. The entity-relationship model, Logical organization of databases; Physical organization of databases; Characteristics of disks and disk blocks, Storage of relations, Query processing and optimization, Concurrency control; Transactions, Serializability, Locking, Recovery, Functional dependencies and forms, Introduction to Distributed DBMS, OO DBMS, ORDBMS.

Recommended Texts:

1. Connolly, Begg; *Database Systems: A Practical Guide to Design, Implementation and Management*; 3rd Edition; Addison-Wesley; ISBN:0-201-70857-4.
2. Ramez Elmasri and Shamkant B. Navathe; *Fundermentals of Database Systems*; 5th Edition; ISBN-10: 0321369572
3. Date, C. J.; *An Introduction to Database Systems*; Addison-Wesley; 2000

CS 204 Programming using Database Management Systems (1 credits)
(Prerequisites: CS 104, CS 105, CS 202, CS 203)
Computer programming using database management packages such as Informix, Sybase, Oracle and FoxPro on PCs and workstations. Programming assignments: A variety of progressively more complex assignments.

Recommended Text:

1. Loney, K.; Koch, G.; *Oracle 8i: The complete reference*; McGraw Hill ; 2000

MT 202 Real Analysis II (3 credits)
(Prerequisite: MT 105)
Cauchy sequences, Convergence tests, Absolute and conditional convergence, Power series, Integration and differentiation of power series, Taylor series, Uniform continuity, Upper and lower Riemann integrals, Characterization of Riemann integrable functions, Functions of several variables, Limits and continuity, Partial derivatives, Differentials, Chain rule, Extrema of functions of several variables, Lagrange Multipliers.

Recommended Texts:

1. S. R. Lay (1986), *Analysis An Introduction to Proof*, Prentice-Hall
2. T. M. Apostol (1974), *Mathematical Analysis*, Addison-Wesley

MT 204 Mathematical Methods (3 credits)
(Prerequisite: MT 107)
Differentiation of Vectors: Scalar and vector point functions and their partial derivatives with respect to coordinate variables, Gradient of a scalar point function; Directional derivative, Divergence and curl of a vector point function**. Integration of Vectors:** Line integrals and their evaluation using parametric representation, Surface integrals, Green's theorem in the plane Stokes theorem, Circulation and flux of a vector point function, Volume integrals, Divergence theorem, Irrotational and Solenoidal vector fields, Orthogonal Curvilinear Coordinates, Grad, Div, Curl in OCC, Cylindrical polar and spherical coordinate systems, Use of these coordinate systems in evaluation of surface and volume integrals. **Special Solution of Laplaces Equation:** Solutions in two-dimensions, Axi-symmetric solutions. **Integral Transforms:**
Laplace transforms; Elementary Properties, Inverse Laplace transform and its properties, Convolution theorem and its use in evaluation of integrals, Uses of Special functions connected with Laplace transform, Evaluation of integrals using LT, Applications in ODE and integro-differential equations, Applications in PDE, Fourier Transforms; Infinite-Fourier sine/cosine transforms and their inverse formulae, Finite-Fourier sine/cosine transforms, Derivation of inverse formulae, Use of Fourier series, Boundary value problems-Use of Fourier transforms.

Recommended Texts:

1. M.R. Spiegel (1968), *Vector Analysis*, McGraw-Hill
2. M.D. Raisinghania (1997), *Vector Analysis*, S. Chand & Comp. Ltd.
3. M.D. Raisinghania (1995), *Integral Transforms*, S. Chand & Comp. Ltd.

MT 209 Graph Theory (2 credits)
Isomorphism of Graphs, Paths, Circuits, Eulerian graphs, Hamiltonian graphs, Shortest path problem, Chinese postman problem, Directed graphs, Graph Colouring, Four colour problem, Proof of five colour theorem, Planar graphs, **Trees and Searching:** Properties of trees, Travelling salesman problem, Tree Analysis of sorting algorithms, Hall's Theorem, Transversal theory, Applications to game theory.

Recommended Texts:

1. F. Harary (1988), *Graph Theory*, Narosa Publishing House
2. R. J. Wilson (1996), *Introduction to Graph Theory*, Addison-Wesley Longman

MT 210 Advanced Linear Programming (3 credits)
(Prerequisite: MT 109)
Transportation problem, Assignment problem, Goal programming, Dantzig-Wolf Decomposition algorithm, Interior point algorithms, Bounded variable Simplex algorithm.
Some practical assignments will be given for this course.

