UNIVERSITY OF VAVUNIYA, SRI LANKA

FACULTY OF APPLIED SCIENCE

HANDBOOK

2021/2022

Foreword

Dear Students

Welcome to the University of Vavuniya!

University of Vavuniya will open up opportunities for you, help you build your future and make your mark in the world. If you choose to join our undergraduate community, you will go on to become one of our graduates who are renowned for their academic achievements, their ability to shape society and contribute to the economy. We will help you to achieve your career goals by putting your academic knowledge into practice, gaining the problem-solving skills and agility you need to adapt and flourish in a changing world.

At University of Vavuniya, we have dedicated academic and other staff members who facilitate your growth. I encourage you all to take advantage of the facilities available at the University. The handbook is one of the tools that can assist you during your academic years. It contains information on the academic, rules, and regulations available to you and many resources to help you find advice and make good choices. I request you to read it, understand it, and refer to it during your ongoing orientation.

A university can never be brought to excellence, but it can be improved. And that's where you come in. You – the students - are the most important part of a university. You must ask the critical questions. Your commitment is needed not only in the lecture theatre and in the learning environment, but in student democracy, student organizations, and public debate. In short, Put your mark on the campus! Leave an imprint!

I wish to appreciate the Dean and staff of Faculty of Applied Sciences who devoted their time and effort in the preparation of this handbook.

I hope that you will enjoy learning more about the University of Vavuniya through the stories shared by our students. If you are driven to make an impact, University of Vavuniya will guide you along your path.

Prof.T.Mangaleswaran
Vice Chancellor
University of Vavuniya

Preface

Dear Students,

Welcome to the Faculty of Applied Science, University of Vavuniya!

The University of Vavuniya was newly established as an independent university in 2021, which was earlier attached to the University of Jaffna as the Vavuniya Campus of the University of Jaffna. The university is located nearly 12 km away from Vavuniya town. The Faculty of Applied Science is one of the faculties at the University of Vavuniya, and it has two departments: bio-science and physical science, both of which offer four-year honors degree programs and three-year general degree programs.

We are proud to express and share our gladness that the faculty celebrates its silver jubilee in the last year, as such a way, the Faculty of Applied Science offers a flexible , cheerful, smart, and green environment to complete the degree programs. The students develop the knowledge and skills from learning course modules of their degree program. In addition to this, they are expected to develop the necessary soft skills, communication skills, and IT skills irrespective of their academic programme. The faculty also offers academic advisory and counseling programs and financial assistance for impoverished students to assist them with study. The Faculty of Applied Science facilitates and encourages students to get involved in sports, cultural, and recreational activities.

This student handbook contains valuable information about the curriculum structure, course syllabi, exam rules and guideline evaluation methods, code of student conduct, and available facilities. The students are expected to be familiar with the information given in this handbook.

Well, this is an excellent opportunity that you have got admission for university higher education. I wish you all to complete your degree program successfully in applied science, applying your knowledge and abilities toward the scientific innovations and sustainable development of the nation.

Good luck!

Dr.(Mrs.)J.Nimalan
Dean
Faculty of Applied Science

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1. General Information

1.1 Introduction

The Vavuniya Campus of the University of Jaffna was established on 1^{st} April 1997 by an order made under Section 22 of the Universities Act No. 16 of 1978 with two faculties, namely, the Faculty of Applied Science and the Faculty of Business Studies. The Faculty of Technological Studies was established in February 2020 (No. 2160/43 order under section 27(1), Universities Act No. 16 of 1978) by the Ministry of Higher Education, Technology and Innovation of Sri Lanka. The Vavuniya Campus of the University of Jaffna was then elevated to a separate state university and established as the "University of Vavuniya, Sri Lanka" by an extraordinary gazette issued on June 8, 2021. Accordingly, the University of Vavuniya became the 17^{th} state University in Sri Lanka with effective from 1^{st} August 2021.

The permanent site of the University of Vavuniya is about ten kilometres away from Vavuniya in the Vavuniya-Mannar road at Sopalapuliyankulam, Pampaimadu. One hundred and sixty acres of land was allocated and reserved for the construction of academic, administrative, and residential buildings. Vavuniya, in the southern part of the Northern Province, is a melting pot of cultures from the Vanni region and the north-central region of Sri Lanka. A culture that has been influenced and shaped by the Vanniyas (of whom the King Pandaravanniyan is a prominent example). This district has ties even with the Paduvankarai regions that extend to the Southernmost part of the Northern and Eastern provinces - an indication of how the Vanniya people have contributed to the rich culture of the Tamil speaking societies of Sri Lanka. Vavuniya is renowned for its mild climate, which provides a pleasant change from the usual arid conditions of the coastal regions of the Northern and Eastern provinces. As such, it provides an ideal setting for the Faculty of Applied Science, with a pleasant environment to indulge in educational and extra-curricular activities. Further, as per present conditions, Vavuniya provides a strategic location that acts as a transit point for the movement of people as well as various financial and industrial activities/processes. Thus, Vavuniya is expected to grow into a prominent financial and cultural hub in Sri Lanka.

The Faculty of Applied Science as an academic organization has a flexible, friendly, and conducive internal environment that allows for effective teaching, learning, and research. This is due to the fact that the faculty has a unique signatured culture where the student and staff interactions are high-level and one-to-one attention is administered to the students by the teachers. Further, the faculty has very strong ties with the community of Vavuniya and it is seen as a key and prominent player in the advisory capacities of all development endeavours taking place in the locality. The Faculty of Applied Science of the University of Vavuniya consists of two departments, namely the Department of Physical Science and the Department of Bio-science.

Vision and Mission

As in the case of any institution, the Faculty has developed a clear-cut vision as an academic entity to actively compete in the dynamic market of higher educational service providers in the local, national, and international arenas.

The **Vision**

> 'To be the centre of excellence in the provision of technologically advanced and appropriate applied science education'.

As per the vision stated above, the Faculty of Applied Science has developed its own unique **motto** or **slogan** which states:

> 'State of the art technological education for applied thinkers, and, dynamic personalities - which provides a cutting-edge advantage to survive and excel in the dynamic and competitive job market'.

The **Mission**

> 'To become the leader in advancing knowledge and skills in applied science and in evolving into a good academic-corporate citizen contributing to the sustainable development of the region and country'

The goals of the Faculty of Applied Science are:

(1) Ensuring and enhancing high academic standards.

(2) Strengthening and enhancing institutional capacity to cater to the present and future needs.

(3) Production of marketable graduates with high academic and practical skills.

(4) Promote pure and applied research of high standards.

(5) Enhancing the projection of a good corporate citizen's image.

As such, the Faculty of Applied Science strives to provide the best possible means of education to its students to enable them to develop both academic and professional skills so that they can be successful individuals in their personal and professional lives.

Department of Bio-science

The Department of Bio-science is one of the departments in the Faculty of Applied Science of the University of Vavuniya, commenced in 1997. The Department of Bio-science offers the course units for the bachelors degree programme in Environmental Science. The Syllabi has been drafted with different courses in Environmental Science with an emphasis on fields of technological importance. The major objective of the department is to train the undergraduates to suit the latest trends in the industry, research, and development of the national economy through course work, practical sessions, industrial training, and research projects pertaining to Environmental Science. The revised curriculum has been approved by the Council and the UGC. The curriculum was revised in such a way to offer the Bachelor of Science Honours in Environmental Science as a four-year honours degree program, in line with the Outcome Based Education and Learner Centered Teaching (OBE-LCT) and Sri Lanka Qualifications Framework (SLQF).

Department of Physical Science

The Department of Physical Science of University of Vavuniya came into existence with the commencement of the Faculty of Applied Science in 1997. Initially, the department offered the course units for a degree programme named Applied Mathematics and Computing. Then the Information and Communication Technology Degree programme was introduced in 2006 for all streams of advanced level students. The Applied Mathematics and Computing Degree programme was also revised and the three-year degree programme named Applied Mathematics and Computing and the four-year degree programme named Computer Science.

The major commitment of the department is to provide up-to-date knowledge in Mathematics and Statistics, Computer Science, and Information Technology to undergraduates through coursework, practical sessions, industrial training, and research projects. The Information and Communication Technology programme was revised as Information Technology degree programme in 2018. The department has been offering the course units for the Bachelor of Science in Applied Mathematics and Computing, Bachelor of Science Honours in Computer Science, Bachelor of Science in Information Technology, and Bachelor of Science Honours in Information Technology from the academic year 2017/18 onwards based on the curriculum revision in 2018. The revised curricula are in line with the Outcome Based Education and Learner Centered Teaching (OBE-LCT), Sri Lanka Qualification Framework (SLQF), IEEE/ACM, and Subject Benchmark Statements of IT (SBS-IT) guidelines.

1.2 Officers of the University of Vavuniya

Chancellor	Dr.S.Mohanadas
Vice Chancellor	Prof.T.Mangaleswaran
Dean/Applied Science	Dr.(Mrs.)J.Nimalan
Dean/Business Studies	Prof.Y.Nanthagoban
Dean/Technological Studies	Mr.V.Senthooran
Registrar	Mr.N.Rajavisahan
Bursar	Mr.L.Ramramanan

1.3 Academic Staff of the Library

Senior Assistant Librarian/Library	Mr.S.Shanmugathasan

1.4 Executive Staff

Deputy Registrar/Establishments	Mr.K.Poheenthiran
Deputy Registrar/Examinations and Admissions	Mr.M.Ganeshalingam
Deputy Registrar/Academic Affairs and Publication Branch	Mr.M.Nanthakumar
Assistant Registrar/Students and Welfare Division	Mr.R.Jeyakumar
Assistant Registrar/Administration	Ms.T.Piranavamalar
Assistant Registrar/Faculty of Applied Science	Ms.K.Anusiga
Assistant Registrar/Faculty of Business Studies	Ms.P.Danoshana
Assistant Registrar/Faculty of Technological Studies	Mr.P.Krishnanathan
Assistant Bursar/Accounts and supplies	Mr.B.Balathas
Assistant Bursar/Payments	Mr.A.E.M.Venesious
Works Engineer	Eng.G.Thanushan
Curator (Landscape)	Mr.T.Raguram

1.5 University Medical Officer

University Medical Officer — Dr.P.Sathiyalingam, MD

1.6 Staff of the Faculty of Applied Science

1.6.1 Office of the Dean

Dean — **Dr.(Mrs.)J.Nimalan**
BScHons (Agri) (Jaffna,SL), MSc (AIT,Thailand),
PhD (Peradeniya,SL)

Assistant Registrar — **Ms.K.Anusiga**
BBAHons (FM) (Jaffna,SL),
MSc in Applied Finance (USJ,SL)

Management Assistant — **Mr.P.Mohanakanth**

1.6.2 Department of Bio-science

Head — **Dr.S.Wijeyamohan**
BScHons (Zoology) (Peradeniya,SL), PhD (Peradeniya,SL)

Academic Staff

Prof.(Mrs.)A.Nanthakumaran
BScHons (Agri) (EUSL,SL), MSc (Norway),
PhD (TNAU,India)

Dr.(Mrs.)J.Nimalan
BScHons (Agri) (Jaffna,SL), MSc (AIT,Thailand),
PhD (Peradeniya,SL)

Mr.A.E.S.Patrick
BScHons (Zoology) (Jaffna, SL), MPhil (Peradeniya,SL)
PhD (Reading)

Dr.(Mrs.)S.Devaisy
BScHons (Env Sc)(Jaffna,SL),
MSc (Peradeniya,SL), PhD (Sydney,Australia)

Dr.S.Wijeyamohan
BScHons (Zoology) (Peradeniya,SL), PhD (Peradeniya,SL)

Mr.G.Naveendrakumar
BScHons (Env Sc) (Jaffna,SL), MPhil (Peradeniya,SL)

Dr.(Mrs.)M.Piratheepkumar
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Mrs.K.Sobana
BScHons (Env Sc) (Jaffna,SL)
MPhil (Peradeniya, SL)

Dr.K.Arjunan
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PhD (WSU, Australia)

Dr.(Mrs.)S.Vijitharan
BScHons (Env Sc) (Jaffna,SL), MSc (Peradeniya,SL)
PhD (AIT,Thailand)

Ms.K.G.S.Madhushani
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Non Academic Staff

Technical Officer	**Mr.S.K.Poongkannan**
Management Assistant	**Ms.N.Palliyaguru**
Laboratory Attendant	**Mr.A.Kamilash**

1.6.3 Department of Physical Science

Head

Dr.S.Kirushanth
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Academic Staff

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BScHons (Computer Science) (Jaffna,SL),
PGDip (Colombo,SL), MEngSc (Malaya,Malaysia), SEDA

Mr.B.Yogarajah
BScHons (Mathematics) (Jaffna,SL), PGDip (Peradeniya,SL),
MPhil (Jaffna,SL)

Dr.R.Nagulan
BSc (Jaffna,SL), MSc (Peradeniya,SL),
PhD (Kent,UK)

Mr.S.S.Suthaharan
BCA (Madras,India), MSc (Madras,India),
MPhil (Peradeniya,SL)
PhD (Reading)

Mrs.R.Yasotha
BScHons (Computer Science) (Jaffna,SL), MPhil (Jaffna,SL)

Mr.T.Jeyamugan
BScHons (AMC) (Jaffna,SL), MSc (Moratuwa,SL)

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BScHons (AMC) (Jaffna,SL), MSc (Moratuwa,SL)

Mr.S.Thilaganathan
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Mrs.S.Subaramya
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MPhil (Peradeniya,SL)

Mrs.A.Ann Sinthusha
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MPhil (Reading)

Mr.T.Kartheeswaran
BScHons (ICT) (Jaffna,SL), MSc (Peradeniya,SL)
PhD (Reading)

Ms.R.Vaishali
BScHons (ICT) (Jaffna,SL)
MSc (Central University of Kerala, India)

Ms.P.Shorubiga
BScHons (ICT) (Jaffna,SL)

Mr.N.Kajan
BScHons (Mathematics) (Jaffna,SL)

Mr.G.Vijayakanthan
BScHons (Computer Science) (Jaffna,SL), MSc (Peradeniya,SL)

Mr. K. Mathanaharan
BScHons (IT) Specialising in Cyber Security (SLIIT,SL)

Mrs. S. Sobana
BScHons (Computer Science) (Jaffna,SL)

Instructors

Mr.K.Santhanakrishnan
BScHons (Computer Science) (Jaffna,SL)
MSc (Peradeniya,SL), PhD (Reading)

Mr.S.Gopinath
BScHons (ICT) (Jaffna,SL), MSc (Peradeniya,SL)

System Engineer

Mr.K.Pratheepan
BSc (Peradeniya,SL), MSc (Peradeniya,SL)

System Analyst

Mr.S.Nithiyanandam
BSc (Jaffna,SL), MSc (UCSC,SL)

Non Academic Staff

Staff Technical Officer	**Mr.K.Jeyakhoban**
Technical Officer	**Mr.M.Sutharshan**
Management Assistant	**Ms.P.J.Dissanayake**
Laboratory Attendants	**Mr.S.Vinayagamoorthy**
	Mr.S.L.Reginold
	Mr.S.Kodeeswaran

1.7 Faculty Quality Assurance Cell (FQAC)

Faculty Quality Assurance Cell is functioning at the faculty level to ensure that the quality and standards of the academic programmes offered by the Faculty to meet the changing demands and challenges of higher education sector.

The objective of this FQAC is to provide suggestions or recommendations and facilitation to implement and monitor the best management practices to ensure quality principles at the faculty level for an effective learning environment according to the SLQF guidelines and relevant benchmarks, student and staff support services, and other various aspects.

FQAC conducts regular meetings with the members to discuss quality aspects, faculty awards and Dean's list, conducts students' feedback and satisfaction surveys, analyzes the results, and communicates with the appropriate staff members for verification and acceptance.

Furthermore, FQAC takes a significant role in facilitating institutional and program reviews and undertakes follow-up actions on the recommendations given during the above reviews and finally reports to the Faculty Board for decision making.

The meeting minutes and documentation are regularly updated on the FQAC official website linked to CQA and ensuring transparency, accountability, affordability, and accessibility to both staff and students, and adding value to the Faculty of Applied Science. Best practices show the path to success through continuous improvement, leading to the benchmark of excellence.

2. Degree Programme – Department of Bio-science

2.1 The Structure of the Programme

2.1.1 The Title of the Degree Programme

The Department of Bio-science offers a four year degree programme titled as Bachelor of Science Honours in Environmental Science. The abbreviation of Bachelor of Science Honours in Environmental Science degree is BScHons (Env Sc).

2.1.2 Admission

Students are admitted annually to the degree programme by the University Grant Commission with the following minimum requirement:

At least 'S' grades in Biology, Chemistry, and in one of the following subjects at the GCE Advanced Level examination;

- Agricultural Science
- Higher Mathematics
- Mathematics
- Combined Mathematics
- Physics

2.1.3 Medium of Instruction

Medium of the instruction shall be English.

2.1.4 Program Overview

This study program is designed to offer theoretical knowledge, practical skills, problem solving, and creative thinking. The course units are distributed at four levels – Level 1, 2, 3, and 4. The proposed study program is credit based and an academic year is divided into two semesters, each with 15 weeks duration. One credit shall constitute 50 notional learning hours. Contents in a theory course may consist of one credit (50 notional learning hours), 2 credits (100 notional learning hours), and 3 credits (150 notional learning hours) while a practical course

may vary from one credit (30 to 45 hours) depending on the practical knowledge required in the respective disciplines. In many course units, the practical is designed as a component along with the theory part. Students enter into the BScHons (Env Sc) are required to follow core course units in all four levels and auxiliary course units in Levels 1, 2, and 3.

The most important course units to be offered in the field of Environmental Science are referred to as core course units while the elective course units are the ones chosen by the students in their field of interest. The number of credits from core course units for the four-year degree programme is 104 and the number of credits to be selected from elective course units is 16 to satisfy the total credit of 120.

Level 1 Semester I has been designed to incorporate the fundamentals of Environmental Science in different disciplines of Chemistry, Botany, and Zoology in addition to Basic Mathematics and Fundamentals of Information Technology. From Level 1 Semester II to Level 4 Semester II, the curriculum deals with the detailed study of environmental science. The curriculum in Level 4 focuses on a research project and industrial training for a period of two months. The chosen research topics of regional and national interest, mainly related to natural resources and environmental issues would help to develop their research skills and promote their in-depth knowledge in the chosen research area. Further, in order to enable students to gain knowledge on the wide range of environmental issues such as the resource exploitation, environmental disasters, environmental pollution, solid and hazardous waste disposal, wastewater discharge, deforestation, wildlife management, and unplanned urbanization, students are requested to prepare field report by visiting to the fields as a part of the course units. These field based assignments and the course unit titled as 'Seminar' facilitate Student Centered Learning (SCL) which cater the skills such as communication, teamwork, leadership, creativity, problem solving, managerial and entrepreneurial, data analysis, IT applications for environmental management, social networking, adaptability, and flexibility to the undergraduates.

Auxillary course units are offered to the students in Level 1, Level 2, and Level 3. In Level 1; English Language I, and Social Harmony and Active Citizenship. In Level 2; Communication and Soft skills, and English Language II. In Level 3; Career Guidance, and Management and Entrepreneurial Skills are designated as auxiliary course units. These course units are designed to impart knowledge and to develop the personality of a graduate in the field of Applied Science though they are not directly related to the field of study. The volume of learning of auxiliary course units is equivalent to 14 credits. Though all these auxiliary course units are not included in the calculation of GPA, the student should satisfy the minimum requirement as specified in the evaluation scheme to be eligible for the award of degree. The course units have gained popularity among the community as it has created a pathway to solve the environmental issues.

2.1.5 Credit Valued Course Unit System

Credit System

All the course units are assigned credit values. One credit is considered to be 50 notional learning hours.

Code Numbers

Each course unit will be denoted by a four-digit number. As stated in Figure 2.1, the first digit denotes the level/year of study. The second digit indicates the semester. The third digit

indicates the serial number of the course unit in the specific semester and the fourth digit indicates the number of credits assigned to the course unit.