Recommended Text:

1. *Linear programming and Network Flows,* Mokhtar S. Bazaraa, Operations Research, Kanti Swarup, (1997)
2. Geroge B. Danzing (1998). *Linear Programming and Extension.* Princeton University Press.

MT 211 Integer Programming (3 credits)
(Prerequisite: MT 210)
Introduction to Integer Programming, Modeling and applications, Dual of Primal Cutting Plane algorithms, Branch and Bound Enumerations, Search Enumerations, Partitioning in Mixed Integer Programming, Group Theory in Integer programming.
Some practical assignments will be given for this course.

Recommended Text:

1. *Integer programming, Applications and Computations,* Hamdy A. Taha., (1998)

MT 212 Operations Research II (2 credits)
(Prerequisite: MT 109)
Theory of games, Queuing theory, Inventory management.

Recommended Text:

1. *Operations Research,* Kanti Swarup., (1987)
2. *Operations Research, Katta G. Murty (1995)*
3. *Operations Research, Applications and Algorithms, Waune L. Winston (2003)*
4. *Schaum's Outline of Theory and Problems*, Richard Bronson
5. *Operation Research,* S.K. Jain and D.M. Mehta

300 LEVEL COURSE

ST 301 Regression Analysis (3 credits)
Some practical assignments will be given for this course. (Prerequisite: ST 203)
Simple linear regression, Tests for regression coefficients, Interval estimation, Prediction, Analysis of variance approach, Diagnostic and remedial measures, Matrix approach to simple linear regression, Multiple regression, Polynomial regression. Introduction to logistic regression and nonlinear regression, Introduction to Time series Analysis.

Recommended Texts:

1. Myers R.H. (1990) *Classical and Modern Regression with Applications*, Duxbury Press
2. Neter J. (1990) wasserman W. & Kunter M.H., A*pplied Statistical Models*, Irwin Inc.
3. Christensen R. (1998) A*nalysis of Vvariance, Design and Regression*, Chapman & Hall/CRC

ST 302 Quality Control (2 credits)

Some practical assignments will be given for this course. (Prerequisite: ST 203)

Control charts for mean, variance, range etc, Properties of control charts, Acceptance sampling procedures and consumer risks, Operating characteristic curves, Process capability analysis, Introduction to Quality assurance and acceptance control, Lot-by-Lot acceptance sampling by attributes, Acceptance procedure based on AQL, Other acceptance procedures, Continues acceptance sampling by attributes, Acceptance procedures for variable characteristics.

Recommended Texts:

1. Hansen B.L. (1987) & Ghare P.M., *Quality Control and Application*, Prentice Hall
2. Montogomery D.C. (1993) I*ntroduction to Statistical Quality Control*, John Wiley & Sons.

ST 303 Design and Analysis of experiments (3 credits)

Some practical assignments will be given for this course. (Prerequisite: ST 203)

Comparison of two samples (independent, dependent), One-way ANOVA: Assumptions, Normal theory, F-tests. Multiple comparisons: LSD method, Tuckey's method, Bon- ferroni method, Scheffe's method, Duncan's multiple range method.

Two-way ANOVA: Normal theory, Randomized block design, The two factor factorial, Multifactor Factorials, Confounding, Introduction to Analysis of covariance, Latin square.

Recommended Texts:

1. Jobson J.D. (1991) A*pplied multivariate data analysis*, *Vol. I : Regression and Experimental Design*, Springer
2. Neter J. (1990) Wasserman W. & Kunter M.H., A*pplied Statistical Models*, Irwin Inc.
3. Lindman H.R. (1992) A*nalysis of Variance in Experimental Design*, Springer Series.

ST 305 Multivariate Methods I (2 credits)

(Prerequisite: ST 203)

Properties of random vectors and Matrices, The Multivariate Normal distribution, Estimation of parameters in the Multivariate Normal distribution, Wishart distribution, Inferences on multivariate mean, and Hotelling's T^2 tests, Multivariate Analysis of Variance, Cluster Analysis.

Some practical assignments will be given for this course

Recommended Texts:

1. *Multivariate Statistics - A Practical Approach,* Flury B and Riedwel H,l (1998)
2. *Multivariate Statistical inference & Applications,* A.C. Rencher (1982)

ST 306 Data Analysis & Preparation of Reports (1 credit)

(Prerequisites: ST 301, ST 302)

Students will be grouped, and assigned instructors. The skills of data analysis, statistical software development and report writing will be given. Initially the student groups are given case studies. Gradually the students will be assigned small projects taken from Industry. At the end of the course students are expected to write reports of their findings.

Recommended Text:

1. *SAS Reference Manuals*

ST 307 Time series (2 credits)
(Prerequisites: ST 203, ST 301)
Introduction; Objectives of time series analysis, Components of time series, Traditional method of time series analysis; Estimation of trend, seasonal effect forecasting; Auto-correlation & Auto-covariance functions Correlogram; Probability models for time series; Stationary processes; Second order stationary processes; Purely random processes; Random walk; Moving average processes; Auto-regressive processes; Mixed models (ARMA, ARIMA); Estimation of parameters; Testing adequacy; Forecasting; Exponentially smoothing forecasting procedure; Non Stationary and Seasonal Time series models (SARIMA); Box-Jenkins forecasting procedure. Introduction to non linear models and Multivariate time series modelling
Some practical assignments will be given for this course

Recommended Texts:

1. *Introduction to Time Series and Forecasting,* P.J. Brockwell and R.A. Davis (2000)
2. *The Analysis of Time Series, An Introduction,* C. Chatfield (1998)

ST 308 Bayesian Statistics I (2 credits)
(Prerequisite: ST 203)
Introduction: Statistical and Non-statistical decisions, Profit, Loss, Risk and utility, Expected Value, Bayes' Theorem, Prior Distribution, Bayesian Inference; Non-statistical Decisions: Maximin, Maximax, Minimax Regret and Hurwicz.

Recommended Texts:

1. *Statistical Decision Theory and Bayesian Analysis,* J.O. Berger (1985)
2. *Bayes and Empirical Bayes methods for Data analysis,* B.P. Carlin and T.A. Louis (1996)

ST309 Non-Parametric & Categorical Data Analysis (3 Credits)
Prerequisites: ST203
Non-Parametrics : One sample sign test, Binomial test, Two sample sign test, Wilcoxon paired samples, Signed rank test, Wilcoxon and Mann Whitney test, Correlation tests, Tests of independence, Wald- Wolfowitz runs test, Kruskal-Wallis test, Friedman test. Categorical Data Analysis: Multinomial distribution and Goodness of fit tests, The Kolmogorov-Smirnov test, Inference on two-dimensional contingency tables, Models for binary response variables and generalized linear models: Logistic regression, logit models, probit models, Model diagnostics

Log-linear models: Log-linear models for two or more dimensions, testing goodness of fit, estimation model parameters, Strategies in model selection, Analysis of deviance, Log-linear models for ordinal variables,
Some practical assignments will be given for this course

Recommended Texts:

1. Nonparametric Statistical Inference, Gibbons J.D. & Chakrabortic S.,
2. Categorical Data Analysis, Alan Agresti
3. Generalised Linear Models, McCullagh and Nelder

ST 325/MT 325 Seminar (1 credit)
(Prerequisites: ST 306, ST 307)
A student is expected to carry out an extensive literature survey on a topic assigned to him/her by a senior staff member. At the completion of the course the student is expected to write a report of not less than ten pages, and make a presentation.

CS 315 Design and Analysis of Algorithms (2 Credits)
(Prerequisites: CS 201, CS 202)
Analysis of algorithms: time complexity, big O notation. Sorting algorithms: bubble sort, selection sort, insertion sort, quick sort, heap sort, merge sort and external sorting methods. Hashing: hash functions and collision resolution: separate chaining, linear probing and double hashing. Classification of Algorithms by Implementation and Design Paradigm: Divide & Conquer Algorithms, Dynamic Programming, Greedy Algorithms, Recursive Algorithms, Backtracking, Alfa-Beta pruning, Branch & Bound Search; Analysis of Algorithms, NP- completeness; Classification by Field of Study: Searching, Sorting, String matching, Graph, Machine Learning; Genetic algorithms