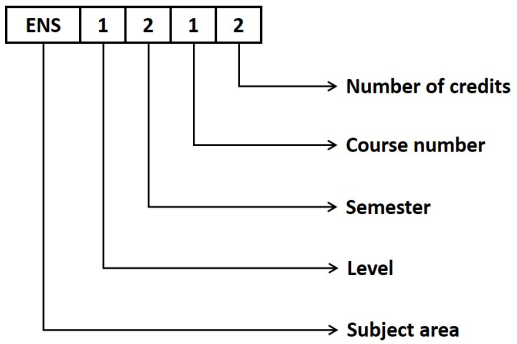

Figure 2.1: Details of a Course Code

Core Course Unit

The core course units are designed in such a way to provide skills in communication, teamwork, leadership, creativity, problem solving, managerial and entrepreneurial skills, data analysis, IT applications for environmental management, social networking, adaptability, and flexibility to the undergraduates. The majority of the course units are designed by incorporating practical sessions. Except for one practical course unit, the rest of them are either theoretical course units or theory incorporated with practical course units. The total volume of learning through core course units amounts to 120 credits distributed as 15 credits in each semester in Level 1, 2, and 3, and 19 credits in Level 4 Semester I and 11 credits in Level 4 Semester II. A student has to choose 12 credits out of 17 credits in Level 4 Semester I and 4 credits out of 6 credits of elective course units in Level 4 Semester II.

Auxiliary Course Unit

The Auxiliary Course units are designed to provide basic knowledge on a wide range of disciplines that an undergraduate should possess in the present era. The credits of the Auxiliary Course Units are not taken for the computation of the GPA, however all the auxiliary course units shall be evaluated and considered for the award of degrees. The list of auxiliary course units offered is tabulated in Table 2.1.

Table 2.1: Auxiliary course units offered for the degree program

Auxiliary course units	**Level and Semester**	**Credits**
English Language I	Level 1 Semester I	3
Social Harmony and Active Citizenship	Level 1 Semester II	2
English Language II	Level 2 Semester I	3
Communication and Soft Skills	Level 2 Semester II	2
Career Guidance	Level 3 Semester I	2
Management and Entrepreneurial Skills	Level 3 Semester II	2

2.1.6 Volume of Learning

All the students selected for this degree programme are entitled to do the four-year honours degree. Each student who follows the Honours Degree programme has to complete the minimum volume of learning of 120 credits of core course units and 14 credits of auxiliary course units offered during four years of study.

It should be noted that Grade 'C' or above in the auxiliary course units English Language I and English Language II, and Grade 'D+' or above in the other auxiliary course units are mandatory to complete the degree programme.

During Level 4 Semester II, students shall be required to carry out a research project for one semester duration on a given topic under the supervision of a senior academic in a state university or senior research staff from a reputed research institute. Students have to undergo an industrial training for two months full-time considered as one credit.

2.1.7 Opting for General Degree

During the fourth year of study, a student following an honours degree programme may opt for a general degree before the submission of the thesis of the research project with valid reason. The final acceptance to opt for the general degree will be subjected to the recommendation of the Faculty Board of Applied Sciences and the Senate. If a student wishes to complete his/her studies in three years, he/she has to complete a minimum of 90 credits of core course units and 14 credits of auxiliary course units during three years of study to obtain the degree titled **Bachelor of Science in Environmental Science**.

2.2 Degree Programme Objectives and Graduate Profile

2.2.1 Programme Objectives

The objective of the degree program in Environmental Science is to produce the skilled graduates in the field of environmental science with the capacity of solving the environmental issues using appropriate scientific techniques, to train manpower to suit the modern trends in industry and research and to disseminate the knowledge to the society in order to contribute to sustainable development nationally and globally.

Specific objectives

- To understand the interconnectivity of environmental processes and challenges
- To identify environmental issues locally, nationally and globally
- To solve environmental issues scientifically
- To develop skills to evaluate and monitor the measures for environmental conservation and protection
- To facilitate the society to acquire skills, and to actively involved in environmental conservation and protection
- To maintain the database in environmental sector
- To facilitate community engagement activities towards environmental conservation and protection

2.2.2 Graduate Profile

The Department of Bio-science, Faculty of Applied Science produces the graduates with a strong sense of commitment to the acquisition of updated knowledge, skills, and an ability to apply these to a dynamic environment. They can critically evaluate science in a real-world context through exposure to industries and act with integrity and fluency across cultures and perspectives for the betterment of society. They will have intellectual openings to engage in research and be innovative through independent learning to meet the necessary requirements. They will possess teamwork spirit, positive attitude, and the ability of effective communication and leadership quality.

Graduates in the discipline of Environmental Science should be able to;

- apply academically gained knowledge in solving environmental issues scientifically
- identify the environmental issues, think critically, research, communicate, write and disseminate the findings scientifically
- ensure the sustainability of the environment
- be a socially and environmentally responsible citizen

Figure 2.2: Graduate profile of the BScHons (Env Sc) degree programme

2.3 Evaluation System of the Degree Programme

2.3.1 Evaluation Methods

A course unit will be evaluated by means of:

(a) In-course Assessment (ICA) (Formative) conducted during the course session consisting of suitable combinations of field based assignments, assessments, viva-voce, quizzes, etc. and students should attend these ICA. The marks assigned for these ICA will be taken for the computation of final marks.

(b) End-semester Examination (ESE) (Summative) will be arranged by the examination branch at the end of each semester.

Evaluation of Theory Course: The final marks of a theory examination is evaluated by adding the ICA and ESE with appropriate ratio assigned to both ICA and ESE. Hence the final mark $M1$ for the theory course is defined as follows:

$$M1 = T \ \times 70\% + A1 \ \times 30\%$$

where T is the mark obtained in the end-semester theory examination, and $A1$ is the average mark of the In-course Assessments.

Evaluation of Practical Course: The final mark of a practical examination is evaluated by giving 40% for In-course Assessment and 60% for the End-semester Examination. The final mark $M2$ for the practical course is defined as follows:

$$M2 = P \ \times 60\% \ + A2 \ \times 40\%$$

where P is the marks obtained in the end-semester practical examination and $A2$ is the average of the In-course Assessments.

Evaluation of Theory Course Unit with Practical Component: The final mark is evaluated using the individual marks obtained in the theory and practical examination. Students obtaining less than 40% marks in either theory or practical will obtain 'E' grade, even if the average is greater than 40%. The final mark M for the course unit with theory and practical components is evaluated as follows:

$$M = \frac{Ct \ \times M1 \ + Cp \ \times M2}{Ct \ + Cp}$$

where Ct and Cp are the credit value of the theory part and practical part of a course respectively.

Evaluation of Industrial Training

The final marks evaluation of industrial training is assessed by the members of the evaluation panel appointed by the Head of the Department with the approval of the Faculty Board and shall contain a senior staff from the institution where the student obtains the training and two senior staff at the Department of Bio-science. The evaluation is based on the following criteria.

a. Attendance and punctuality during training period	10%
b. Output and the quality of the work done	10%
c. Reliability without supervision	05%
d. Industriousness	05%
e. Enthusiasm	05%
f. Personality	05%
g. Leadership	10%
h. Preparation of report (Training course report)	30%
i. Presentation of report	10%
j. Viva-voce	10%

Evaluation of Project

The final marks evaluation of the research project will be assessed based on the following criteria.

a. Project proposal	10%
b. Conduct of project	20%
c. Project Report/Thesis	40%
d. Oral presentation	15%
e. Viva-voce	15%

The members of the evaluation panel for the final oral presentation and viva-voce are appointed by the head of the department with the recommendation of the faculty board and the approval of the senate. Project proposal and conduct of the project will be evaluated by the Supervisor (30%). Project report, oral presentation, and viva-voce will be evaluated by two examiners (70%), one senior member related to the discipline other than the Supervisor at the department and one external examiner who is also a senior member preferably an academic or the researcher from any other University or research institute with the approval of the Senate.

2.3.2 Grading system and Grade Point Average (GPA)

Based on the scheme of evaluation stated above, marks obtained in respect of a course unit will be graded as follows.

Table 2.2: Grade point values for the range of marks

Range of Marks	Grade	Grade Point Value
80 — 100	A+	4.0
75 — 79	A	4.0
70 — 74	A–	3.7
65 — 69	B+	3.3
60 — 64	B	3.0
55 — 59	B–	2.7
50 — 54	C+	2.3
45 — 49	C	2.0
40 — 44	C–	1.7
35 — 39	D+	1.3
30 — 34	D	1.0
00 — 29	E	0.0

The minimum grade to pass a course unit will be 'C–'.
Grade Point Average (GPA) is the credit-weighted arithmetic mean of the Grade Points which is formulated as

$$GPA = \frac{Sum\ of\ (credits\ \times grade\ points)}{Total\ credits} = \frac{\sum c_i \mathrm{g}_i}{\sum c_i}$$

Where c_i is the number of credits for the i^{th} course and g_i is the grade point for the i^{th} course. The Overall GPA (OGPA) for the degree programme would be the credit weighted mean giving **equal weight for all levels**, computed and rounded to two decimals.

2.3.3 Examination Process

(a) **In-course Assessments:** In-course Assessments of any course unit will be carried out during the academic session of that course unit. The dates and times for the In-course Assessments will be determined by the lecturer-in-charge of that course unit. The grades scored by a student in various components of In-course Assessment of any course unit shall be brought to the notice of the students by the lecturer concerned of the course unit. In-course assessments of any course unit or a component of a course unit shall be carried out during the lecture delivery period of that course unit.

(b) **End-semester Examinations:** End-semester Examination shall be conducted for each course unit at the end of the semester as indicated in the academic calendar approved by the faculty board. All the arrangements for the End-semester Examination shall be made by the Examination branch of the University of Vavuniya. The date and time of the examinations shall be decided at the beginning of each semester by the Dean in consultation with the Heads of Departments. The faculty level pre-examination board

shall finalize the results of a course unit subject to the approval of Senate. The finalized result (grade) of a course unit will be displayed by the Dean of the faculty. The Dean shall send the grades list to the Examination Branch along with detail mark sheets.

The examination branch will summon a meeting of the examination board chaired by the Vice-Chancellor once the results of the examination on all the course units of a particular semester of an academic year are received by the examination branch. The board will release the results of the students with semester wise GPA and level GPA.

The Examination Board chaired by the Vice-Chancellor will also release the awards of degrees with the overall GPA and the Class of Honours obtained by the students who have completed that degree program in an academic year.

Eligibility for the End-semester Examination

- Minimum of 80% attendance is compulsory for the lectures and practical sessions of each course unit.
- The students who are not allowed to sit for the examinations due to poor attendance may resit the course with the approval of the Faculty Board.

Resit Examinations

- A core or elective course unit with a grade below 'C–', the course units of English Language I and II with grade below 'C', Auxiliary course units other than English Language I and II with grade below 'D+' must resit.
- The students who failed to sit for an End-semester Examination are requested to sit for such examination at the next earliest opportunity and it will be considered as resit.
- The students who failed to appear for an End Semester Examination of a course unit or a component of a course unit on medical ground are requested to submit a medical certificate to Assistant Registrar of the Faculty, certified by the University medical officer, within 14 days from the last date of the examination. In these circumstances the candidate may be allowed as a proper candidate for the course unit or the component of the course unit when the examination is held next based on the recommendation of the Committee for Medical Certificate & Mercy Chance (CMCMC) and with the approval of the Senate.
- For students resitting the End-semester Examination of a course unit, the marks obtained for In-course Assessment examination at their first attempt is used to determine the Final Grade for that course unit.
- Students will not be allowed to resit the In-course Assessments of any course unit or component. If a student is unable to sit for an In-course Assessment for valid reasons, he/she shall inform the lecturer-in-charge at the earliest possible and make necessary arrangement to conduct the particular In-course Assessment examination. No such opportunity shall be given after the completion of the End-semester Examination of that particular course unit.

- A candidate fails to sit the examination without giving valid reasons acceptable by the Faculty Board and the Senate, he/she shall be considered as forfeiting a chance to sit that examination and will be given grade 'E' for the End-semester Examination of that course unit.
- The highest grade awarded to the candidate resitting the course unit is 'C'.
- A student who obtains a grade 'C–' for a course unit may also resit for the End-semester Examination of that course unit in order to improve his/her grade. If a student obtains a lower grade while resitting, he/she is entitled to keep the previous grade.
- A student will not be allowed to resit a course unit more than two times. Thus, a student can sit for a course unit at a maximum of three times.
- The maximum duration for completing the Bachelor of Science in Honours in Environmental Science degree programme shall be six academic years. This would exclude periods of absence caused by medical or other valid reasons acceptable by the Faculty Board and the Senate.

Provision for Re-scrutinization

The Commission Circular No: 978 dated 9th April, 2012 on "Provision for re-scrutinization of marks and grades of undergraduates" has been adopted by the Faculty with effect from 6th February 2013. However, the candidate who apply for re-scrutiny should accept the final grade which may be higher, lower or no-change after the re-scrutinization.

2.3.4 Award of Degree

Award of Honours Degree (SLQF Level 6)

A student deemed to have satisfied the requirement for the award of **Bachelor of Science Honours in Environmental Science** degree if he/she has;

a. successfully completed minimum 120 credits of core course units during the study programme in Levels 1, 2, 3, and 4,

b. obtained Grade 'C' or above in the Auxiliary Course Units English Language I and English Language II,

c. obtained Grade 'D+' or above in Auxiliary course units other than English Language I and English Language II,

d. obtained a minimum OGPA of 2.00, and

e. completed the above relevant requirements within the period of 6 academic years.

Award of General Degree (SLQF Level 5)

A student deemed to have satisfied the requirement for the award of General Degree of Bachelor of Science in Environmental Science if he/she has;

a. successfully completed minimum 90 credits of core course units during the study programme in Levels 1, 2, and 3,

b. obtained Grade 'C' or above in the Auxiliary Course Units English Language I and English Language II,

c. obtained Grade 'D+' or above in the Auxiliary course units other than English Language I and English Language II,

d. obtained a minimum OGPA of 2.00 in Level 1, 2 and 3, and

e. completed the above relevant requirements within the period of 5 academic years.

2.3.5 Award of Classes

Award of classes for the Honours in Environmental Science Degree will be decided by the Board of Examiners based on the following criteria:

First Class: A student shall be awarded First Class if he/she

a. is eligible for Bachelor of Science Honours in Environmental Science degree,

b. obtains minimum OGPA of 3.70, and

c. completes the relevant requirement within four academic years.

Second Class (Upper Division): A student shall be awarded Second Class (Upper Division) if he/she

a. is eligible for Bachelor of Science Honours in Environmental Science degree,

b. obtains minimum OGPA of 3.30, and

c. completes the relevant requirement within four academic years.

Second Class (Lower Division): A student shall be awarded Second Class (Lower Division) if he/she

a. is eligible for Bachelor of Science Honours in Environmental Science degree,

b. obtains minimum OGPA of 3.00, and

c. completes the relevant requirement within four academic years.

Award of classes for the Environmental Science Degree will be decided by the Board of Examiners based on the following criteria:

First Class: A student shall be awarded First Class if he/she

a. is eligible for Bachelor of Science in Environmental Science degree,

b. obtains minimum OGPA of 3.70, and

c. completes the relevant requirement within three academic years.

Second Class (Upper Division): A student shall be awarded Second Class (Lower Division) if he/she

a. is eligible for Bachelor of Science in Environmental Science degree,

b. obtains minimum OGPA of 3.30, and

c. completes the relevant requirement within three academic years.

Second Class (Lower Division): A student shall be awarded Second Class (Lower Division) if he/she

a. is eligible for Bachelor of Science in Environmental Science degree,

b. obtains minimum OGPA of 3.00, and

c. completes the relevant requirement within three academic years.

2.3.6 Award of Diploma/ Higher Diploma

Award of Higher Diploma in Environmental Science (SLQF Level 4)

A student who wishes to leave the course after completing the Level 1 and Level 2 of the degree programme shall be awarded a 'Higher Diploma in Environmental Science' if he/she has;

a. successfully completed minimum 60 credits core course units in Level 1 and Level 2 of the study programme,

b. obtained Grade 'C' or above in the Auxiliary Course Units ACU1113 and ACU2113,

c. obtained Grade 'D+' or above in the other Auxiliary course units other than English, and

d. obtained a minimum GPA of 2.00 in each Level 1 and Level 2.

Award of Diploma in Environmental Science (SLQF Level 3)

A student who wishes to leave the course after completing the Level 1 of the degree programme shall be awarded a 'Diploma in Environmental Science' if he/she has;

a. obtained Grade 'C' or above in the Auxiliary Course Units ACU1113,

b. obtained Grade 'D+' or above in the other Auxiliary course units,

c. completed 30 credits of core course units in Level 1 of the study programme, and

d. obtained a minimum GPA of 2.00 in Level 1.

2.3.7 Effective Date of the Degree

The effective date of a degree programme for a student shall be the last date of final End-semester Examination.

2.4 Curriculum Layout

Level 1 – Bachelor of Science Honours in Environmental Science

Level 1 - Semester I				
Course Code	**Course Title**	**Credits**	**Theory Hours**	**Practical Hours**
ENS1112	Fundamentals in Environmental Chemistry	2	30	–
ENS1121	Analysis of Chemical Elements and Compounds	1	–	30
ENS1132	Cell and Molecular Biology	2	25	10
ENS1142	Plant Biology	2	20	30
ENS1153	Fundamentals of Animal Biology	3	30	45
ENS1162	Basic Mathematics	2	30	–
CCCU1113	Fundamentals of Information Technology	3	30	30
ACU1113	English Language I	3	45	–
Level 1 - Semester II				
Course Code	**Course Title**	**Credits**	**Theory Hours**	**Practical Hours**
ENS1212	Environment and Agriculture	2	30	–
ENS1223	Soil Science	3	30	45
ENS1232	Environmental Sanitation	2	25	15
ENS1242	Principles of Economics	2	30	–
ENS1253	Earth and Atmospheric Sciences	3	45	–
ENS1263	Fundamentals in Environmental Microbiology	3	40	15
ACU1212	Social Harmony and Active Citizenship	2	30	–

Level 2 – Bachelor of Science Honours in Environmental Science

Level 2 - Semester I				
Course Code	**Course Title**	**Credits**	**Theory Hours**	**Practical Hours**
ENS2112	Biodiversity and Conservation	2	25	15
ENS2123	Food, Nutrition and Environment	3	40	15
ENS2132	Analytical Chemistry	2	25	10
ENS2142	Animal Behavior	2	25	15
ENS2152	Forest Environmental Biology and Management	2	30	–
ENS2162	Resource and Environmental Economics	2	30	–
ENS2172	Sustainable Development for Environment	2	30	–
ACU2113	English Language II	3	45	–
Level 2 - Semester II				
Course Code	**Course Title**	**Credits**	**Theory Hours**	**Practical Hours**
ENS2213	Applied Hydrology and Water Resource Management	3	40	15
ENS2222	Applied Ecology and Community Environment	2	30	–
ENS2233	Environmental Disaster Management	3	45	–
ENS2242	Energy and Environment	2	25	15
ENS2252	Ecotourism	2	20	30
ENS2263	Environmental Pollution and Control	3	40	15
ACU2212	Communication and Soft skills	2	30	–

Level 3 – Bachelor of Science Honours in Environmental Science

Level 3 - Semester I				
Course Code	**Course Title**	**Credits**	**Theory Hours**	**Practical Hours**
ENS3113	Geographic Information System and Remote Sensing	3	30	30
ENS3122	Wildlife Conservation and Management	2	25	15
ENS3132	Environmental Policies and Law	2	30	–
ENS3143	Solid Waste Management	3	40	15
ENS3153	Environmental Biotechnology	3	40	15
ENS3162	Industrial Chemistry and Pollution Monitoring	2	25	15
ACU3112	Career Guidance	2	30	–
Level 3 - Semester II				
Course Code	**Course Title**	**Credits**	**Theory Hours**	**Practical Hours**
ENS3213	Statistics for Environmental Science	3	30	30
ENS3222	Environmental Impact Assessment and Environmental Audit	2	30	–
ENS3232	Marine Environment and Management	2	25	15
ENS3242	Wastewater Treatment	2	25	15
ENS3251	Seminar	1	50 notional hours	
ENS3262	Biomolecules and Bioseparation Techniques	2	25	15
ENS3273	Environmental Toxicology	3	40	15
ACU3212	Management and Entrepreneurial Skills	2	30	–

Level 4 – Bachelor of Science Honours in Environmental Science

Level 4 - Semester I				
Course Code	**Course Title**	**Credits**	**Theory Hours**	**Practical Hours**
ENS4112	Project Planning and Management	2	30	–
ENS4122	Cleaner Production	2	20	30
ENS4133	Research Methods and Experimental Design	3	40	10
Elective Course Units				
ENS4142	Limnology and Wetland Management	2	25	15
ENS4152	Advanced Water Treatment	2	20	30
ENS4163	Groundwater Management	3	45	–
ENS4173	Environmental Microbiology	3	35	30
ENS4183	Advanced Spectroscopic Methods	3	40	10
ENS4192	Climate Change	2	30	–
ENS41(10)2	Environmental Communication	2	25	15
ENS41(11)3	Metrology	3	40	15
Note: Students should select 12 credits from elective course units.				
Level 4 - Semester II				
Course Code	**Course Title**	**Credits**	**Theory Hours**	**Practical Hours**
ENS4211	Industrial Training	1	200 notional hours	
ENS4226	Research Project	6	600 notional hours	
Elective Course Units				
ENS4232	Environmental System Modeling	2	25	10
ENS4242	Plantation Forestry and Environment	2	30	–
ENS4252	Integrated Weed Management	2	25	15
Note: Students should select 4 credits from elective course units.				

3. Degree Programmes - Department of Physical Science

3.1 Structure of the Degree Programmes

3.1.1 The Names of the Degree Programmes

The Department of Physical Science offers the following degree programmes:

- Bachelor of Science in Applied Mathematics and Computing
- Bachelor of Science Honours in Computer Science
- Bachelor of Science in Information Technology
- Bachelor of Science Honours in Information Technology

The abbreviations of the Bachelor of Science in Applied Mathematics and Computing degree and the Bachelor of Science Honours in Computer Science degree are BSc (Applied Mathematics and Computing) and BScHons (Computer Science) respectively.

The abbreviations of the Bachelor of Science in Information Technology degree and Bachelor of Science Honours in Information Technology degree are BSc (IT) and BScHons (IT) respectively.

3.1.2 Admission

Bachelor of Science in Applied Mathematics and Computing

Students are admitted annually to the programmes by the University Grants Commission from the GCE Advanced Level Physical Science stream.

Bachelor of Science in Information Technology

Students are admitted annually to the programme by the University Grants Commission. Students from all the GCE Advanced Level streams are eligible to apply for this degree programme and should pass three subjects with atleast two passes in any of the following subjects in the advanced level examination.
Higher Mathematics
Mathematics / Combined Mathematics
Physics
Chemistry

Accounting
Business Statistics
Economics
Business Studies
Biology
Political Science
Logic & Scientific Method
Geography
Civil Technology
Mechanical Technology
Electrical, Electronic and Information Technology
Information and Communication Technology

In addition, the student should satisfy the following criteria:

- Have at least a Credit Pass (C) in English at the G.C.E. (O/L) Examination.
- Have at least a Credit Pass (C) in Mathematics at the G.C.E. (O/L) Examination.
- Pass the Aptitude Test as decided by the University of Vavuniya to become eligible for this degree programme.

3.1.3 Medium of Instruction

The Medium of instruction shall be English.

3.1.4 Programmes Overview

The degree programmes follow a semester based course unit system. As such, each academic year is considered as level 1, 2, 3, and 4 respectively. Each level of study is divided into two semesters, semester 1 and semester 2. The duration of a semester is sixteen weeks, with a one week mid-semester vacation nearly halfway through the semester.

The Bachelors degree programmes encompass six semesters (three consecutive academic years), whereas the Honours degree programmes consist of eight semesters (four consecutive academic years). Each course unit carries a credit value that defines contact hours for that course unit. The student should satisfy the credit requirement of a minimum of 90 credits of core course units at the end of the sixth semester for the award of Bachelors Degree and a minimum of 120 credits of core course units at the end of the eighth semester for the award of Honours Degree. In addition, the students are requested to complete 16 credits in auxiliary course units. Initially, students would be admitted to a Bachelors degree programme (6 semesters), and a selected number of students will be admitted to follow the Honours degree (8 semesters) based on their performance.

3.1.5 Credit Valued Course Unit System

A course unit is a subject module that has a credit value. A credit is a time based quantitative measure assigned to course units on the basis of number of contact hours. Each course unit consists of a theory component or a practical component or theory and practical components together. In theory course units, 15 hours of lectures is considered as one credit and in practical

course unit, 30 hours of practical sessions is considered as one credit. However, one credit is considered equivalent to 50 notional learning hours including assignments, tutorials, and self-learning through a Virtual Learning Environment (VLE). The credit values of course units that have both theory and practical components are computed by giving due weight to the components accordingly, as stipulated above.

The course units of the programmes are derived from the following categories:

- Core Course Units
- Auxiliary Course Units
- Elective Course Units
- Industrial Training Course Unit

Core Course Units

Bachelor of Science in Applied Mathematics and Computing/Bachelor of Science Honours in Computer Science: The core course units are designed from the principal subject areas of Applied Mathematics, Pure Mathematics, Statistics, and Computer Science. These subject areas are equally distributed in the Bachelor of Science in Applied Mathematics and Computing Degree programme. The Bachelor of Science Honours in Computer Science degree programme is more focused on the subject area of Computer Science at level 3 and level 4.

Bachelor of Science in Information Technology/Bachelor of Science Honours in Information Technology: The core course units are designed to provide the core of the degree programme. The core course units consist of the subject areas of Data management, Platform technologies, Programming, Web development, Networking, Graphics and Multimedia, High-performance computing and relevant Mathematics and Statistics.

Auxiliary Course Units

The auxiliary course units are designed to provide basic knowledge across a wide range of disciplines that an undergraduate should possess in the present era. The credits of the auxiliary course units are not taken for the computation of the Grade Point Average (GPA). However, all the auxiliary course units shall be evaluated and considered for the award of degrees. The auxiliary course units are listed below:

- English Language I and English Language II
- Social Harmony and Active Citizenship
- Communication and Soft Skills
- Career Guidance
- Management and Entrepreneurial Skills
- Research Methodology and Scientific Writing

Elective Course Units

Bachelor of Science Honours in Information Technology: Elective Course units are core course units designed to complement the theoretical and technological content of the curriculum and to offer some parallel pathways. The students who are selected for the honours degree programme must apply for the suitable elective course units to cover 10 credits at Level 4. The final decision regarding the elective course units for a particular academic year will be made by the department based on the resource availability and the students' request for those course units.

Industrial Training Course Unit

Bachelor of Science Honours in Computer Science: Industrial Training is offered in the second semester of Level 4 for the Bachelor of Science Honours in Computer Science degree programme. This course unit aims to provide opportunities for students to apply the computing knowledge, develop and consolidate practical computing skills in an industrial environment. Students will be trained in an appropriate computing related industry for a period of 4-6 months which amounts to 600 notional hours (6 credits) under the guidance of academic and industrial supervisors. The credits of this course unit are not taken for the computation of the Grade Point Average (GPA). However, the course unit shall be evaluated and considered for the award of the Bachelor of Science Honours in Computer Science degree.

Bachelor of Science Honours in Information Technology: Industrial Training is offered in the second semester of Level 4 for the Bachelor of Science Honours in Information Technology. This course unit is designed to provide hands-on, real-time industrial experience in Software development, Business analytics, UX and UI Design, Quality Assurances, Computer networking, and official communication and correspondence. Students will be trained in an appropriate IT related industry for a period of 4-6 months which amounts to 600 notional hours (6 credits) under the guidance of academic and industrial supervisors. The credits of this course unit are not taken for the computation of the Grade Point Average (GPA). However, the course unit shall be evaluated and considered for the award of the Bachelor of Science Honours in Information Technology degree.

Course Codes

Table 3.1: Abbreviations for Subject Areas

Subject Area	Abbreviation
Applied Mathematics	AMA
Pure Mathematics	PMA
Statistics	STA
Computer Science	CSC
Computer Science Honours	CSH
Information Technology	IT
Elective Course Units	EL
Auxiliary Course Units	ACU

Each course unit is coded with the subject area abbreviation (Table 3.1) and a four digit number. The sequence of the digits denotes the level of study, the semester, the serial number

of the course unit in the specific semester of the subject area, and the number of credit values assigned to the course unit respectively.

3.1.6 Selection to the Honours Degree Programmes

Bachelor of Science Honours in Computer Science: The students who aspire to follow the honours degree programme in Computer Science are required to apply after the completion of level 2. Each student selected to follow the honours degree programme has to complete 120 credits core course units (including a 6 credits Research Project) during the four academic years of study. Industrial training course unit (6 credits) and auxiliary course units (16 credits) are also offered for the honours degree students. The courses for the honours degree programme commence from semester 1 of level 3. The requirements for selection to the Honours in Computer Science degree programme are as follows:

- Obtaining Grade 'C-' or above in all the core course units (60 credits) offered in level 1 and level 2,
- Obtaining Grade 'C' or above in the auxiliary course units English Language I and English Language II and Grade 'D+' or above in the auxiliary course units other than English Language I and English Language II offered in level 1 and level 2, and
- Obtaining an Overall Grade Point Average (OGPA) of not less than 3.00 for the course units offered in level 1 and level 2.

Bachelor of Science Honours in Information Technology: At the end of level 3, the students are required to apply for the Honours degree programme. Based on the academic performance of levels 1, 2, and 3, the selected number of students will be allowed to follow the honours degree programme. Each student selected to follow the honours degree programme has to complete 120 credits core course units (including a 6 credit Research Project) during the four academic years of study. Industrial training course unit (6 credits) and auxiliary course units (16 credits) are also offered for the honours degree students. The requirements for selection to the Honours in Information Technology degree programme are as follows:

- Obtaining Grade 'C-' or above in all the core course units offered in levels 1, 2 and 3,
- Obtaining Grade 'C' or above in the auxiliary course units English Language I and English Language II and Grade 'D+' or above in the auxiliary course units other than English Language I and English Language II offered in levels 1, 2 and 3, and
- Obtaining an Overall Grade Point Average (OGPA) of not less than 3.00 for the course units offered in levels 1, 2 and 3.

3.1.7 Opting for Bachelors Degree

During the fourth year of study, a student following an honours degree programme may opt for a three-year bachelor's degree before the submission of the thesis of the research project with valid reason. The final acceptance to opt for the bachelor degree will be subjected to the recommendation of the Faculty Board of Applied Science and the approval of the Senate.

3.2 Degree Programmes Objectives and Graduate Profiles

3.2.1 Programmes Objectives

Bachelor of Science in Applied Mathematics and Computing/Bachelor of Science Honours in Computer Science: The primary objective of the Applied Mathematics and Computing degree is to provide students who are better able to do problem-solving in the technical fields that require skills in both analytical mathematics and computer science. The main objective of the honours degree program in Computer Science is to provide students with the foundations that support both a successful career path in computing as well as offer appropriate qualifications for further degree work in computer science-related disciplines.

Specific objectives of the degree programmes

- To provide interdisciplinary qualifications to allow students to compete successfully for the many industrial positions that call for strong mathematics backgrounds supplemented by good computing skills.
- To possess theoretical and practical knowledge of computer science sufficient to earn a living and contribute to the economic development of the nation.
- To prepare for advanced education in computer science and software engineering.
- To provide a wide-ranging set of qualities such as deep knowledge in the subjects, excellence in research, strong sense of intellectual integrity, ethics, creative thinking power, self-directed learning, and active citizenship.

Bachelor of Science in Information Technology/Bachelor of Science Honours in Information Technology: The main goal of this degree programme is to provide students a synergize Information Technology in its entire ramification and would equip students who wish to enter any careers in IT and computing especially like software and network industries. The students also able to do expertise in a particular area through a flexible curriculum in their final year. The degree programme in Information Technology

- educates students to excel in their immediate employment and continuous professional career advancement to succeed in computing industry profession.
- produces students with state-of-the-art technological knowledge with the highly sophisticated research project and industrial activities to pursue advanced study or life-long research.
- prepares the students with the solid foundation to demonstrate critically analysing skills in solving computing and information technology problems.
- provides knowledge for innovative computing and Information Technology products and solutions for real-life problems.
- instills positive contributions to community and society by applying skills and abilities learned during undergraduate studies

- inculcates effective communication and soft skills in teamwork with social awareness globally showing leadership and entrepreneurship and exhibit good citizenship.

3.2.2 Graduate Profiles

Bachelor of Science in Applied Mathematics and Computing/Bachelor of Science Honours in Computer Science: A graduate of the degree programmes should have the below mentioned qualities.

Academic and research excellence

- acquire deep knowledge in the subject areas.
- analyze complex problems and design, develop and evaluate solutions.
- develop skills in writing, presentation, and communication.
- develop skills on designing, implementing and reporting of scientific investigations.
- apply mathematical and computer science algorithms and tools to solve problems using intellectual abilities.
- internalize strong personal and professional ethics and etiquette.

High employability, personality development, and active citizenship

- work cooperatively and effectively in multi-disciplinary teams.
- be self-motivated, enthusiastic and undertake lifelong learning to continue professional development.
- take leadership and responsibilities.
- discuss issues of national importance.
- nurture independence of mind and intellectual integrity.
- be socially responsible and respect cultures and values of others.

Bachelor of Science in Information Technology/Bachelor of Science Honours in Information Technology: The graduates of the Information Technology degree shall have the ability to

- apply the knowledge of Information Technology and necessary computing appropriate to the discipline.
- demonstrate the problem-solving skill in information technology and computing.
- participate in teamwork to plan and implement projects successfully and sustainably.
- communicate efficiently to work out and solve the computing problem in organizations.
- maintain the updated IT knowledge by critically analysing the systems and doing research.

- undertake lifelong learning for the continuous professional development.
- be as a team cooperatively and effectively under pressure.
- function effectively in an industrial setting and apply learned skills to real-world problems.
- acquire intrusive attitude and skills to enable making a discovery or design related to Information Technology.

3.2.3 Career Prospects

Bachelor of Science in Applied Mathematics and Computing: The main aim of this program is to provide students with a comprehensive tertiary-level education in Applied Mathematics, Computer Science and related areas of learning to produce competent graduates. The graduates of the degree programmes have proven their calibre as professionals in public sectors as well as in private sectors such as teaching, banking field, IT professionals, etc.. The graduates can choose the academic career path and proceed to further studies for master or PhD degrees.

Bachelor of Science Honours in Computer Science: There is high demand nationally and internationally from industry, organizations and research centres for software engineers, data scientists, artificial intelligence researchers, systems analysts and technical consultants. Computer Science is the fastest developing field in the world, and the requirement for graduates with the skills to work in this field is continuing to grow. The graduates can continue their studies at postgraduate level, studying a field of computer science in greater detail through an MSc, MPhil or PhD. Further study is essential for a career in academia and can be useful for a range of other careers.

Bachelor of Science in Information Technology/Bachelor of Science Honours in Information Technology: The present era pushes the state and private institutions towards digital management. It is necessary to produce more graduates with IT discipline to cater the fast-moving digital world. The BSc in IT graduates of the Department of Physical Science of Faculty of Applied Science will suit all the IT and computing related sectors of the country such as software and web development, computer networking and telecommunication, banking, and educational institutions, in the title of Software engineer, quality assurance engineer, web developer, UI and UX engineer, database designer, system administrator, system analyst, network manager, ICT service officer, digital marketing expert, big data analyst. In addition to the above opportunities, this degree programme facilitates to create entrepreneurs as IT service providers, software developers and hardware and networking service providers and IT consultants service providers. The graduates can continue their studies at postgraduate level, studying a field of IT in greater detail through an MSc, MPhil or PhD.

3.3 Evaluation System of the Degree Programmes

3.3.1 Evaluation Methods

A course unit shall be evaluated by means of

- In-Course Assessments (ICA) (Formative) which consist of suitable combinations of assignments, course-works, reports, oral presentations, oral examinations, quizzes, continuous assessment etc.
- End Semester Examination (ESE) (Summative) which is conducted at the end of the semester.

Evaluation of Theory Course Unit : The final mark is evaluated by giving 30% for in-course assessments and 70% for the end semester examination. The final mark $M1$ for the theory course unit is defined as follows:

$$M1 = T * 70\% + A1 * 30\%$$

where T is the mark obtained in the end semester theory examination and $A1$ is the average mark of the best two out of three in-course assessments.

Evaluation of Practical Course Unit : The final mark is evaluated by giving 40% for in-course assessments and 60% for the end semester examinations. The final mark $M2$ for the practical course unit is defined as follows:

$$M2 = P * 60\% + A2 * 40\%$$

where P is the marks obtained in the end semester practical examination and $A2$ is the average of the best two out of three in-course assessments.

Evaluation of Course Unit with Theory and Practical Components : The final mark is evaluated using the individual marks obtained in the theory component ($M1$) and practical component ($M2$). The final marks M for the course unit with theory and practical components is evaluated as follows:

$$M = \frac{Ct * M1 + Cp * M2}{Ct + Cp}$$

where Ct and Cp are the credits of the theory component and practical component of the course unit respectively.

Evaluation of Group Project : The final mark evaluation of group project is assessed based on the followings:

- Final report 40%
- Oral presentation 30%
- Viva-voce 30%

The members of the evaluation panel for the final oral presentation and viva-voce are appointed by the Head of the department with the approval of the Faculty Board. The final report is evaluated by the project supervisor.

Evaluation of Research Project : The final mark evaluation of research project is assessed based on the followings:

- Project Report 50%
- Oral presentation 25%
- Viva-voce 25%

The members of the evaluation panel for the final oral presentation and viva-voce are appointed by the Head of the department with the approval of the Faculty Board. The thesis is evaluated by the supervisor.

Evaluation of Industrial Training : The final marks evaluation of industrial training is assessed based on the followings:

- Daily diary 30%
- Final report 40%
- Oral presentation 30%

The members of the evaluation panel for the final oral presentation are appointed by the Head of the department with the approval of the Faculty Board. The daily diary is evaluated by the supervisor assigned from the industry. The final report is evaluated by the academic supervisor assigned from the department.

3.3.2 Grading System and Grade Point Average

Based on the scheme of evaluation mentioned above, final grade obtained in respect of a course unit is illustrated in Table 3.2. **The minimum grade to pass a core course unit is 'C-'.** For a core course unit with theory and practical components, the student should obtain a minimum 'C-' grade in each component to pass the course unit. The lowest grade of the component is given for the course unit if a component is failed.

Grade Point Average (GPA) for each level is the credit-weighted arithmetic mean of the Grade Point Values which is formulated as

$$GPA = \frac{\sum(c_i \times g_i)}{\sum c_i}$$

where c_i is the number of credits for the i^{th} course unit and g_i is the grade point value for the i^{th} course unit.

Any calculated GPA is rounded to the two decimal places. The Overall GPA (OGPA) for the degree programmes would be the credit weighted mean giving **equal weight for all levels** (three levels for three-year bachelor degree and four levels for honours degree), computed to two decimal places.

Table 3.2: Grades and Grade Point Values

Marks	Grade	Grade Point Value
80-100	A+	4.00
75-79	A	4.00
70-74	A-	3.70
65-69	B+	3.30
60-64	B	3.00
55-59	B-	2.70
50-54	C+	2.30
45-49	C	2.00
40-44	C-	1.70
35-39	D+	1.30
30-34	D	1.00
00-29	E	0.00

3.3.3 Examination Process

In-Course Assessments

In-course assessments of any course unit or a component of a course unit shall be carried out during the lecture delivery period of that course unit. The dates and time for the in-course assessments shall be determined by the lecturer in-charge of that course unit. The grades of the in-course assessments of any course unit shall be displayed on the notice board by the Head of the Department to enable the students to know the grade.