Recommended Texts:

1. Sara Baase, Allen Van Gelder (2000), *Computer Algorithms - Introduction to Design & Analysis*, Addison-Wesley
2. Thomas H. Cormen, Charles E. Leiserson & Ronald L. Rivest (2000), *Introduction to Algorithms*, McGraw-Hill

MT 304 Partial Differential Equations (2 credits)
(Prerequisite: MT 103)
First order partial differential equations: Linear equations, Non-linear equations, Characteristics.
Second order partial differential equations: Equations with constant coefficients, Equations with variable coefficients, Laplace equation, Wave equation, Diffusion equation, Boundary value problems,
Use of Fourier series.
Numerical methods of solving partial differential equations.

Recommended Texts:

1. R. V. Churchill & J.W. Brown (1987), *Fourier Series and Boundary Value Problems*, McGraw-Hill
2. E.T. Copson (1975) *Partial Differential Equations*, Cambridge University Press

MT 313 Convex Analysis (2 credits)
(Prerequisite: MT 202)
Convex sets, Convex functions, Continuity and Differentiability of convex functions, Minimum and maximum of a Convex function over a Convex set, Lagrange multipliers, Minimax theorems and duality, Saddle-functions

Recommended Text:

1. *Convex Analysis*, R. Tyrell Rockafellar.(1987)

MT 314 Network Optimization Theory (3 credits)
(Prerequisite: MT 210)
Introduction, Paths, Trees and Cycles, Shortest Paths, Maximum flows, The Traveling Salesman problem.

Recommended Text:

1. *Linear programming and Network Flows*, Mokhtar S. Bazaraa. (1997)

MT 315 Operations Research III (2 credits)
(Prerequisites: MT 109, MT 314)
Simulation, Network Scheduling, Information Theory.

Recommended Text:

1. *Operations Research*, Kanti Swarup. (1982)

MT 316 Non-Linear Programming (3 credits)
(Prerequisite: MT 210)
Quadratic programming, Dynamic programming, Geometric programming, Probabilistic programming, Fractional programming, Gradient Search methods.

Recommended Text:

1. *Linear and Nonlinear Programming,* David G. Luenberger
2. Operations Research, Kanti Swarup, (1997).
3. *Non-linear Programming, Theroy and Algorythms* Mokhtar S Bazra et al. (2006)

400 LEVEL COURSES

ST 401 Actuarial Statistics (2 credits)
(Prerequisite: ST 203)
Economics of uncertainty. Risk theory and utility. Jensen's inequality. Sums of random variables and convolutions. Applications to individual risk models. Failure rates and the force of mortality. Mixtures of random variables and mixtures of distributions. Loss distributions, Reinsurance. Risk models, Estimating distribution by simulation. Actuarial applications of statistical inference. Compound distribution. Collective risk models. Ruin theory. Lundberg's Inequality, Introduction to credibility theory. Compound stochastic processes. Applications of risk theory in insurance problems. No claims discounting. Run off triangles.

Recommended Texts:

1. *An Introduction to the Mathematics of Finance* (Chapters 1-4), J.J. McCutcheon and W.F. Scott.,(1998)
2. *Life Contingencies* (Chapters 1-6)A. Neill.(1999)
3. *Actuarial Mathematics* (Chapters 3-8), N.L. Bowers Jr, ... [et al.].(2001)
4. *Mathematical Models for the Growth of Human Populations,* .H. Pollard (1997)

ST 402 Data Mining Techniques (3 credits)
(Prerequisites: CS 409)
Introduction: Basic Data Mining Tasks, Database / OLTP Systems, Data Warehousing, OLAP Systems, Related Concepts (Statistics, Fuzzy Sets and Fuzzy Logic, Information Retrieval, Decision Support Systems, Dimensional Modeling, Machine Learning, Pattern Matching). Data Preprocessing, Exploratory Data Analysis, Statistical Approaches to Estimation and Prediction. Association Rule Mining. Classification and Prediction: Introduction, Decision Tree Induction Methods, Bayesian Classification, Rule Based Algorithms, Neural Network Based Algorithms. Cluster Analysis: Introduction, Similarity and Distance Measures, Partitioning Methods, Hierarchical Methods, Outlier Analysis. Web Mining: Web Content Mining, Web Structure Mining, Web Usage Mining. Applications and Trends in Data Mining.
Some practical assignments will be given for this course