End Semester Examinations

An End Semester Examination shall be conducted for each course unit at the end of the semester in which the teaching of the course unit is completed. The end semester examinations shall be conducted by the Examination Branch of the University of Vavuniya. The date and time of the end semester examinations shall be decided at the beginning of each semester by the Dean in consultation with the Heads of Departments. The Faculty Level Examination Board shall finalise the results of a course unit subject to the approval of Senate. The finalised result (grade) of a course unit (or components) shall be displayed on the notice board by the Dean of the faculty. The Dean shall send the Grades List to the Examination Branch along with detailed mark sheets.

When the results of the examinations on all the course units of a particular semester of an academic year are received by the Examination Branch, the Examination Branch will summon a meeting of the Examination Board chaired by the Vice-Chancellor. The Board will release the results of the students in that Level of that academic year giving the GPA scored by the students.

The Examination Board chaired by the Vice-Chancellor will also release the awards of Degrees with the Overall GPA (OGPA) and the Class obtained by the students who have completed the degree programmes in an academic year.

Attendance

- 80% of attendance is compulsory for both practical and theory lectures.
- The students who are not allowed to sit for the examinations due to poor attendance may resit the course unit with the approval of the Faculty Board.

Resit Examinations

- A core course unit or a component (theory/practical) with grade below 'C-' must resit. English Language I and II with grade below 'C', auxiliary course units other than English Language I and II with grade below 'D+' and industrial training course unit with grade below 'C' must also resit.
- The students who failed to appear for an End Semester Examination are requested to appear for such examination at the next earliest opportunity and it will be considered as resit.
- The students who failed to appear for an End Semester Examination of a course unit or a component of a course unit on medical ground are requested to submit a medical certificate to Assistant Registrar of the Faculty, certified by the University medical officer, within 14 days from the last date of the examination. In these circumstances the candidate may be allowed as a proper candidate for the course unit or the component of the course unit when the examination is held next based on the recommendation of the Committee for Medical Certificate & Mercy Chance (CMCMC) and with the approval of the Senate.
- For students resitting the End-semester Examination of a course unit, the marks obtained for In-course Assessment examination at their first attempt is used to determine the Final Grade for that course unit.
- For students resitting the End Semester Examination of a course unit or a component of a course unit, the marks obtained for In-Course Assessments at their first attempt is used to determine the Grade for that course unit or component.
- Students will not be allowed to resit the In-Course Assessments of any course unit or component of a course unit. If a student is unable to sit for an In-Course Assessment for valid reasons, he/she shall inform to the lecturer in-charge at the earliest possible and make necessary arrangement to conduct the particular In-Course Assessment. No such opportunity shall be given after the completion of the End Semester Examination of that particular course unit or component.
- A candidate fails to sit the examination without giving valid reasons acceptable by the Faculty Board and the Senate, he/she shall be considered as forfeiting a chance to sit that examination and will be given the grade 'E' for the end of course examination of that course unit.
- The highest grade that could be awarded for resitting a course unit is 'C'.
- A student who obtained a grade 'C-' for a course unit may resit the end semester examination of that course unit or a component of that course unit in order to improve

his/her grade. If a student obtained a lower grade while resitting a course unit or a component of a course unit, he/she is entitled to keep the previous grade.

- A student will not be allowed to resit a course unit or a component of a course unit more than two times. Thus, a student appears for a course unit or a component at a maximum three times.
- The maximum duration for completing the three-year bachelor's degree programme shall be five academic years. This would exclude periods of absence caused by medical or other valid reasons acceptable to the Faculty Board and the Senate.
- The maximum duration for completing the Honours degree programme shall be six academic years. This would exclude periods of absence caused by medical or other valid reasons acceptable to the Faculty Board and the Senate.

Provision for Re-scrutinization

The Commission Circular No: 978 dated 9th April, 2012 on "Provision for re-scrutinization of marks and grades of undergraduates" has been adopted by the Faculty with effect from 6th February 2013. However, the candidate who apply for re-scrutiny should accept the final grade which may be higher, lower or no-change after the re-scrutinization.

3.3.4 Award of Degrees

Bachelor of Science in Applied Mathematics and Computing (SLQF Level 5)

A student deemed to have satisfied the requirement for the award of "Bachelor of Science in Applied Mathematics and Computing" degree, if he/she has;

a. obtained Grade 'C-' or above in 90 credits of core course units offered in level 1, level 2, and level 3 of the degree programme,

b. obtained Grade 'C' or above in the auxiliary course units English Language I and English Language II, and Grade 'D+' or above in the auxiliary course units other than English Language I and English Language II,

c. obtained a minimum OGPA of 2.00, and

d. completed the relevant requirements within a period of five academic years.

Bachelor of Science Honours in Computer Science (SLQF Level 6)

A student deemed to have satisfied the requirement for the award of "Bachelor of Science Honours in Computer Science" degree, if he/she has;

a. obtained Grade 'C-' or above in 120 credits of core course units offered in level 1, level 2, level 3, and level 4 of the degree programme,

b. obtained Grade 'C' or above in the auxiliary course units English Language I and English Language II and Grade 'D+' or above in the auxiliary course units other than English Language I and English Language II,

c. obtained Grade 'C' or above in the Industrial Training course unit,

d. obtained a minimum OGPA of 2.00, and

e. completed the relevant requirements within a period of six academic years.

Bachelor of Science in Information Technology (SLQF Level 5)

A student deemed to have satisfied the requirement for the award of "Bachelor of Science in Information Technology" degree, if he/she has;

a. obtained grade C- or above for the core course units of 90 credits offered in level 1, level 2, and level 3 of the degree programme,

b. obtained Grade C or above in the Auxiliary Course Units English Language I and English Language II and Grade D+ or above in the Auxiliary course units other than English Language I and English Language II,

c. obtained a minimum OGPA of 2.00, and

d. completed the relevant requirements within a period of five academic years.

Bachelor of Science Honours in Information Technology (SLQF Level 6)

A student deemed to have satisfied the requirement for the award of "Bachelor of Science Honours in Information Technology" degree, if he/she has;

a. obtained grade C- or above for the core and elective course units of 120 credits offered in level 1, level 2, level 3, and level 4 of the honours degree programme,

b. obtained Grade C or above in the Auxiliary course units English Language I and English Language II, and Grade D+ or above in the Auxiliary course units other than English Language I and English Language II,

c. obtained grade C or above in the Industrial Training course unit,

d. obtained a minimum OGPA of 2.00, and

e. completed the relevant requirements within a period of six academic years

3.3.5 Award of Classes

Bachelor of Science in Applied Mathematics and Computing

Award of classes for the Applied Mathematics and Computing degree will be decided by the Board of Examiners based on the following criteria:

First Class: A student shall be awarded First Class if he/she

a. is eligible for Bachelor of Science in Applied Mathematics and Computing Degree,

b. obtains minimum OGPA of 3.70, and

c. completes the relevant requirements within three academic years.

Second Class (Upper Division): A student shall be awarded Second Class (Upper Division) if he/she

a. is eligible for Bachelor of Science in Applied Mathematics and Computing Degree,

b. obtains minimum OGPA of 3.30, and

c. completes the relevant requirements within three academic years.

Second Class (Lower Division): A student shall be awarded Second Class (Lower Division) if he/she

a. is eligible for Bachelor of Science in Applied Mathematics and Computing Degree,

b. obtains minimum OGPA of 3.00, and

c. completes the relevant requirements within three academic years.

Bachelor of Science Honours in Computer Science

Award of classes for the Honours in Computer Science Degree will be decided by the Board of Examiners based on the following criteria:

First Class: A student shall be awarded First Class if he/she

a. is eligible for Bachelor of Science Honours in Computer Science degree,

b. obtains minimum OGPA of 3.70, and

c. completes the relevant requirements within four academic years.

Second Class (Upper Division): A student shall be awarded Second Class (Upper Division) if he/she

a. is eligible for Bachelor of Science in Honours Computer Science degree,

b. obtains minimum OGPA of 3.30, and

c. completes the relevant requirements within four academic years.

Second Class (Lower Division): A student shall be awarded Second Class (Lower Division) if he/she

a. is eligible for Bachelor of Science Honours in Computer Science degree,

b. obtains minimum OGPA of 3.00, and

c. completes the relevant requirements within four academic years.

Bachelor of Science in Information Technology

Award of classes for the Information Technology degree will be decided by the Board of Examiners based on the following criteria:

First Class: A student shall be awarded First Class if he/she

a. is eligible for Bachelor of Science in Information Technology Degree,

b. obtains minimum OGPA of 3.70, and

c. completes the relevant requirements within three academic years.

Second Class (Upper Division): A student shall be awarded Second Class (Upper Division) if he/she

a. is eligible for Bachelor of Science in Information Technology Degree,

b. obtains minimum OGPA of 3.30, and

c. completes the relevant requirements within three academic years.

Second Class (Lower Division): A student shall be awarded Second Class (Lower Division) if he/she

a. is eligible for Bachelor of Science in Information Technology Degree,

b. obtains minimum OGPA of 3.00, and

c. completes the relevant requirements within three academic years.

Bachelor of Science Honours in Information Technology

Award of classes for the Honours in Information Technology Degree will be decided by the Board of Examiners based on the following criteria:

First Class: A student shall be awarded First Class if he/she

a. is eligible for Bachelor of Science Honours in Information Technology degree,

b. obtains minimum OGPA of 3.70, and

c. completes the relevant requirements within four academic years.

Second Class (Upper Division): A student shall be awarded Second Class (Upper Division) if he/she

a. is eligible for Bachelor of Science Honours in Information Technology degree,

b. obtains minimum OGPA of 3.30, and

c. completes the relevant requirements within four academic years.

Second Class (Lower Division): A student shall be awarded Second Class (Lower Division) if he/she

a. is eligible for Bachelor of Science Honours in Information Technology degree,

b. obtains minimum OGPA of 3.00, and

c. completes the relevant requirements within four academic years.

3.3.6 Award of Diploma/Higher Diploma

Applied Mathematics and Computing

A student who wishes to leave the degree programme after completing the level 1 or level 2 is advised to make a request to the faculty board. The Diploma/Higher Diploma in Applied Mathematics and Computing will be awarded after the approval of the Senate.

Award of Diploma (SLQF Level 3)

A student deemed to have satisfied the requirement for the award of "Diploma in Applied Mathematics and Computing" degree, if he/she has;

a. obtained Grade 'C-' or above in all the core course units (30 credits) offered in level 1,

b. obtained Grade 'C' or above in the auxiliary course unit English Language I and Grade 'D+' or above in the auxiliary course units other than English Language I offered in level 1, and

c. obtained a minimum GPA of 2.00 in level 1.

Award of Higher Diploma (SLQF Level 4)

A student deemed to have satisfied the requirement for the award of "Higher Diploma in Applied Mathematics and Computing" degree, if he/she has;

a. obtained grade 'C-' or above in all the core course units (60 credits) offered in level 1 and level 2,

b. obtained grade 'C' or above in the auxiliary course units English Language I and English Language II and Grade 'D+' or above in the auxiliary course units other than English Language I and English Language II offered in level 1 and 2, and

c. obtained a minimum OGPA of 2.00.

Information Technology

A student who wishes to leave the course after completing the level 1 or level 2 is advised to make a request to the faculty board. The Diploma/Higher Diploma in Information Technology will be awarded after the approval of the Senate.

Award of Diploma (SLQF Level 3)

A student deemed to have satisfied the requirement for the award of "Diploma in Information Technology" degree, if he/she has;

a. obtained Grade 'C-' or above in all the core course units (30 credits) offered in level 1,

b. obtained Grade 'C' or above in the auxiliary course unit English Language I and Grade 'D+' or above in the auxiliary course units other than English Language I offered in level 1, and

c. obtained a minimum GPA of 2.00 in level 1.

Award of Higher Diploma (SLQF Level 4)

A student deemed to have satisfied the requirement for the award of "Higher Diploma in Information Technology" degree, if he/she has;

a. obtained grade 'C-' or above in all the core course units (60 credits) offered in level 1 and level 2,

b. obtained grade 'C' or above in the auxiliary course units English Language I and English Language II and Grade 'D+' or above in the auxiliary course units other than English Language I and English Language II offered in level 1 and 2, and

c. obtained a minimum OGPA of 2.00.

3.3.7 Effective Date of the Degree

The effective date of the degree programmes of a student shall be the last date of the final end semester examination.

3.4 Curriculum Layout

Level 1 - Bachelor of Science in Applied Mathematics and Computing and Bachelor of Science Honours in Computer Science

Level 1 - Semester 1				
Course Code	**Course Title**	**Credits**	**Theory Hours**	**Practical Hours**
AMA1113	Differential Equations	3	45	-
PMA1113	Foundation of Mathematics	3	45	-
STA1113	Introduction to Statistics	3	45	-
CSC1113	Foundation of Computer Science	3	30	30
CSC1123	Introduction to Programming	3	30	30
ACU1113	English Language I	3	45	-
Level 1 - Semester 2				
Course Code	**Course Title**	**Credits**	**Theory Hours**	**Practical Hours**
AMA1213	Methods of Applied Mathematics	3	45	-
PMA1213	Analysis and Number Theory	3	45	-
STA1213	Statistical Inference	3	45	-
CSC1213	Object Oriented Programming	3	30	30
CSC1223	Database Systems	3	30	30
ACU1212	Social Harmony and Active Citizenship	2	30	-

Level 2 - Bachelor of Science in Applied Mathematics and Computing and Bachelor of Science Honours in Computer Science

Level 2 - Semester 1				
Course Code	**Course Title**	**Credits**	**Theory Hours**	**Practical Hours**
AMA2113	Optimization I	3	30	30
AMA2122	Vector Calculus	2	30	-
PMA2113	Linear Algebra	3	45	-
STA2113	Design of Experiments	3	30	30
CSC2113	Data Structures and Algorithms	3	30	30
CSC2122	Computer Security	2	30	-
ACU2113	English Language II	3	45	-
Level 2 - Semester 2				
Course Code	**Course Title**	**Credits**	**Theory Hours**	**Practical Hours**
AMA2213	Mechanics	3	45	-
STA2213	Sampling Theory	3	45	-
CSC2212	Data Communication and Computer Networks	2	30	-
CSC2222	Software Engineering	2	30	-
CSC2234	Numerical Computing	4	45	30
ACU2212	Communication and Soft Skills	2	30	-

Level 3 - Bachelor of Science in Applied Mathematics and Computing

Level 3 - Semester 1				
Course Code	**Course Title**	**Credits**	**Theory Hours**	**Practical Hours**
AMA3113	Mathematical Modelling	3	45	-
AMA3122	Optimization II	2	30	-
STA3113	Regression Analysis and Time Series	3	30	30
CSC3112	Computer Graphics	2	30	-
CSC3123	Operating Systems	3	30	30
CSC3132	Web Application Development	2	-	60
ACU3112	Career Guidance	2	30	-
Level 3 - Semester 2				
Course Code	**Course Title**	**Credits**	**Theory Hours**	**Practical Hours**
AMA3213	Analytical Dynamics	3	45	-
PMA3213	Complex Variables	3	45	-
STA3212	Statistical Quality Control	2	30	-
CSC3213	Computer Architecture	3	30	30
CSC3222	Graph Theory	2	30	-
CSC3232	Group Project	2	200 notional hours	
ACU3212	Management and Entrepreneurial Skills	2	30	-
ACU3222	Research Methodology and Scientific Writing	2	30	-

Level 3 - Bachelor of Science Honours in Computer Science

Level 3 - Semester 1				
Course Code	**Course Title**	**Credits**	**Theory Hours**	**Practical Hours**
AMA3122	Optimization - II	2	30	-
CSC3112	Computer Graphics	2	30	-
CSC3123	Operating Systems	3	30	30
CSC3132	Web Application Development	2	-	60
CSH3143	Knowledge Representation and Programming in Logic	3	30	30
CSH3153	Human Computer Interaction	3	30	30
CSH3163	Advanced Database System	3	45	-
ACU3112	Career Guidance	2	30	-
Level 3 - Semester 2				
Course Code	**Course Title**	**Credits**	**Theory Hours**	**Practical Hours**
CSC3213	Computer Architecture	3	30	30
CSC3222	Graph Theory	2	30	-
CSH3242	Theory of Computation	2	30	-
CSH3254	Parallel Computing	4	45	30
CSH3263	Advanced Computer Networks	3	45	-
CSH3273	Artificial Intelligence	3	45	-
ACU3212	Management and Entrepreneurial Skills	2	30	-
ACU3222	Research Methodology and Scientific Writing	2	30	-

Level 4 - Bachelor of Science Honours in Computer Science

Level 4 - Semester 1				
Course Code	**Course Title**	**Credits**	**Theory Hours**	**Practical Hours**
CSH4112	System Analysis and Design	2	30	-
CSH4123	Bioinformatics	3	30	30
CSH4133	Digital Image Processing	3	45	-
CSH4144	Machine Learning	4	45	30
CSH4152	Cryptography	2	30	-
CSH4162	Compiler Design	2	30	-
CSH4173	Numerical Linear Algebra and Finite Element Method	3	45	-
Level 4 - Semester 2				
CSH4216	Research Project	6	600 notional hours	
CSH4226	Industrial Training	6	600 notional hours	
Note: The Research Project course unit will be carried out throughout the level four and it is evaluated at the end of the level four.				

Level 1 - Bachelor of Science in Information Technology and Bachelor of Science Honours in Information Technology

Level 1 - Semester 1				
Course Code	**Course Title**	**Credits**	**Theory Hours**	**Practical Hours**
IT1113	Fundamentals of Information Technology	3	30	30
IT1122	Foundation of Mathematics	2	30	-
IT1134	Fundamentals of Programming	4	30	60
IT1144	Fundamentals of Web Programming	4	30	60
IT1152	Essentials of Statistics	2	30	-
ACU1113	English Language I	3	45	-
Level 1 - Semester 2				
Course Code	**Course Title**	**Credits**	**Theory Hours**	**Practical Hours**
IT1214	Object Oriented Design and Programming	4	30	60
IT1223	Database Management Systems	3	30	30
IT1232	Project Management	2	30	-
IT1242	Principles of Computer Networks	2	30	-
IT1252	Electronics and Device Interfacing	2	15	30
IT1262	Mathematics for Computing	2	30	-
ACU1212	Social Harmony and Active Citizenship	2	30	-

Level 2 - Bachelor of Science in Information Technology and Bachelor of Science Honours in Information Technology

Level 2 - Semester 1				
Course Code	**Course Title**	**Credits**	**Theory Hours**	**Practical Hours**
IT2114	Data Structures	4	30	60
IT2122	Software Engineering	2	30	-
IT2133	Advanced Web Programming	3	30	30
IT2143	Visual Programming	3	15	60
IT2153	Computer Graphics	3	30	30
ACU2113	English Language II	3	45	-
Level 2 - Semester 2				
Course Code	**Course Title**	**Credits**	**Theory Hours**	**Practical Hours**
IT2212	Management Information Systems	2	30	-
IT2223	Design and Analysis of Algorithms	3	30	30
IT2234	Web Services and Server Technologies	4	30	60
IT2244	Operating Systems	4	30	60
IT2252	Social and Professional Issues in IT	2	30	-
ACU2212	Communication and Soft Skills	2	30	-

Level 3 - Bachelor of Science in Information Technology and Bachelor of Science Honours in Information Technology

Level 3 - Semester 1				
Course Code	**Course Title**	**Credits**	**Theory Hours**	**Practical Hours**
IT3113	Knowledge Based Systems and Logic Programming	3	30	30
IT3122	Computer Security	2	30	-
IT3133	Mobile Communication and Computing	3	30	30
IT3143	Digital Image Processing	3	30	30
IT3152	Software Quality Assurance	2	30	-
IT3162	Group Project	2	200 notional hours	
ACU3112	Career Guidance	2	30	-
Level 3 - Semester 2				
Course Code	**Course Title**	**Credits**	**Theory Hours**	**Practical Hours**
IT3213	Human Computer Interaction	3	30	30
IT3223	Advanced Database Management Systems	3	30	30
IT3232	E-Commerce	2	15	30
IT3243	Parallel Computing	3	30	30
IT3252	Multimedia Computing	2	30	-
IT3262	Operations Research	2	30	-
ACU3212	Management and Entrepreneurial Skills	2	30	-
ACU3222	Research Methodology and Scientific Writing	2	30	-

Level 4 - Bachelor of Science Honours in Information Technology

Level 4 - Semester 1				
Course Code	**Course Title**	**Credits**	**Theory Hours**	**Practical Hours**
IT4113	Computer Organisation and Architecture	3	30	30
IT4123	Agent Based Computing	3	30	30
IT4133	Bioinformatics and Computational Biology	3	30	30
IT4142	Compiler Design	2	30	-
IT4153	Advanced Computer Networks	3	30	30
Elective Course Units				
EL4112	Augmented and Virtual Reality	2	30	-
EL4122	Data Science	2	30	-
EL4132	GIS and Remote Sensing	2	30	-
EL4142	Graph Theory	2	30	-
EL4152	Machine Learning	2	30	-
EL4162	Numerical Computing	2	30	-
EL4172	Optical Networks	2	30	-
EL4182	Smart Systems	2	30	-
EL4192	Software Defined Networking	2	30	-
Note: Students should select courses from elective course units to fulfill the 10-credits requirement for the level 4				
Level 4 - Semester 2				
IT4216	Research Project	6	600 notional hours	
IT4226	Industrial Training	6	600 notional hours	
Note: The Research Project course unit will be carried out throughout the level four and it is evaluated at the end of the level four.				

4. Examination Rules

4.1 Attendance

Candidates shall be in attendance outside the examination hall at least 15 minutes before the commencement of each paper, but shall not enter the hall until they are requested to do so by the Supervisor.

4.2 Seating

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

4.3 Admission to Hall

No candidate shall be admitted to the examination hall for any reason whatsoever after the expiry of half an hour from the commencement of the examination. Nor shall a candidate be allowed to leave the hall until half an hour has lapsed from the commencement of the examination or during the last 15 minutes of the paper.

4.4 Record Book as Identity

A candidate shall have his/her student Record Book and the 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 Record Book. If he/she fail to bring his/her Record Book on any occasion, he/she shall sign a declaration in the form provided for it, and produce the Record Book in the next occasion when he/she appears for the examination. If it is the last paper or the only paper he/she is sitting, he/she shall produce the Record Book/Identity Card to the Deputy Registrar/Examination on the following day. If a candidate loses his/her Record Book in the course of the day or if a candidate loses his/her Record Book in the course of the Examination, he/she shall obtain a duplicate Record Book, Identity Card from the Deputy Registrar/Examination, for production at the examination hall.

4.5 Documents which candidates should not bring

No candidate is allowed to have any written documents in his or her possession.

4.6 Declaration of Articles in Possession

If a supervisor requires every candidate shall declare everything he/she has in his/her possession

4.7 Copying

No candidate shall copy or attempt to copy from any book or paper or notes or similar material or from the answer scripts of another candidate. A candidate shall neither help another candidate nor obtain help from another candidate or person. A candidate shall not conduct himself/herself negligently in any way that gives opportunity for another candidate to read anything written by him/her or to watch any practical work conducted by him/her. A candidate shall not use any other unfair means to obtain or render improper assistance at the examination. Need for assistance for genuine purposes should be indicated to the Supervisor/Invigilator by raising the hand.

4.8 Cheating

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

4.9 Articles that candidate may bring

Candidates shall bring their own pens, ink, mathematical instruments, erasers, pencils or any other equipment or stationary which the candidates have been instructed to bring.

4.10 Examination Stationery

Examination stationery (i.e. writing paper, graph paper, drawing paper, ledger paper, precise paper etc.) will be supplied as and when necessary. No sheet of paper or answer book supplied to candidate may be torn, crumpled, folded or otherwise mutilated. No other papers shall be used by candidates. Log tables or any other materials provided by the University shall be used with care and left behind on the desk. Such material supplied whether used or unused, shall be left behind on the desk and not removed from the examination halls.

4.11 Index Number

Every candidate shall enter his/her Index Number on the answer book and on every continuation paper. He/She also enter all necessary particulars as indicated in the cover of the answer book. A candidate who inserts on his/her own script an index number other than his/her is liable to be considered as having cheated. A script that bears no Index Number or an Index 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.

4.12 Rough work to be cancelled

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 admission cards, time tables, question papers, record books or on any other paper. Any candidate who disregards these instructions will be considered as having written notes or outline of answers with the intension of copying.

4.13 Unwanted parts of Answers to be crossed out

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

4.14 Supervisors Authority

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

4.15 Conduct

Every candidate shall conduct himself/herself in the Examination Hall and its precincts so as not to cause disturbance or inconvenience to the Supervisor or his/her staff or to other candidates. In entering and leaving the hall, shall conduct him/her as quietly as possible. A candidate is liable to be executed from the examination hall for disorderly conduct.

4.16 Stopping work

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

4.17 Maintenance of Silence

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

4.18 Leaving

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

4.19 Impersonation

No person shall impersonate a candidate whether in the examination hall or before or after the examination, nor shall any candidate allow himself to be impersonated by any other person.

4.20 Prior knowledge

No candidate shall obtain or attempt to obtain prior knowledge of questions.

4.21 Dishonesty

Serious action will be taken of any dishonest assistance given to candidate, by any person.

4.22 Cancellation/Postponement

If circumstances arise which in the opinion of the Supervisor render the cancellation or postpone of the examination necessary, he/she shall stop the examination, collect the scripts already written and then report the matters as soon as possible to the Vice Chancellor or Deputy Registrar/Examination.

4.23 Making of statements

The Supervisor/Invigilator is empowered to request 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.

4.24 Whom to contact in Examination Matters

No candidate shall contact any person other than the Vice Chancellor or Dean or Deputy Registrar/Examinations regarding any matter concerning the examinations.

4.25 Handing over of Answer scripts

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

4.26 Withdrawal

Every candidate who registers for an examination shall be deemed to have sat an examination within the specified period unless he/she submits a medical certificate prior to the commencement of the examination. The medical certificate shall be from the University Medical Officer.

If this is not possible the medical certificate should be obtained from a Government Medical Practitioner and should be submitted to the University Medical Officer for certification at the earliest possible time.

4.27 Absence from Examination

The students who are unable to appear for an examination of a course unit or a component of a course unit on the medical grounds should report to the University medical officer at least half an hour before the commencement of the examination. Those who are unable to do so due to the unavoidable circumstances should obtain a valid medical certificate from the government hospital or private practitioners of the residential area and submit it to the University medical officer as early as possible. Medical certificate recommended by the University medical officer should be submitted to the Deputy Registrar/Examination within 14 days of the conclusion of the examination.

4.28 Plagiarism

The Faculty operates on a **zero tolerance** policy when it deals with acts of plagiarism. The students are advised to ensure that all their course work, reports and other reportive work are referenced properly when quoting or citing from another person's work. Of particular importance is the common tendency to 'copy and paste' from the internet that is practiced voraciously at present. This, in the case of the Faculty of Applied Science **will not be tolerated** even to the very minor levels.

5. Services and Facilities

The office of the Deputy Registrar (Examinations and Admission) is located in the Main Campus Building at Pampaimadu. This office carries out Students Registration, Issuing Identity Card, Admission Card for end semester examination, Result Sheets, Official Transcript, Statements and, Degree Certificates.

The office of the Marshal and Assistant Registrar (Welfare) is located in Pampaimadu premises. All the needs of the students outside their study courses such as loan facilities, grants, scholarships, hostel facilities, cafeterias are provided through the Welfare Branch.

5.1 Financial Assistance

Financial Assistances available are as follows:

- Mahapola Scheme
- Bursary Scheme
- Vice Chancellor welfare fund
- Late Mrs. Puvaneswary Loganathan Memorial fund

5.2 Awards and Prizes

The Faculty of Applied Science students are eligible to apply for the following awards. However, the students must satisfy the minimum requirements to apply for these awards.

- Faculty Award
- Late Mrs. Puvaneswary Loganathan Memorial Gold Medal
  (Only for Environmental Science Students)
- Prof. Alagaiah Thurairajah Gold Medal
- Prof. Kanthia Kunaratnam Gold Medal
- University Prize (Thambiah Mudhaliyar Chatram Trust)

5.3 IT Facilities

The Faculty has well established Computer Laboratories with networking and Wi-Fi facilities for teaching and learning purposes. All the students have access to Internet facilities in the laboratories. Students can also access the eduroam internet connectivity inside the University premises. All the students are entitled to get the institutional email ID.

5.4 Laboratory Facilities

Manuscript writing, High performance computing, Multimedia, Computer Vision, and Embedded System Laboratories were established in the Faculty of Applied Science under the AHEAD, ELTA-ELSE project for the research students of the Faculty. Computer-assisted language learning (CALL) laboratory has been established to teach English for the Faculty of Applied students under the AHEAD, ELTA-ELSE project.
The department of physical science has three well-equipped computer laboratories for teaching, learning and research activities. Cisco Networking laboratory and Electronic laboratory have been established to teach advanced course modules and for research activities. The Department of Bio-science has well-equipped laboratories for Environmental Chemistry and Environmental Biology related course modules. The department has begun establishing a computer laboratory to accommodate more IT based course modules under the environmental science curriculum.

5.5 Self Access Learning Centre

There is a Self Access Learning Centre with computers and internet facilities at the Faculty of Applied Science. The students can utilize this learning centre to enhance their knowledge and independent learning.

5.6 IT Centre

The IT Centre of the University of Vavuniya is located in Pampaimadu premises. There are 50 computers available with internet facilities for teaching, learning and training purposes. Further, the centre supports to train the state and non-state employees and school leavers in IT and other aspects. The students of the Faculty of Applied Science also can enjoy the facilities of this centre.

5.7 Library Services

The University possesses a well established library to support the teaching, learning and research in all disciplines. It is situated in the Park Road premises and Pampaimadu premises. Further, the library also provides facilities that enable students to access scientific information through selected online journals. The detail of available books can be browsed through Online Public Access Catalogue (OPAC).

5.8 Physical Education

Students are encouraged to participate and utilize the facilities available for sports in the University. The Physical Education Unit is located in Pampaimadu Hostel premises having a cricket playground where we can partially used for Football and Volleyball. Further an indoor stadium with badminton court , netball court and a gymnasium is available for students and staff. The physical education unit organizes Inter Faculty meets, Freshers meet, Big Matches, and Open Tournaments annually.

5.9 Accommodation and Lodging

At present University of Vavuniya has four hostels in order to accommodate 1000 students both male and female.

5.10 Facilities for the differently abled students

The Faculty has the ramp facility in the laboratories to support the differently abled students. In addition to that lecture halls are equipped with left-handed arm chairs. Further, Faculty is taking initiative to construct washrooms and elevators for the differently abled students.

5.11 Health Facilities

The University Health Centre is established to help the students of the University to lead an active life free from disease. The University Medical Officer (UMO) will be available at Health centres of the Main Campus at Park Road and Pampaimadu Premises during the office hours. University students are entitled for free consultations and medicine from the Health Centre.

5.12 Student Union and Societies

The students' union of faculty of Applied Science represents the entire undergraduate student community of the faculty. The students' union organizes many events with the participation of all the students and the faculty administration.

There are other student societies in the Faculty of Applied Science. These include ENSOC, ITCS, and IEEE Student Branch. Many events such as workshops and competitions are conducted through these student societies with the approval of the authorities.

5.13 Staff and Students Interaction

A committee has been set up to promote staff and students interaction. This committee arranges various programmes to enhance togetherness and social harmony.

5.14 Students Counsellors

Student Counsellors guide you in your transition from school to university environment, and assist in overcoming learning, financial and emotional difficulties, and help to make your university life rewarding, pleasant and memorable.

5.15 Academic Advisors

Academic advisors are assigned for students at each level of the Faculty of Applied Science to guide you for academic planning.

5.16 Anti Ragging Committee

The Anti Ragging Committee is consisting of Deputy proctor, Senior Student counsellor, Student counsellors, Senior Lecturers, Warden, Marshal and Sub warden of the University of Vavuniya. The Committee closely monitor the ragging and other related issues. Further, the students are requested to go through the below given documents to avoid unnecessary inconveniences in the university system.

- Commission Circular 919: Guidelines to be introduced to curb the menace of ragging in the Universities or Higher Educational Institutes (HEIs)
- Commission Circular 946: Common Guidelines on Student Discipline
- Prohibition of ragging and other forms of violence in educational institutions act no 20 of 1998
- Assistance to and protection of victims of crime and witnesses act no 04 of 2015

5.17 Virtual Learning Environment (VLE)

All the course units offered by the Faculty of Applied Science are designed in such a way that accommodates Virtual Learning Environment (VLE) as a tool to facilitate the undergraduates to learn by means of learner centred approach. All the staff members and students of the faculty are given an account for accessing the VLE. The activities of each student will be monitored by the respective lecturer through the VLE and the course materials of the course units shall be updated in the VLE regularly. Also, announcements, feedbacks, questionnaires, practice quizzes, assignments and tutorials submission of a course unit will be managed with the VLE. The VLE can be accessed through https://vle.fas.vau.ac.lk

Appendix A

Detailed Syllabus

Bachelor of Science in Applied Mathematics and Computing

Bachelor of Science Honours in Computer Science

LEVEL 1

Course Code	AMA1113
Course Title	Differential Equations
Credit Value	03 (45h Theory + 105h Independent learning)
Prerequisites	None

Objective

To provide knowledge in solutions of differential equations and its basic applications.

Intended Learning Outcomes

- describe the concepts of differential equations
- solve first-order and higher-order linear differential equations
- demonstrate the methods for solving systems of linear differential equations
- explain the conditions for integrability and methods for solving integrable total differential equations
- create mathematical models for a range of scientific and engineering problems involving differential equations

Contents

- Introduction: Basic concepts of the differential equations.
- Equations of First Order and First Degree: Separable variables and reduction to separable variables, Exact equations and those reducible to that form, Linear equations and those reducible to linear forms, Applications of First Order Differential Equations.
- Equations of First Order and Higher Degree: Linear differential equations with constant coefficients, Linear differential equations with variable coefficients, System of Linear Differential Equations.
- Total Differential Equations: Conditions for integrability and exactness, Solving integrable Total Differential Equations.

Teaching and Learning Methods

Classroom lectures, individual and group tasks, and tutorial discussions.

Evaluation Methods

In-Course Assessments	30%
End Semester Examination	70%

Recommended Readings

[1] M. D. Raisinghania, Ordinary and Partial Differential Equations, S.Chand Publishing, 8^{th} edition, 2015.

[2] D.G. Zill, A Differential Equations with Boundary Value problem, Brookes Cole, 5^{th} edition, 2000.

Course Code	PMA1113
Course Title	Foundation of Mathematics
Credit Value	03 (45h Theory + 105h Independent learning)
Prerequisites	None

Objective

To provide a strong foundation in Mathematics to follow the remaining courses in Applied Mathematics and Computing.

Intended Learning Outcomes

- describe the basic concepts and terminology of sets, functions, and relations with examples
- apply the operations of sets, functions, and relations in real scientific examples
- translate logical statements from informal language to propositional and predicate logic expressions
- identify the proof technique used in a given proof
- simplify Boolean expressions using Karnaugh maps.

Contents

- Foundations of Sets: Basic notation, Representations and examples, Membership and subsets, Operations on sets, Cartesian products, Power sets, Cardinality, Infinite sets.
- Relations and Functions: Domain and range of a relation, One-to-one, one-to-many, many-to-one, inverse, reflexive, symmetric, and transitive relations, Into, Onto, One-one, and bijective functions.
- Propositional and Predicate Logic: Propositions, Quantifiers, Predicates, Proofs.
- Boolean Algebra and Logic Gates: Introduction, Duality, Representation theorem, Sum-of-products, Combinatorial circuits, Boolean Functions, Karnaugh map and applications.
- Group theory: Definitions and examples, Order of elements, Sub-groups, Cosets and Lagrange's theorem, Cyclic groups.

Teaching and Learning Methods

Classroom lectures, smaller tutorial groups and seminars, individual assignments and group tasks.

Evaluation Methods

In-Course Assessments	30%
End Semester Examination	70%

Recommended Readings

[1] K.H. Rosen, Discrete Mathematics and Its Applications, McGraw Hill, 7^{th} Edition, 2012.

[2] D.S. Dummit and R.M. Foote, Abstract algebra, Wiley, 3^{rd} edition, 2003.

Course Code	STA1113
Course Title	Introduction to Statistics
Credit Value	03 (45h Theory + 105h Independent learning)
Prerequisites	None

Objective

To provide knowledge in how to summarize, interpret and present statistical information, probability reasoning and probability theory.

Intended Learning Outcomes

- describe the basic concepts and principles of statistics
- illustrate given data in appropriate graphs
- interpret summary statistics of a given dataset
- explain the elements of probability theory and probability distributions with suitable examples
- apply probabilistic and statistical reasoning to describe the problems in real-life situations

Contents

- Descriptive Statistics: Introduction, Quantitative measures, Variables, Central tendency, Variability, Measures of location.
- Charts and Graphs: Patterns in data, Dotplots, Histograms, Stemplots, Boxplots, Ogives, Scatterplots.
- Measures of Dispersion: Skewness, Coefficient of skewness, Kurtosis.
- Probability: Introduction, Axiomatic probability, Conditional probability, Bayes' Theorem, Independence, Combinatorial methods.
- Random Variables: Discrete and continuous random variables, Expectation and variance, Joint and conditional distributions, Moment generating functions, Probability generating functions, Binomial, Poisson, Uniform, and Normal distributions and Student's t-distribution.

Teaching and Learning Methods

Classroom lectures, homework, and tutorial discussions.

Evaluation Methods

In-Course Assessments	30%
End Semester Examination	70%

Recommended Readings

[1] B.W. Lindgren, Statistical Theory, MacMillan, 3^{rd} edition, 1976.

[2] J.Schiller, R. Alu Srinivasan, and M. Spiegel, Schaum's Outline of Probability and Statistics, McGraw-Hill Education, 4^{th} edition, 2012.

Course Code	CSC1113
Course Title	Foundation of Computer Science
Credit Value	03 (30h Theory + 30h Practical + 90h Independent learning)
Prerequisites	None

Objective

To provide the basic concepts in computer science and introduce basic software.

Intended Learning Outcomes

- describe the purpose of basic computer components
- list the functions of network devices, transmission media, and protocols
- solve problems using arithmetic operations and conversions on different number systems
- explain different types of software and their use
- demonstrate skills in installing, configuring and troubleshooting hardware devices and software

Contents

- Introduction to Computer Systems: Evolution of computers, Classification of modern computers.
- Representation of Data: Number Systems, Binary Arithmetic, Signed Integer Representation, Floating Point Representation.
- Computer Hardware: Input/output devices, CPU organization, Storage Devices, Expansion cards and System Interfaces.
- Computer Software: Operating systems, Utility programs, Application software, Concepts of Programming, Web-based, Desktop and Mobile applications.
- Computer Network: Use of Network, Communication Media, Network Devices, Types of Networks.
- System Maintenance and Troubleshooting: PC maintenance tools, Troubleshooting guidelines, Upgrading a system.
- Practical: Basic commands of Windows and Linux, Introduction to Word Processing, Spreadsheet and Presentation software.

Teaching and Learning Methods

Classroom lectures, computer assisted learning, presentation, tutorial discussions, and practical demonstrations.

Evaluation Methods

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks = $(2 \times Theory + 1 \times Practical)/3$

Recommended Readings

[1] B. Forouzan, Foundations of Computer Science, 4^{th} edition, 2017.
[2] S. Mueller, Upgrading and Repairing PCs, Que Publishing, 22^{nd} edition, 2015.

Course Code	CSC1123
Course Title	Introduction to Programming
Credit Value	03 (30h Theory + 30h Practical + 90h Independent learning)
Prerequisites	None

Objective

To introduce the principles of programming and to provide knowledge in structured programming concepts and techniques.