Recommended Texts:

1. *Data Mining Introductory and Advanced topics,* M.H. Dunham (2003)
2. *Predictive Data Mining,* Weiss SM & Indurkhya N, Morgan Kaufmann (1997)
3. *Principles of Data Mining,* Hand DJ et al, MIT Press (2001)

ST 403 Statistics for Bioinformatics (2 credits)
Review of the following in the context of bioinformatics: Basic probability, statistical inference, stochastic processes, computer intensive approaches to statistical inference, applications. Mathematical models and computational methods of statistical genetics including mendelian genetic traits, population genetics, pedigree relationships and gene identity, meiosis and recombination, linkage detection, multipoint linkage analysis. Course work involves some computation in a Unix environment.

Recommended Texts:

1. *Biological Sequence Analysis,* R. Durbin, S. Eddy, A. Krogh and G. Mitchison (1998)
2. *Statistical Methods in Bioinformatics, An Introduction,* W. J. Evans, G.R. Grant (2001)

ST 404 Stochastic Processes (2 credits)
(Prerequisites: ST 201, ST 203)
Introduction to Stochastic processes: Markov Chains, Markov Processes with Discrete state space, Markov Processes with Continuous state space, Stationary processes, Branching Processes, Stochastic processes in Queueing and Reliability

Recommended Text:

1. *Stochastic Processes,* J. Medhi (1996)

ST 405 Multivariate methods II (2 credits)
(Prerequisite: ST 305)
Discriminant analysis of two group and multiple groups, Principal component analysis (PCA). Interpretation using illustrative examples. Factor analysis. Comparison with PCA, factor loadings, rotations, Interpretation, Canonical correlation, Covariance structure models.
Some practical assignments will be given for this course

Recommended Texts:

1. *Multivariate Statistical inference & Applications,* A.C. Rencher(1990)
2. *Applied Multivariate Statistical Analysis,* R.A. Johnson and D.W. Wichern (1982)

ST 406 Bayesian Statistics II (2 credits)
(Prerequisite: ST 308)
Decision Rules; Making Decisions when data is not available: Specifying a prior distribution, Making decisions with only prior information; Making Decisions when data is available: Decision trees, Expected Value of Perfect Information (EVPI), Expected Value of Sample Information (EVSI), Non-informative and natural conjugate prior, Bayesian confidence intervals.

Recommended Texts:

1. *Statistical Decision Theory and Bayesian Analysis,* J.O. Berger (1985)
2. *Bayes and Empirical Bayes methods for Data analysis,* B.P. Carlin and T.A. Louis (1996)

CS 409 Neural networks and Fuzzy logics (3 Credits)
(Prerequisities: CS 401)
Fuzzy system models, Fuzziness and certainty, fuzzy sets, basic properties and characteristics, Domains, Alpha- level sets and support sets, Linear representation, Fuzzy set operators, Conventional (crisp) set operations, basic Zadeh type operations, intersection, union and complement of fuzzy sets, General algebraic operations, Fuzzy set hedges, Fuzzy reasoning, linguistic variables, Fuzzy models, Fuzzy systems and modeling, Design methodologies, modeling and utility software. Parallel and distributed processing, Neuron, Connectivity, Activation function, propagation rule, Learning rules, pattern Preparation, Perceptron, Multilayer perceptron, Associative memory, Hopfield neural networks, Self organizing map (SOM), Adaptive Resonance theory, topologies, Training methods, supervised and unsupervised learning

Recommended Text:

1. *Artificial Intelligence: A Modern Approach* (Second Edition) by Stuart Russell and Peter Norvig.

MT 409 Selected Topics in Applied Operations Research (2 credits)
(Prerequisites: MT 315, MT 316)
Topics will be selected from significant areas in Operations Research. Topics may vary each year.

MT 410 Optimization of Engineering Design (3 credits)
(Prerequisites: MT 315, MT 316)
Introduction, Single-variable optimization algorithms, Multivariable optimization algorithms, Constrained optimization algorithms, Specialized algorithms, Nontraditional optimization algorithms.