Intended Learning Outcomes

- describe the purpose of various types of programming languages and their differences.
- identify strategies for solving basic programming problems
- select appropriate control structures required for performing given programming tasks
- apply the concepts of primitive data types, selection statements, loops, functions and arrays in C++ programs.
- demonstrate the use of debugging functions in programming

Contents

- Programming Languages: Machine language, Assembly language and High level languages.
- Techniques of Problem Solving: Algorithm, Flowchart and Pseudo codes.
- Introduction to C++ Programming: Structure of a C++ program, Input/output streams, Variable declaration, Arithmetic operations, Relational operations, Logical operations.
- Control Structures: Selection structures including if and switch statements, Repetition structures including while repetition, for repetition, and do/while repetition, Break and continue statements.
- Functions and Arrays: Functions, Scope of variables and parameters, One dimensional and multi dimensional arrays.
- Practical: Practical implementation of the above concepts using C++.

Teaching and Learning Methods

Classroom lectures, self-learning, computer assisted learning, tutorial discussions, and practical demonstrations.

Evaluation Methods

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks = $(2 \times Theory + 1 \times Practical)/3$

Recommended Readings

[1] Y.D. Liang, Introduction to Programming with C++, Pearson, 3^{rd} edition, 2013.
[2] D.S. Malik, C++ Programming: From Problem Analysis to Program Design, Cengage Learning, 5^{th} edition, 2010.

Course Code	ACU1113
Course Title	English Language I
Credits Value	03 (45h Theory + 105h Independent learning)
Prerequisites	None

Objective

To provide necessary language skills to read, write, listen and speak in English in formal and informal academic and professional contexts at the intermediate level.

Intended Learning Outcomes

- adapt the fundamental knowledge on the use of the four skills speaking, listening, reading and writing
- identify the semantic and pragmatic forms and meanings for contextual application
- demonstrate efficiency and effectiveness in both receptive and expressive skills
- create distinct style and rhetoric orally, aurally, graphically, and grammatically

Contents

At the intermediate level,

- Reading: Reading skills, Identifying main points, Understanding vocabulary.
- Writing: Introducing the mechanics of writing, Introducing vocabulary in and around the University environment, Developing sentences and paragraphs, Transferring graphic, pictorial information into writing, Preparing to write an essay or a project.
- Speaking: Describing objects, Interviewing, Giving instructions, Making short speeches.
- Listening: Listening to discriminate sounds, Listening for specific information, Listening and responding to telephone conversion.
- Language Structures: Introducing structures, Question formation, Articles, Preposition, Pronouns, Quantifier, Word class, Active and passive, Topics to be selected from student's field of interest, Submission of individual projects.

Teaching and Learning Methods

Class room lectures, self-learning, computer assisted language learning, individual and group discussion and presentation.

Evaluation Methods

In-Course Assessments 30% (Listening and Speaking)
End Semester Examination 70% (Reading, Writing and Language Structures)

Recommended Readings

[1] M.Craven, C.Thaine, and S. Logan, Cambridge English Skills: reading. Writing, listening and speaking from Elementary Advanced, Cambridge University Press.

[2] A. Pohl, E. Glendinning, and L. Lansford, Oxford English for Careers Technology for Engineering and Applied Sciences: Student Book, Oxford University Press, United Kingdom, 2013.

[3] R. Murphy, Essential English Grammar, Cambridge Publications, 2012.

Course Code	AMA1213
Course Title	Methods of Applied Mathematics
Credit Value	03 (45h Theory + 105h Independent learning)
Prerequisites	AMA1113

Objective

To provide a broad understanding of Fourier approximation in various mathematical methods in physical system modelling, modelling of physical system using partial differential equation and the use of power series method in solving differential equations.

Intended Learning Outcomes

- define the series solution of differential equations
- solve applied problems using the series solution methods
- solve homogeneous and non-homogeneous partial differential equations with constant coefficient
- describe the use of second order quasi linear partial differential equations to solve problems
- apply the Fourier series, Laplace transforms methods to solve differential equations

Contents

- Ordinary Differential Equations: Solution of ordinary differential equations of second order by series methods. Legendre and Bessel functions.
- Partial Differential Equations: Partial differential equations by elimination of arbitrary constants and functions, Linear Partial differential equations of order one, Homogeneous Partial differential equations. Complementary functions and particular integrals, Non homogeneous Partial differential equations with constant coefficients, Second order Quasi linear Partial differential equations, Reduction to canonical form.
- Fourier Series: Fourier coefficients, Sine series Cosine Series, Perceval identity, Application of Fourier series to Partial differential equations.
- Integral Transforms: Laplace transforms, Fourier transforms, Z-transform, Application to differential equations.

Teaching and Learning Methods

Classroom lectures, group assignments and tutorial discussions.

Evaluation Methods

In-Course Assessments	30%
End Semester Examination	70%

Recommended Readings

[1] M.D. Raisinghania, Ordinary and Partial Differential Equations, S.Chand Publishing, 8^{th} edition. 2015.

[2] N.M. Kapoor, A Text Book of Differential Equations, Pitambar Publishing, 1997.

Course Code	PMA1213
Course Title	Analysis and Number Theory
Credit Value	03 (45h Theory + 105h Independent learning)
Prerequisites	PMA1113

Objective

To provide a broad understanding of analysis techniques that are basic stepping-stones for contemporary research and improve creativity and problem solving skills.

Intended Learning Outcomes

- illustrate fundamental properties of the real numbers that lead to the formal development of real analysis
- demonstrate proficiency in limit of real sequences and series and their properties.
- describe key definitions and theorems of real analysis related to limits of functions, continuity, and differentiation
- apply important ideas and techniques in number theory for real world problems
- explain the concepts of divisibility, congruence, greatest common divisor, and prime-factorization

Contents

- Rationals and Reals: Algebraic and order properties of the real numbers, Infimum and Supremum, Completeness properties of real numbers, Dense property of rationals and irrationals.
- Sequence: Limits, Convergence, Cauchy sequence, Monotone convergence theorem, Cauchy's criterion for convergence, Recurrence sequences.
- Series: Convergence, Test for absolute convergence, Alternating series.
- Functions: Limits of functions, Sequential characterization of limits
- Continuous Functions: Definitions and properties, Continuous functions on closed intervals, Intermediate value theorem and extreme value theorem.
- Differentiation and its simple properties: Rolle's theorem, Mean value theorem and applications, Taylor's theorem, L'Hospital rule.
- Number Theory: Introduction, Integers, Factors and Euclid's Algorithm, Unique factorization, Linear congruences, Inverses, Chinese remainder theorem.

Teaching and Learning Methods

Classroom lectures, group assignments and tutorial discussions.

Evaluation Methods

In-Course Assessments	30%
End Semester Examination	70%

Recommended Readings

[1] R.G. Bartle and D.R. Sherbert, Introduction to Real Analysis, Wiley, 4^{th}edition, 2011.

[2] I. Niven, H.S. Zuckerman, and H.L. Montgomery, An Introduction to the Theory of Numbers, Wiley, 5^{th} edition, 1991.

Course Code	STA1213
Course Title	Statistical Inference
Credit Value	03 (45h Theory + 105h Independent learning)
Prerequisites	STA1113

Objective

To provide the basic elements of estimation of population parameters, various methods of hypothesis testing, and decision-making abilities.

Intended Learning Outcomes

- describe the basic principles of inferential statistics
- determine point estimates and confidence intervals of the population parameters
- formulate hypothesis tests in some common models with correct use of terms such as null hypothesis and alternative hypothesis
- solve inference problems using appropriate non-parametric test
- construct a statistical report based on findings of the statistical data analysis for real inferential problems

Contents

- Point and Interval Estimation: Standard errors of means, Method of moments estimation, Least squares estimation and maximum likelihood estimation, Confidence limits.
- Testing of Statistical Hypotheses: Type I and type II Errors, Use of central limit theorem, One-sample tests and two-sample tests, Inference for variances, Significance testing.
- Non-parametric Methods: Kolmogorov-Seminov test, Mann-Whitney test, Wald-Wolf Owitz runs test, Sign test, Wilcoxon signed rank test, Kruskal-Wallis test, Goodness-of-fit tests, Contingency tables.

Teaching and Learning Methods

Classroom lectures, assignments and tutorial discussions.

Evaluation Methods

In-Course Assessments	30%
End Semester Examination	70%

Recommended Readings

[1] G. Casella and R.L. Berger, Statistical Inference, Duxbury Press, 2^{nd} edition, 2001.

[2] I. Miller and M. Miller, John E.Freund's Mathematical Statistics with Applications, Pearson, 8^{th} edition, 2012.

Course Code	CSC1213
Course Title	Object Oriented Programming
Credit Value	03 (30h Theory + 30h Practical + 90h Independent learning)
Prerequisites	CSC1123

Objective

To provide experience and confidence in the use of an object oriented programming using Java for problem solving activities.

Intended Learning Outcomes

- distinguish the features of structured and object oriented languages
- explain how real world objects mapped into object oriented programming paradigm
- design object oriented solutions for small systems involving multiple objects
- relate classes using inheritance hierarchies to minimize the duplication of object code
- utilize the object oriented concepts in program development.

Contents

- Object Oriented Concepts: Classes and Objects, Abstraction, Encapsulation, Inheritance and Polymorphism, Access Modifiers, Specifying a Class, Defining Member Methods, Constructor and Destructor, Copy Constructors, Static Data Members, Static Member Methods.
- Inheritance: Extending Classes, Defining Derived Classes, Single Inheritance, Making A Private Member Inheritance, Multilevel Inheritance, Multiple Inheritance, Hierarchical Inheritance, Hybrid Inheritance.
- Polymorphism: Operator Overloading, Method Overloading, Overriding, Virtual Functions, Abstract Base Classes, Templates.
- Practical: Practical implementation of the above concepts using Java.

Teaching and Learning Methods

Class room lectures, self-learning, computer assisted learning, and practical demonstrations.

Evaluation Methods

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks = $(2 \times Theory + 1 \times Practical)/3$

Recommended Readings

[1] C. Thomas Wu, An Introduction to Object-Oriented Programming with Java, McGraw-Hill Education, 5^{th} edition, 2009.
[2] P. Deitel and H. Deitel, Java how to program, Prentice Hall, 8^{th} edition, 2009.

Course Code	CSC1223
Course Title	Database Systems
Credit Value	03 (30h Theory + 30h Practical + 90h Independent learning)
Prerequisites	None

Objective

To enable students to design and develop an effective database for realistic applications and write complex database queries in relational algebra and SQL.

Intended Learning Outcomes

- describe the concepts of database systems and benefits of these systems in the modern society
- design a conceptual model for given requirements
- create an efficient relational database by eliminating anomalies
- apply Relational Structured Query Language to create and manipulate database
- utilize database management system software for creating and manipulating databases

Contents

- Introduction to Databases and Database System Concepts: Evolution of database systems, Components of database systems, Database system architecture and data independence, Users of Database.
- Database Design: Entity types, Keys, Attributes, ER and EER model, Relational Data Model, Relations, Domains, Schemas, Constraints, Integrity rules, ER to Relational Mapping, EER to Relational mapping.
- Normalization Theory: Functional dependencies, Normal Forms (1NF, 2NF, 3NF and BCNF).
- Relational Algebra and Query Languages: Relational algebra (Select, project, join and set operations), introduction to SQL, DDL, DML, Sub-queries, Set operations, Aggregate functions, Derived relations, and Data Views, Triggers.
- Practical: Creating relational databases and manipulating them with SQL (MySQL)

Teaching and Learning Methods

Classroom lectures, Laboratory lectures (SQL), group assignments, tutorial discussions, and practical demonstrations.

Evaluation Methods

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks = $(2 \times Theory + 1 \times Practical)/3$

Recommended Readings

[1] R. Elmasri and S.B. Navathe, Fundamentals of Database Systems, Pearson, 7^{th} edition, 2015.

[2] R. Ramakrishnan and J. Gehrke, Database Management Systems, McGraw-Hill, 3^{rd} edition, 2002.

Course Code	ACU1212
Course Title	Social Harmony and Active Citizenship
Credits Value	02 (100h Notional learning)
Prerequisites	None

Objective

To provide basic knowledge in social concepts, human rights and the importance of social harmony in a multicultural and multi-ethnic society and to identify their own cultural traits through engagement with people from different cultures to work with the society through different projects and contribute for the sustainable development in regional, national and global perspectives.

Intended Learning Outcomes

- define peace building processes in terms of cultivation of peace culture
- explain the need for the harmony among different ethnic groups for the sustainable development
- develop the motivation to work as a team with the community with understanding
- recognize as socially and environmentally responsible citizen
- evolve themselves to work in the community level projects

Contents

- **Peace Building:** Steps to peace building, Activity based session to enhance and build social harmony, Political reform and devolution of powers. Sustainable peace process, participation of the grass root level society in the peace process, cohabitation among political parties and forces, effectively handling pressure groups.
- **Active Citizens:** learning journey of active citizens, role of Active citizens in universities and colleges, Understanding individual, culture, society and citizen, Local and global active citizenship, Understanding our place in society and the world: local and global citizenship, Planning, delivery and need assessment for environmental projects.
- **Influencing Skills:** Dealing with people in power, understanding conflicts, conflict resolution, gender sensitization, avoiding misunderstandings, Introduction to non-violent communication, Understanding yourself, Understanding the culture that you grow up in, Understanding how to get to know people that are different from you, How to dialogue with others, Understanding how your society is structured, Recognizing how some people need help and support, Creating a project, developing a team, Working together in team.

Teaching and Learning Methods

Learning by doing themselves with the guidance of facilitators.

Evaluation Methods

In-Course Assessments (Peer evaluation)	50%
Proposal presentation	20%
Final presentation	30%

Recommended Readings

[1] C. Packham, Active Citizenship and Community Learning, 2008

[2] K. Bush, The Intra Group Dimensions of Ethnic Conflict in Sri Lanka, 2003

[3] Winslow, D. & Michael, D.W. (2004) *Economy Culture and Civil Wars in Sri Lanka.* Bloomington: Indiana University Press.

LEVEL 2

Course Code	AMA2113
Course Title	Optimization I
Credit Value	03 (30h Theory + 30h Practical + 90h Independent learning)
Prerequisites	None

Objective

To introduce the fundamental concepts of optimization techniques to make the students aware of the importance of optimizations in real scenarios and to provide the concepts of various classical and modern methods for constrained problems.

Intended Learning Outcomes

- formulate real-world problems as mathematical programming models
- describe the theoretical workings of the simplex method for linear programming
- determine the direction and magnitude of change of a model's optimal solution as the data change using sensitivity analysis
- solve specialized linear programming problems and network models in project scheduling
- build models using spreadsheet programs and mathematical tools

Contents

- Linear Programming: Linear Programming Formulations, Linear Programs, Optimal Solutions, Unboundedness, Geometry of Linear Programming.
- Simplex Method: Transforming the Linear Programs to Standard Form, Simplex Method, Artificial Variable techniques in Simplex Method, Linear Programming Duality, Revised Simplex Method, Sensitivity and Post Optimality Analysis.
- Transportation Models: Balanced and Unbalanced transportation problems, Degeneracy, Transportation Algorithms, Transshipment Problems.
- Assignment Models: Hungarian Method of Assignment Problems.
- Project Scheduling Programme: Evaluation Review Technique (PERT) and Critical Path Method (CPM), Network analysis and applications.
- Practical: Practical implementation of the above concepts using Spread Sheets programs and Mathematical tools.

Teaching and Learning Methods

Classroom lectures, tutorial discussions, and practical demonstrations.

Evaluation Methods

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks = $(2 \times Theory + 1 \times Practical)/3$

Recommended Readings

[1] C. B. Gupta, Optimization Techniques in Operation Research, 2^{nd} edition, 2012
[2] M. Kunc and J. Malpass, Behavioral Operational Research: Theory, Methodology and Practice, 2018
[3] C.H. Antunes and M.J. Alves, Multiobjective Linear and Integer Programming, 2016

Course Code	AMA2122
Course Title	Vector Calculus
Credit Value	02 (30h Theory + 70h Independent learning)
Prerequisites	AMA1113

Objective

To introduce the methods of vector calculus and give the ability to use them for geometry and some physical concepts.

Intended Learning Outcomes

- define the vector equations of lines and planes in three dimensions
- explain the use of vector functions of a single variable with examples
- find gradient of a function, and divergence and curl of a vector field
- describe various integral theorems related to line, surface and volume integrals

Contents

- Vectors and Scalars: Vector algebra, Laws of vector algebra, Unit vectors, Components of a vector, Scalar fields, and Vector fields.
- Vector and Scalar Product: Scalar products, Vector products, Triple products, Reciprocal sets of vectors.
- Vector Differentiation: Ordinary derivatives of vectors, Space curves, Continuity and differentiability, Differentiation formulas, Partial derivatives of vectors, Differentials of vectors, Differential geometry.
- Vector Differential Operators: del, gradient, divergence, curl, Formulas involving del.
- Vector Integration: Ordinary integrals of vectors, Line integrals, Surface integrals, Volume integrals.
- Integral Theorems: Divergence theorem of Gauss, Stokes' theorem, Green's theorem in the plane, Related integral theorems, Integral operator form for del.

Teaching and Learning Methods

Classroom lectures, group assignments and tutorial discussions.

Evaluation Methods

In-Course Assessments	30%
End Semester Examination	70%

Recommended Readings

[1] S. Lipschutz, D. Spellman, and M.R. Spiegel, Schaum's outlines vector analysis and an introduction to tensor analysis, McGraw-Hill, 2^{nd} edition.

[2] P.C. Matthews, Vector Calculus, Springer, 2000.

Course Code	PMA2113
Course Title	Linear Algebra
Credit Value	03 (45h Theory + 105h Independent learning)
Prerequisites	PMA1113

Objective

To provide knowledge in vectors, properties of matrices and its application to follow the other relevant courses.

Intended Learning Outcomes

- solve systems of linear equations by using Gaussian elimination method
- utilize the basic ideas of vector algebra, linear dependence and independence and spanning
- explain how to find row space, column space and null space of a matrix
- describe the concepts of dimension of a subspace and the rank and nullity of a matrix
- determine eigenvalues and eigenvectors of a square matrix using the characteristic polynomial

Contents

- Linear Equations: Systems of linear equations, Matrices and row echelon form, Gaussian elimination, Gauss-Jordan elimination.
- Vectors and Matrices: Linear combinations of vectors, Linear independence of vectors, Matrix operations, Matrix algebra.
- Elementary Matrices: Inverse of a matrix, Finding the inverse of a matrix by Gauss-Jordan elimination, LU factorization, Diagonalization of matrices, Eigenvalues and Eigenvectors, Determinants, Characteristic equation.
- Vector Spaces: Definition of vector spaces, Subspaces, Subspace criterion, Sum of subspaces, Spanning sets, Linear independence, Basis, Dimension, Dimension of the sum of two subspaces, Coordinates, Change of bases, Change-of-basis matrices, Gauss-Jordan method for computing change-of-basis matrices.
- Linear Transformations: Definition and examples, Composition, Inverse, Kernel and range of a linear transformation, Kernel, Range, Rank and nullity, Rank Theorem, One-to-one and onto linear transformations and inverses, Change-of-basis and similarity, Diagonalization of linear transformations.

Teaching and Learning Methods

Classroom lectures, group assignments, and tutorial discussions.

Evaluation Methods

In-Course Assessments	30%
End Semester Examination	70%

Recommended Readings

[1] D.C. Lay, Study Guide for Linear Algebra and Its Applications, Pearson, 3^{rd} edition, 2002.

[2] G. Strang, Introduction to Linear Algebra, Wellesley-Cambridge Press, 5^{th} edition, 2016.

Course Code	STA2113
Course Title	Design of Experiments
Credit Value	03 (30h Theory + 30h Practical + 90h Independent learning)
Prerequisites	STA1113, STA1213

Objective

To provide basic elements of design of statistical experiments and analysis of variance methods as an approach to analyze data.

Intended Learning Outcomes

- describe the principles of Design of Experiments and Analysis of Variance (ANOVA) methods, and the assumptions behind ANOVA
- choose an appropriate experimental design based on the study Objective
- construct one-way and two-way ANOVA tables to determine whether there are any statistically significant differences between groups
- analyze the collected data based on the design used and its underlying assumptions
- develop competence in the use of appropriate statistical packages to perform above experiments.

Contents

- Introduction: Basic concepts, Design, Analysis, Randomization.
- Completely Randomized Design: Normal equations and estimates, Analysis of Variance, Test of Hypothesis.
- Randomized Block Design: Normal equations and estimates, Analysis of Variance, Test of Hypothesis, Efficiency of Randomized Block Design.
- Two-way Analysis of Variance: Two factor interaction, Analysis of Variance, Test of Hypothesis.
- Latin Squares Designs: Normal equations and estimates, Analysis of Variance, Test of Hypothesis, Efficiency of Latin Squares Design.
- General Factorial Design: Terminology, Main effects and interactions, Analysis of Variance, Test of Hypothesis.
- Practical: Practical implementation of the above concepts using statistical software.

Teaching and Learning Methods

Class room lectures, self-learning, tutorial discussions, and practical demonstrations.

Evaluation Methods

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks= $(2 \times Theory + 1 \times Practical)/3$

Recommended Readings

[1] D.C. Montgomery, Design and Analysis of Experiments, John Wiley and Sons, 2^{nd} edition, 1984.
[2] G.W. Oehlert, A First Course in Design and Analysis of Experiments, 2000.

Course Code	CSC2113
Course Title	Data Structures and Algorithms
Credit Value	03 (30h Theory + 30h Practical + 90h Independent learning)
Prerequisites	CSC1123, CSC1213

Objective

To provide a solid background in essential components of data structures and algorithms, which can be used to manipulate data efficiently.

Intended Learning Outcomes

- analyze algorithms for their efficiency in terms of time complexity
- describe the operations of common data structures and their usage
- utilize appropriate data structures for solving computing problems
- demonstrate the operation of various sorting and searching techniques
- develop computer programs to implement different data structures and related algorithms

Contents

- Algorithms: Efficiency of algorithms, Asymptotic analysis of algorithms, Time complexity, Best, average, and worst case behaviors of an algorithm.
- Linear Data structures: Linear List, Stack, and Queue (Array and linked list based implementations).
- Recursion: Concepts of recursion, Types of recursion, Applications of recursion, Usage of recursion in divide and conquer algorithms.
- Non-Linear Data structures: Graphs and Trees (Array and linked list based implementations).
- Searching Algorithms: Sequential search algorithm, Binary search algorithm, and their time complexities.
- Sorting Algorithms: Selection sort, Bubble sort, Insertion sort, Merge sort, Quick sort, Heap sort, and their time complexities.
- Practical: Practical implementation of the above concepts using Java.

Teaching and Learning Methods

Classroom lectures, group assignments, tutorial discussions and practical demonstrations.

Evaluation Methods

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks = $(2 \times Theory + 1 \times Practical)/3$

Recommended Readings

[1] M.T.Goodrich, R.Tamassia, and M.H.Goldwasser, Data structures and algorithms i Java, wily, 2014.

[2] M.A. Weiss, Data Structures and Algorithms Analysis in Java, Pearson, 3^{rd} edition, 2011.

Course Code	CSC2122
Course Title	Computer Security
Credit Value	2 (30h Theory + 70h Independent learning)
Prerequisites	CSC1113

Objective

To provide fundamental issues of computer security and network security, and latest developments on security protocols, technologies, standards and applications.

Intended Learning Outcomes

- explain the relationship between threats, vulnerabilities, attacks and controls
- compare different security notions for private and public key encryption methods
- identify common vulnerabilities in programs, operating systems and database systems
- solve real world network security problems using current practices

Contents

- Foundational Concepts in Security: Assets, Threats, Attacks, Risks, Vulnerabilities, Controls, Meaning of Computer Security (CIA triad), Security Services, Control Mechanisms.
- Elementary Cryptography: Classical Ciphers, Cryptanalysis, Stream and Block Ciphers, Modern Ciphers, Symmetric and Asymmetric cryptography, DES, AES, RSA, Message Authentication Code, Hash Functions, Digital Signature, Digital Certificate.
- Program Security: Secure Programs, Non-malicious Program Errors, Viruses and Other Malicious Code, Database Security, SQL Injection.
- Operating Systems Security: Protected Objects and Methods of Protection, Memory and Address Protection, Control of Access to General Objects, File Protection Mechanisms, User Authentication.
- Security in Networks: Threats in Networks, Denial of Service, Network Security Controls, Authentication Protocols, Firewalls, Intrusion Detection Systems, Secure E-Mail, Secure Shell (SSH), IP Security (IPSec) Protocol, Virtual Private Networks (VPN).

Teaching and Learning Methods

Class room lectures, laboratory lectures, group presentations and tutorial discussions.

Evaluation Methods

In-Course Assessments	30%
End Semester Examination	70%

Recommended Readings

[1] C.P. Pfleeger, S.L. Pfleeger and J. Margulies, Security in Computing, Prentice-Hall, 5^{th} edition, 2015.

[2] W. Stallings, Cryptography and Network Security: Principles and Practice, 6^{th} edition, 2013.

Course Code	ACU2113
Course Title	English Language II
Credit Value	3 (45h Theory + 105h Independent learning)
Prerequisites	ACU1113

Objective

To provide necessary language skills to read, write, listen and speak in English in formal and informal academic and professional contexts at the advanced level.

Intended Learning Outcomes

- adapt the advanced knowledge on the use of the four skills – speaking, listening, reading and writing
- identify the semantic and pragmatic forms and meanings for diverse application
- demonstrate efficiency and effectiveness in both receptive and expressive skills
- create distinct style and rhetoric orally, aurally, graphically, and grammatically

Contents

At the advanced level

- Reading: Reading for details, contextual understanding, Intensive reading, Making inference, Summarizing.
- Writing: Application of advanced structures and grammatical items-phrases and clauses, Sentences and Paragraphs, Texts and Discourses, Controlled Writing - Transforming visual, Oral and Aural information into writing, Communicating in writing-writing notes, memos, personal/official letters, report writing.
- Listening: Listening for specific information, For gist of the passages, For comprehension, For making inferences, Note taking, and Reproducing.
- Speaking: Describing people/events/pictures, Asking for information, giving directions/instructions, Making requests/complains, Using model dialogues/improvisations/reading to stimulate conversations and small group discussion.
- Project: Writing essays.

Teaching and Learning Methods

Class room lectures, self-learning, computer assisted language learning, individual and group discussion and presentation.

Evaluation Methods

In-Course Assessments	30% (Listening and Speaking)
End Semester Examination	70% (Reading, Writing and Language Structures)

Recommended Readings

[1] M. Craven, Cambridge English Skills: reading, Writing, listening and speaking-from Elementary-Advanced.

[2] M. Hewings, Advanced English Grammar, Cambridge University Press, 2005.

[3] R. Gill, Mastering English Literature, 3^{rd} edition, 2006.

[4] E. Glendinning and L. Lansford, Oxford English for Careers Technology for Engineering and Applied Sciences: Student Book, 2013.

Course Code	AMA2213
Course Title	Mechanics
Credits Value	03 (45h Theory + 105h Independent learning)
Prerequisites	AMA1113, AMA2122

Objective

To provide the mathematical concepts in dynamic and static systems.

Intended Learning Outcomes

- describe the basic concepts of dynamic and static systems
- solve for the resultants of any force systems.
- explain the basic principles of uniform, harmonic, curve and gravitational motions with examples
- determine stress and strain in a body under some simple loading cases
- analyse rigid body motion in terms of external forces

Contents

- Introduction: Kinematics, Dynamics and statics, Foundation of mechanics and mathematical models, Newton's laws, Force and mass, Work, Power, Kinetic energy, Conservative force field, Potential energy, Conservation of energy, Impulse, Conservation of momentum and non-conservative forces.
- Motion in a uniform field: Uniformly accelerated motion, Freely falling bodies, Potential and potential energy in a uniform force field, Motion in a resisting medium, Pulley motion and inclination motion.
- Harmonic Oscillator: Simple harmonic oscillator, Amplitude, period and frequency of simple harmonic motion, Energy of a simple harmonic oscillator, Damped harmonic oscillator, Over-damped, Critically damped and under-damped motion, Simple pendulum.
- Gravitation: Basic concepts of gravitation and formulas, Field and potential, Rocket motion, Equation of rocket motion, Relative-motion analysis.
- Motion of a particle on a curve: Motion of a particle on a smooth vertical curve, Tangential equation of the motion, Normal equation of the motion.
- Flexible chains and strings: Catenary, Equation of common catenary, Cartesian equation of common catenary, Properties of catenary, Equations of equilibrium of a string, Catenary of uniform strength.
- Shear force and Bending moment: Types of beams and loads, Internal stress in a rigid body, Concentrated and distributed forces, Relationship between bending moment and shearing force and Diagrams.

Teaching and Learning Methods

Classroom lectures, group assignments, and tutorial discussions.

Evaluation Methods

In-Course Assessments	30%
End Semester Examination	70%

Recommended Readings

[1] M.R. Spiegel, Schaum's Theory and Problems of Theoretical Mechanics, McGraw-Hill, 1980.

[2] R.K. Bansal, A Textbook of Strength of Materials: Mechanics of Solids, Laxmi Publications, 2012.

Course Code	STA2213
Course Title	Sampling Theory
Credit Value	03 (45h Theory + 105h Independent learning)
Prerequisites	STA1113, STA1213

Objective

To provide the basic concepts and techniques in sampling methods and common errors that occur during the sampling process.

Intended Learning Outcomes

- describe the concepts and techniques in sampling methods
- estimate population parameters under different sampling methods
- determine sample size under different sampling methods
- explain the use of various estimators in successive sampling
- apply sampling methods to more general problems in statistics

Contents

- Introduction: Population, Sample, Sampling Design, Estimators.
- Simple Random Sampling: Simple Random Sampling With Replacement, Simple Random Sampling Without Replacement, Estimation of population mean and total under SRS, Determination of sample size under SRS, Estimation of Population Proportion.
- Stratified Sampling: Estimation of population mean and total under Stratified Sampling, Determination of sample size under Stratified Sampling, Allocations.
- Ratio estimator: Bias and Mean Square Error, Estimation of Variance, Confidence Interval, Ratio Estimator in Stratified Random Sampling.
- Difference estimator and Regression estimator: Difference Estimator, Difference Estimator in Stratified Random Sampling, Regression Estimator, Regression Estimators in Stratified Sampling.
- Systematic Sampling: Estimation of population mean and total under Systematic Sampling, Comparison of Systematic Sampling, Simple Random Sampling and Stratified Random Sampling for Different Types of Populations, Circular Systematic Sampling.
- Cluster Sampling: Estimation of Population Mean, Estimation of Efficiency by a Cluster Sample.

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Teaching and Learning Methods

Class room lectures, individual and group presentation, field visit, and project assignment and reporting

Evaluation Methods

In-Course Assessments	30%
End Semester Examination	70%

Recommended Readings

[1] P. Mukhopadhyay, Theory and Methods of Survey Sampling, PHI Learning, 2^{nd} edition, 2013.

[2] W.G. Cochran, Sampling Techniques, Wiley, 3^{rd} edition.

Course Code	CSC2212
Course Title	Data Communication and Computer Networks
Credit Value	2 (30h Theory + 70h Independent learning)
Prerequisites	CSC1113

Objective

To provide the basic concepts in data communication and computer network.

Intended Learning Outcomes

- describe the basic concepts of data communication, computer network, different types of protocols, and transmission media
- explain the layers of the OSI model and TCP/IP and the functions of each layer
- classify the different types of network devices and their functions within a network
- demonstrate practical implementation, troubleshooting of computer network in an organizational environment

Contents

- Introduction: Data Communication concepts, Networks, Internet, Protocols and Standards, Topology, Transmission mode, Categories of network, Applications.
- Signals: Periodic and aperiodic signals, Analog signals, Time and frequency domains, Frequency spectrum and bandwidth, Digital signals, Analog and digital data.
- Network Models: Layered Task, OSI Model, TCP/IP Model.
- Transmission Media: Guided media, Unguided media, Transmission impairment, Signal propagation, Digital Modulation and Multiplexing.
- Network Devices: NIC, Switches, Bridges, Hub and Routers, network design and implementation. .

Teaching and Learning Methods

Classroom lectures, laboratory lectures, tutorial discussions, and group practical assignments.

Evaluation Methods

In-Course Assessments	30%
End Semester Examination	70%

Recommended Readings

[1] A.S. Tanenbaum and David J. Weatherall, Computer Networks, 5^{th} edition, 2010.

[2] W. Stallings, Data and Computer Communications, Pearson, 10^{th} edition, 2013.

[3] B.A. Forouzan, Data Communication and Networking, McGraw-Hill Education, 5^{th} edition, 2012.

Course Code	CSC2222
Course Title	Software Engineering
Credit Value	02 (30h Theory + 70h Independent learning)
Prerequisites	CSC1113

Objective

To provide fundamental knowledge and skills to analyze and evaluate system demands and develop skills that will enable students to construct software of high quality, reliable, and reasonably easy to understand, modify and maintain.

Intended Learning Outcomes

- describe major software process models and software requirement collection, design, and testing methodologies.
- identify the functional and non-functional requirements for a software
- explain the principal issues associated with software evolution
- apply software engineering techniques to create a software design and standard documentation for a software

Contents

- Software Processes: Introduction to software process models, Activities within software life-cycles, Evaluation of software process models.
- Requirements Engineering: Properties of requirements, Software requirements elicitation, Describing system data, Functional requirements, Non-functional requirements.
- Software Design: Design Models, class, architectural and interface designs. Different types of architecture, levels of abstraction, separation of concerns, information hiding, coupling and cohesion, re-use of standard structures.
- Software Testing: Verification and validation concepts, Testing types, Testing fundamentals. Unit, integration, validation, and system testing, Test plan creation and test case generation, Black-box and white-box testing techniques.
- Software Evolution: Software development in the context of large, pre-existing code bases, Software change, Refactoring, Software evolution, Characteristics of maintainable software, Re-engineering systems, Software reuse.

Teaching and Learning Methods

Classroom lectures, group software project presentation, and reporting.

Evaluation Methods

In-Course Assessments	30%
End Semester Examination	70%

Recommended Readings

[1] I. Sommerville, Software Engineering, Pearson, 10^{th} edition, 2015.
[2] R.S. Pressman and B. Maxim, Software Engineering: A Practitioner's Approach, McGraw-Hill Education, 8^{th} edition, 2014.

Course Code	CSC2234
Course Title	Numerical Computing
Credit Value	04 (45h Theory + 30h Practical + 125h Independent learning)
Prerequisites	PMA1113, PMA2113, CSC1123

Objective
To provide knowledge of numerical algorithms and skills to implement algorithms to solve broad range of mathematical problems on the computer.

Intended Learning Outcomes

- describe the concepts of number representation and types of errors arise due to these representations in digital computers
- apply numerical methods to solve systems of linear, non-linear, polynomial, differential equations
- explain curve fitting, interpolation and polynomial approximation techniques with suitable examples
- analyse accuracy, efficiency and convergence properties of various numerical methods
- formulate differentiation and integration problems in a way that is appropriate for numerical treatment
- utilize mathematical software to compute the solutions for engineering problems using appropriate numerical methods

Contents

- Error analysis: Computer number representation, round off errors, truncation errors, loss of significance.
- Solution of equation of one variable: Bisection method, the method of false-position, fixed point iteration, convergence of iterative methods, Aiken's Δ^2 process, order of convergence, Newton-Raphson method, convergence of Newton-Raphson iteration, Secant method, Order of Secant method.
- Roots of Polynomials: Computing with polynomials, Newton method to compute the roots of a polynomial, Muller's method, Bairstow's method for quadratic factors.
- Interpolation: Interpolation and Lagrange polynomial, Errors in Interpolation, Divided Difference, Interpolation with equally spaced points, Interpolation with cubic spline.
- Numerical Differentiation: Numerical Differentiation, Derivatives from difference table, Derivation of derivative formula using Lagrange's Interpolation formula, Richardson's Extrapolation, five point's formula.
- Numerical Integration: Trapezodial Rule and Simpon's Rule, Round off error in Trapezodial Rule and Simpon's Rules, adaptive quadrature method, Gaussian quadrature.
- Numerical solution of system of linear equation: Direct method: Gaussion Elimination, pivoting strategies, operational count, Matrix factorization, compact schemes (Crouts, Choleski), Tridiagonal system, stability and Ill conditioning, Vector and matrix norms, condition number. Jacobi, Gauss-Seidal methods, Convergence of Iteration methods, Successive over relaxation method, Krylov subspace and conjugate gradient methods.
- Solution of Ordinary Differential Equations: Derivation of method, One step method, Runge-Kutta (R-K) method, Derivation of R-K methods, Euller's method and Errors Estimation, Linear Multistep methods, Adams methods and predictor-corrector methods, Stability of Numerical methods.
- Practical: Practical implementation of the above concepts using Mathematical software.

Teaching and Learning Methods
Classroom lecture, tutorial discussions, and practical demonstrations.

Evaluation Methods
Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks=$(3 \times Theory + 1 \times Practical)/4$

Recommended Readings

[1] S. Kanaganathan, Fundamentals of Numerical Computing, 2009.
[2] J. Stoer and R. Bulirsch, Introduction to Numerical Analysis, Springer, 3^{rd} edition, 2010.
[3] K. Atkinson and W. Han, Elementary numerical analysis, Wiley, 3^{rd} edition, 2003.

Course Code	ACU2212
Course Title	Communication and Soft Skills
Credits Value	02 (30h Theory + 70h Independent learning)
Prerequisites	None

Objective

To excel in communication and soft skills for productivity and personality development.

Intended Learning Outcomes

- explain the necessary knowledge and skills required for efficient and effective communication
- identify the knowledge and skills for personality development
- find problems and challenges to overcome barriers to communication and soft skills
- show excellence in communication using critical and creative sills

Contents

- Introduction: Communication and soft skills, Patterns and process, Downward and Upward communication, Horizontal and vertical communication, One-way and two-way communication, Multi-directional communication, Communications for Management, Efficiency in communication.
- Forms and Levels: Oral and written communication, Verbal and non-verbal communication, Para-language Code, Signals, Symbols, Icons, Gestures, Active Listening and Speaking, Writing for your people, Publishing and Editing, Inter personal communication, Public communication.
- Planning and Organization of communication: Establishment of Objective, Information search, Identification, Collection, Organization and presentation, Analytical skills, Resource allocation, Delegation, Timing, Coordination.
- Motivational Communication: Motivation, Instrumental and inspirational, Internal and external, Instructions, Reporting, Recommendations, Performance Appraisal and Styles of Control.
- Staffing and Leadership: Interview Techniques, Communication in Training, Development, Feedback, and Industrial Relations, Supportive Leadership, Directive leadership, Achievement Oriented leadership and Participative leadership.
- Public Relations, Marketing Communication: Negotiating and conflict resolution skills: Opening the process, Negotiations types, Conduct of Negotiation and problem solving skills, balancing personal and professional life, Communication during Negotiations, Bargaining, Teamwork, Flexibility and adaptation, Time management, Decisiveness, Responsibility and Accountability.

Teaching and Learning Methods

Class room lectures, self-learning and discussion, individual and group presentation, field visit, and project assignment and reporting.

Evaluation Methods

In-Course Assessments	30%
End Semester Examination	70%

Recommended Readings

[1] T. Dixon and M. O'hara, Communication Skills: University of Ulster, 2010.

[2] H.F. Garcia, The Power of Communication: Skills to Build Trust, Inspire Loyalty, and Lead Effectively, 2012.

LEVEL 3

Course Code	AMA3113
Course Title	Mathematical Modelling
Credit Value	03 (45h Theory + 105h Independent learning)
Prerequisites	AMA1113, AMA1213

Objective

To provide mathematical modeling techniques using graphical, numerical, symbolic, and verbal techniques to describe and explore real-world data and phenomena.

Intended Learning Outcomes

- model observable world in terms of a mathematical language
- describe the basic concepts and terminology of systems characterization
- explain the formulations of static, dynamic, and ordinary and partial differential equations
- solve multiple-step problems through different (inductive, deductive and symbolic) modes of reasoning
- utilize appropriate technology in the evaluation, analysis, and synthesis of information in problem-solving

Contents

- Introduction: Role of mathematics in problem solving, Nature of mathematical modeling, Systems approach.
- Systems Characterization: Basic concepts, System, Variable, Parameter, Environment, Relationships, Static vs Dynamic, Continuous time vs Discrete time, Deterministic vs Stochastic.
- Mathematical Formulations: Static formulations, Dynamic formulations, Difference equation formulations, Ordinary differential equation formulations, Partial differential equation formulations.
- Case Studies: Models leading to difference equations, Models leading to ordinary differential equations, Models leading to partial differential equations, Population growth models, Growth and decay models, Combat Model, Stochastic models.

Teaching and Learning Methods

Classroom lectures and tutorial discussions.

Evaluation Methods

In-Course Assessments	30%
End Semester Examination	70%

Recommended Readings

[1] D.G. Zill, A First Course in Differential Equations with Modelling Applications, Brooks Cole, 11^{th} edition, 2017.

[2] R.L. Borrelli and C.S. Coleman, Differential Equations: A Modelling Perspective, Wiley, 2^{nd} edition, 2004.

Course Code	AMA3122
Course Title	Optimization II
Credit Value	02 (30h Theory + 70h Independent learning)
Prerequisites	AMA2113

Objective

To provide the advanced knowledge to develop linear optimization theory that apply for dynamic programming, goal programming, and game theory and nonlinear programming optimization concepts of advanced optimization in computer science and decision making.

Intended Learning Outcomes

- solve dynamic programming problems using divide-and-conquer methods
- apply simplex method to solve goal programming problems
- describe the fundamental ideas, concepts, and nature of game theory.
- explain the role of nonlinearity in optimization with example

Contents

- Dynamic Programming: Characteristic of dynamic programming problems, deterministic dynamic programming, probabilistic dynamic programming.
- Goal programming: Objective of goal programming, Non-pre-Emotive goal programming, pre-Emotive goal programming, Formulation of linear programming models for variables of linear functions with positive and negative component.
- Game Theory: Two-Person Zero-sum games, solving simple games, Dominated strategies method, Minimax criterion, Games with mixed strategies.
- Non-linear programming: Optimization fundamentals, Types of non -linear programming problems, Unconstrained optimization, Constrained optimization, the Karush-Kuhn-Tucker (K. K. T) condition for constrained optimization, Fractional programming, Quadratic programming, Separable programming, Convex programming, Newton's method, Steepest descent and conjugate gradient method for non-linear optimization.

Teaching and Learning Methods

Class room lectures, individual assignments, and tutorial discussions.

Evaluation Methods

In-Course Assessments	30%
End Semester Examination	70%

Recommended Readings

[1] D.P. Bertsekas, Nonlinear Programming, Athena Scientific, 2^{nd} edition, 1999.

[2] D.S. Hira, Operations Research, S Chand, Revised edition, 2007.

[3] C.B Gupta, Optimization Techniques in Operation Research, 2^{nd} edition, 2012.

Course Code	STA3113
Course Title	Regression Analysis and Time Series
Credit Value	03 (30h Theory + 30h Practical + 90h Independent learning)
Prerequisites	STA1113, STA1213

Objective

To provide knowledge in the simple and multiple regression analysis, how to use and interpret these results in a real world setting and the basic time series models.

Intended Learning Outcomes

- describe the basic concepts and terminology of Regression Models.
- utilize inferential statistical methods to estimate and test hypothesis about regression line parameters
- determine the coefficients of the multiple linear regression model
- interpret a simple Time Series
- demonstrate Simple and Multiple Regression model building process using statistical software

Contents

- Introduction: Simple Linear and Multiple Linear Regression Models.
- Simple Regression: Model estimation, Least-Squares Estimator, Hypothesis Test and Confidence Interval, Correlation and Coefficient of Determination.
- Multiple Regression: Model estimation, Least-Squares Estimator in Matrix from, Properties of the Least-Squares Estimator, Hypothesis Test and Confidence Interval, Correlation and Coefficient of Determination in matrix form.
- Univariate Time Series Analysis: Introduction to some real data models, Isolation of trend, Seasonal variation and cyclic Variation, Autocorrelation Function (ACF), Partial Autocorrelation Function (PACF), Autoregressive (AR) model of order p, the Moving Average (MA) model of order q and the mixed Autoregressive Moving Average (ARMA) model of order (p, q).
- Practical: Practical implementation of the above concepts using R.

Teaching and Learning Methods

Classroom lectures, laboratory lectures, self-learning, presentations, and practical demonstrations.

Evaluation Methods

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks = $(2 \times Theory + 1 \times Practical)/3$

Recommended Readings

[1] N.R. Draper and H.Smith, Applied regression analysis, 3^{rd} edition, 2005.

[2] S. Chatterjee and A.S. Hadi, Regression Analysis by Example, Wiley, 5^{th} edition, 2012.

[3] J.D. Cryer and K. Chan, Time Series Analysis: With Applications in R, Springer, 2^{nd} edition, 2010.

Course Code	CSC3112
Course Title	Computer Graphics
Credit Value	02 (30h Theory + 70h Independent learning)
Prerequisites	None

Objective

To provide background knowledge in the computer graphics concepts, methods and algorithms.

Intended Learning Outcomes

- describe the concepts behind computer graphics and algorithms for modeling and rendering graphical data
- explain the concepts and drawing algorithms of line, circle, and filled areas
- apply the techniques and algorithms for modelling, transforming and viewing 2D, 3D objects
- develop programs to implement standard algorithms in computer graphics

Contents

- Introduction: Concepts of graphics, Applications of Computer Graphics, Graphics Mathematics, Basic Graphics Pipeline, Display Devices, OpenGL.
- Scan-Conversion of Graphics Primitives: Scan-Conversion of points and lines, Line drawing algorithms, Circle drawing algorithms, Filled areas drawing algorithms.
- Two dimensional geometric transformations: Basic transformations, Matrix representations, Composite transformations.
- Two dimensional viewing: 2D viewing pipeline, Windows, Viewports, Window to viewport mapping, Clipping operations.
- Three dimensional Graphics Concept: Three dimensional coordinate system, Three dimensional display methods, Hidden lines and surface removal.
- Three-dimensional Transformations and Viewing: 3D Objects in Homogeneous Coordinates, Scaling, Translation, Rotation, Shear, Reflection transformations, World Coordinates and Viewing Coordinates, Projections.
- Implementation of standard algorithms of computer graphics

Teaching and Learning Methods

Class room lectures, laboratory lectures, tutorial discussions, and practical demonstrations.

Evaluation Methods

In-Course Assessments	30% (Practical Examinations)
End Semester Examination	70%

Recommended Readings

[1] D.D. Hearn and M.P Baker, Computer Graphics with OpenGL, 4^{th} edition, 2010.

[2] S. Marschner and P. Shirley, Fundamentals of Computer Graphics, CRC Press, 4^{th} edition, 2015.

Course Code	CSC3123
Course Title	Operating Systems
Credit Value	03 (30h Theory + 30h Practical + 90h Independent learning)
Prerequisites	CSC1113, CSC1123, CSC2113

Objective

To provide conceptual knowledge on structure and functions of modern operating systems.

Intended Learning Outcomes

- describe the structure and components of modern operating systems
- explain the concepts of concurrency control and techniques for managing concurrency
- evaluate memory management issues including virtual memory, paging, and segmentation techniques
- contrast most common processor scheduling techniques including the advantages and disadvantages of each.
- demonstrate algorithms of threading, concurrent management using C programming language .

Contents

- Operating System Concepts: History of Operating Systems, Operating System Structure, Kernel services, System calls.
- Process Management and Scheduling: Processes, Threads, Address spaces, Process Model, Synchronization, Mutual exclusion, Semaphores, Monitors.
- Concurrency Control and Inter-Process communication: Resource allocation, Deadlock, CPU scheduling, Scheduling criteria, Scheduling algorithms, Performance issues, Bankers algorithm.
- Memory Management: Memory allocation, Virtual memory, Address translation, Paging, Segmentation, Relocation and protection.
- I/O and File Systems: Structure of the I/O System, Organizing the I/O function, Block and character devices, Disk caching, File organization, Secondary storage management, File systems, Consistency, Redundancy, UNIX, DOS and Windows file systems.
- System programming in the UNIX environment: Review of C Programming, Shell command language, System calls for process management, File access, Network system calls.
- Practical: Practical implementation of the above concepts using Shell commands and C.

Teaching and Learning Methods

Classroom lecture, tutorial discussions, and practical demonstrations.

Evaluation Methods

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks=$(2 \times Theory + 1 \times Practical)/3$

Recommended Readings

[1] A.S. Tanenbaum and A.S. Woodhull, Operating Systems Design and Implementation, Pearson, 3^{rd} edition, 2006.

[2] W. Stallings, Operating Systems: Internals and Design Principles, Pearson, 9^{th} edition, 2017.

Course Code	CSC3132
Course Title	Web Application Development
Credit Value	02 (60h Practical + 40h Independent learning)
Prerequisites	CSC2212, CSC2222, CSC1213

Objective

To provide concepts, methods and tools needed to develop basic web sites and client side and server side web applications along with the advance features.

Intended Learning Outcomes

- explain the basic concepts, methods and tools needed to develop basic web sites
- utilize HTML and CSS to create web pages
- develop client-side programming using JavaScript to add interactivity to web pages
- create web application using PHP and MySQL

Contents

- Internet and World Wide Web: Internet, Services of Internet, Web application architecture, IP addresses and Domain Names, URL and URI, HTTP protocol.
- Hyper Text Markup Language: Fundamentals of HTML, Basic structure of (X)HTML document, elements, forms, Multimedia in HTML.
- Cascading Style Sheets: Basics, Cascading and inheritance, Properties and values, Fonts, colours and positioning, Table Layouts.
- Client-side programming using JavaScript: Basic syntax rules, variables, operators, functions and events, JavaScript an CSS.
- Server Side Web Development: PHP Syntax and semantics, Arrays, Form, File system management, Email sending using PHP, Object Orientation with PHP, PHP and MySQL database, XML.

Teaching and Learning Methods

Laboratory lectures, practical demonstrations, group assignments, and presentations.

Evaluation Methods

In-Course Assessments	40%
End Semester Examination	60%

Recommended Readings

[1] HTML5 BLACK BOOK, Wiley, 2011.

[2] L. Shklar and R. Rosen, Web Application Architecture: Principles, Protocols and Practices, 2^{nd} edition, 2009.

[3] J. Valade and S. Suehring, PHP, MySQL, JavaScript and HTML5 All-in-One For Dummies, John Wiley and Sons, 2013.

Course Code	ACU3112
Course Title	Career Guidance
Credit Value	02 (30h Theory + 70h Independent learning)
Prerequisites	None

Objective

To provide an overall view of the career prospective and guidance.

Intended Learning Outcomes

- develop attitudes of the outside world of work
- find career options and goals
- apply soft and survival skills in career development
- identify expectation of private employers
- select suitable carrier opportunity by analyzing job banks and databases
- create effective resume

Contents

- The world of work: Unemployment in Sri Lanka, Recent demographic, Economic and social changes of Sri Lanka and how they affect the graduate labour market, The private sector culture-emphasis on attitudes, The role of scientists in various employment sectors, The expectations of private sector employer from new graduate employees, Career guidance, Employment search.
- Image Projection: Social graces, Public relations, Career development and survival skills of young graduates, Personality development, Leadership, Team work, Human relations, Elective communication, Problem solving, Stress management.
- Presentation Techniques: The bio-data, Facing interviews, Assertiveness.

Teaching and Learning Methods

Class room lectures, self-learning and discussion.

Evaluation Methods

In-Course Assessments	30%
End Semester Examination	70%

Recommended Readings

[1] S. Niles and J. Harris-Bowlsbey, Career development interventions in the 21st century, 2^{nd} edition, 2005.

[2] S. Whitney and S. Power, Guide Your Career, 2017.

Course Code	AMA3213
Course Title	Analytical Dynamics
Credit Value	03 (45h Theory + 105h Independent learning)
Prerequisites	AMA1113, AMA1213, AMA2122, AMA2213

Objective

To provide advanced theoretical developments, which solve dynamical problems and develop a deep understanding of the fundamentals of analytical dynamics and applications to mechanical systems.

Intended Learning Outcomes

- apply the methods of Lagrange and Hamilton to simple systems of particles and rigid bodies
- solve the resulting differential equations of motion
- identify conserved quantities and use them to simplify the analysis of the motion
- explain the central force problems and rigid body motion

Contents

- Introduction: Generalized Coordinates, Constraints, Virtual displacement and virtual work, Generalized force, Principle of virtual work for static equilibrium, D'Alembert's Principle.
- Lagrange's equations: Lagrange's equations for Holonomic systems, Generalized momenta. Lagrange's equations for non-holonomic systems, Lagrange's equations with impulsive forces.
- Hamiltonian Theory: Hamiltonian Principle, Hamilton's equations, Hamiltonian for conservative systems, Canonical transformations. Condition that a transformation be canonical.
- Plane Motion of Rigid Bodies: Rigid bodies, Translations and rotations, Moment of inertia, Euler's theorem, Euler's Equation of motion of a Rigid Body, Motion under no force.
- Space motion of Rigid Bodies: Theory of rotating axis, Rotation of the earth, Motion of a particle in a rotating frame near the earth surface.
- Top Motion: Motion of a Spinning Top, Equation of Motion of a top, Steady Motion and Stable motion.

Teaching and Learning Methods

Classroom lectures, homework, and tutorial discussions.

Evaluation Methods

In-Course Assessments	30%
End Semester Examination	70%

Recommended Readings

[1] H. Baruh, Analytical Dynamics, WCB/McGraw-Hill, 1998.

[2] A.K. Sharma, Rigid Dynamics, Discovery Publishing Pvt.Ltd, 2007.

Course Code	PMA3213
Course Title	Complex Variables
Credit Value	03 (45h Theory + 105h Independent learning)
Prerequisites	PMA1113, PMA1213

Objective

To provide an introduction to the theories for functions of a complex variable and the exploration of the algebraic, geometric and topological structures of the complex number field.

Intended Learning Outcomes

- describe the nature and operations of Functions of Complex Variables and Special Functions
- demonstrate the ability to integrate knowledge and ideas of complex differentiation and complex integration in a coherent and meaningful manner
- define integrals by means of the residue method
- utilize the Cauchy integral theorem and Cauchy integral formula for the suitable complex variable problems
- apply properties of complex contour integrals .

Contents

- Complex numbers and functions sequences and series.
- Limits and continuity, Complex differentiation, Cauchy Riemann equations, Harmonic functions.
- Taylor's and Laurent's series, Uniform Convergence.
- Singularities, Poles, Residues, Residue theorem and its applications.
- Complex integration and Cauchy integral formula, Application of contour integrals to evaluate real integrals.
- Argument principle, Rouche's theorem with applications.

Teaching and Learning Methods

Classroom lectures and tutorial discussions.

Evaluation Methods

In-Course Assessments	30%
End Semester Examination	70%

Recommended Readings

[1] D.G. Zill and P.D. Shanahan, Complex Analysis: A First Course with Applications, Jones and Bartlett Learning, 3^{rd} edition, 2013.

[2] E.M. Stein and R. Shakarchi, Complex Analysis, Princeton University Press, 2003.

Course Code	STA3212
Course Title	Statistical Quality Control
Credit Value	02 (30h Theory + 70h Independent learning)
Prerequisites	STA1113, STA1213, STA2213

Objective

To provide the theory and methods of quality control including process capability, control charts, acceptance sampling, and process improvement.

Intended Learning Outcomes

- explain the concepts and functions of quality control
- describe the DMAIC (define, measure, analyse, improve, and control) process
- interpret control charts for variables, control charts for attributes and moving average control charts
- analyze process capability and measurement system capability of a production line or an industrial system.

Contents

- Introduction: A Brief History of Quality Control and Improvement, Statistical Methods for Quality Control and Improvement.
- DMAIC Process: Overview of DMAIC, Define Step, Measure Step, Analyse Step, Improve Step, Control Step.
- Modelling Process Quality: Describing Variation, Probability Plots.
- Statistical Basis of the Control Chart: Basic Principles, Choice of Control Limits, Sample Size and Sampling Frequency, Rational Subgroups, Analysis of Patterns on Control Charts, Discussion of Sensitizing Rules for Control Charts, Phase I and Phase II of Control Chart Application.
- Control Charts for Variables: Control Charts for x and r, Control Charts for x and s.
- Control Charts for Attributes: Control Chart for Fraction Nonconforming, Control Charts for Nonconformities, Choice Between Attributes and Variables.
- Process and Measurement System Capability Analysis: Process Capability Analysis Using a Histogram or a Probability Plot, Process Capability Ratios, Process Capability Analysis Using a Control Chart.

Teaching and Learning Methods

Classroom lectures, tutorial discussions, field visits and group assignments.

Evaluation Methods

In-Course Assessments	30%
End Semester Examination	70%

Recommended Readings

[1] D.C. Montgomery, Statistical Quality Control, Wiley, 7^{th} edition, 2012.

[2] M. Jeya Chandra, Statistical Quality Control, CRC Press, 1^{st} edition, 2001.

Course Code	CSC3213
Course Title	Computer Architecture
Credit Value	03 (30h Theory + 30h Practical + 90h Independent learning)
Prerequisites	CSC1113, PMA1113, CSC1123, CSC2113.

Objective

This course aims to provide the concepts of modern computer system architecture and enable students to apply these insights and principles to future computer designs.

Intended Learning Outcomes

- describe the conceptual design of a computer organisation including microprocessor, I/O and memory systems
- explain the internal functions of microprocessors
- discuss the issues in program execution and their solutions
- design a logic circuit to solve any given simple problem
- develop an assembly language program to solve problem

Contents

- Introduction: Computer organization and computer architecture, Evolution of computers, Function of basic computer components.
- Digital Logic Design: Combination and Sequential Logic Devices, Encoders, Decoders, Multiplexers, Address, Registers and counters, Logical expressions and simplifications.
- Typical Instruction Set: Fetch and execution cycle, Addressing modes, Function and the interaction between arithmetic/logic unit, Stored program control concept, Principles of serial and parallel data transmission, Interrupts, hazards, Micro programing control.
- Memory Hierarchy: Read only and read/write memory, Registers, Cache, Main Memory and Virtual Memory, Back up storage, Access and cycle time, Address translation, Multilevel, Unified, and Multi-way set-associative caches.
- Input/output and Storage Systems: I/O methods and architectures, Performance measurement, Redundant array of inexpensive disks (RAID) technology, Emerging data storage technologies.
- Practical: Assembly Language Programming, Detail study of instruction set of a microprocessor and writing simple programs.

Teaching and Learning Methods

Classroom lecture, individual and group assignments, tutorial discussions, and practical demonstrations.

Evaluation Methods

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks= $(2 \times Theory + 1 \times Practical)/3$

Recommended Readings

[1] S.Harris and D.Harris, Digital Design and Computer Architecture, 2^{nd} edition, 2012.

[2] J.L. Hennessy and D. Patterson, Computer architecture: a quantitative approach, 6^{th} edition, 2017.

[3] R.E. Bryant and D.R. O'Hallaron, Computer systems: a programmer's perspective, 3^{rd} edition, 2016.

Course Code	CSC3222
Course Title	Graph Theory
Credit value	02 (30h Theory + 70h Independent learning)
Prerequisites	None

Objective

To provide a broad understanding of graph theory and its application in various fields of mathematics and computer science.

Intended Learning Outcomes

- describe the basic definitions and concepts of Graph theory.
- determine whether graphs are Hamiltonian and/or Eulerian
- solve problems involving vertex, edge connectivity, edge colouring, planarity and crossing numbers
- model real world problems using graph theory.

Contents

- Introduction: Graphs and simple graphs, Graphs isomorphism, Incidence and adjacency matrices, Vertex degrees, Paths and connection, Cycles and the shortest path problem.
- Trees: Trees, spanning trees, Cut edges and bonds, Cut vertices, Cayley's formula and Kruskal's algorithm.
- Connectivity: Connectivity, Blocks and construction of reliable communication networks.
- Euler Tours and Hamilton Cycles: Euler tours, Hamilton cycles, Chinese postman problem and the travelling salesman problem.
- Planar Graphs: Planar