Recommended Texts:

1. *Optimization for Engineering Design* (*Algorithms and Examples*), Kalyanmoy Deb, (1999)
2. *Engineering Optimization Theory and Practice, 4th edition,* Singiresu S. Rao, (2009) Wiley books.

MT 411 Optimization Modeling (2 credits)
(Prerequisites: MT 315, MT 316)
Optimization models in Linear programming, Nonlinear programming and Integer programming. Students are expected to develop reasonable modeling skills allowing them to cast appropriate real world problems as optimization problems and solve them with available software.

MT 412 Financial Mathematics (3 credits)
An introduction to options and markets, Interest and present value analysis, Geometric Brownian Motion, Pricing contract via arbitrage, Arbitrage theorem, Black-Scholes option pricing formula, The binomial option pricing model, More results on options, Valuing by expected utility, Exotic options.

Recommended Texts:

1. *An Elementary Introduction to Mathematical Finance. Options and other Topics,* S.M. Ross, (1987)
2. *The Mathematics of Financial Derivatives, A student Introduction,* P. Wilmott, S. Howisan, J. Dewynne,(2000)
3. *Options, Futures and other Derivatives,* J. Hull, Prentice Hall,(1998)

ST 425 / MT 425 Project Work / Industrial Training (6-8 Credits)

Each student will undergo full time training in the industry for the prescribed period on projects assigned by the industry. Students are required to have a duly maintained 'Daily Diary' and 'Students Record Book' which should be submitted to the Head of the Department within two weeks after completion of training. In addition, the students are expected to write a report and make presentation on the work carried out by them.

ENGLISH FOR ACADEMIC PURPOSES

Intensive course (Duration: 4-6 weeks)
The intensive course is designed to achieve UTEL level 4.
Grammar & Writing - Parts of speech, sentence structures, simple descriptions
Reading - Identify the main idea, supporting details of a short text, read for gist and details to answer questions, use contextual, structural and morphological clues to deduce meanings of unfamiliar words, understand the function of basic punctuations in a text.
Speech - Communicate information of personal / familiar topics
Use question forms to elicit information of familiar topics.
Listening - Familiarize students with basic techniques of grasping information from a spoken text. Identify key ideas in a short academic text and take down notes

EN 100 (compulsory foundation course, 2 credits)
The EN 100 course is designed to achieve UTEL levels 5 and 6.
Grammar and writing- Tenses : Six basic tenses and its application in academic and scientific writing. Present and past passive voice : Structure, application in process and lab report writing. Relative clauses: Application in definition writing and providing information. Prepositions : Describing position, movement and time and appropriate use in scientific context. Conditionals : Expressing real and hypothetical situations and their application in science. Paragraph writing : Topic sentence and supporting statements, use of cohesive devices, sequence markers, transitional signals, structures and vocabulary in comparison, classification and cause and effect
Reading - Consolidates reading skills. Reading complex texts for gist and details, reading and note taking: Presenting given information using illustrations, graphs, charts, symbols and abbreviations.
Speech- Express opinions on topics guided by prompts. Deliver a short speech on a given topic using limited range of cohesive devices. Use simple present / present continues to talk about situations depicted in visuals.
Listening -Listening for comprehension, specific and general information and note taking based on texts dealing with general and academic contexts.

EN 200 (compulsory certificate course)
The EN 200 course is designed to achieve UTEL level 7.
Grammar and Writing -Direct speech and reported speech: Reporting statements, questions, suggestions and instructions, highlighting punctuation in direct and indirect forms. Impersonal passive constructions. Perfect Tenses: Present and past perfect tenses, continuous forms and usage. Interpretation of graphs: Writing interpretations of bar graphs, pie charts and line graphs, structures used: comparison and contrast, 'There be' structure. Report writing : Reporting an incident. Structures used: Past tense, direct and indirect speech. Letter and email writing: Letters/emails of request, invitation, excuse, enquiry, complaint, reply letters to complaints and informative letters. Essay Writing: Writing argumentative and discursive essays.
Reading - Reading comprehension, Reading and summarizing
Speech - Group presentations (focus on presentation skills, slide preparation and report based on the presentation). Functional language
Listening - Listen to authentic spoken texts from a range of contexts, including variety of accents, both academic and social and draw inferences, understand opinions, extract specific and general information.

Notes: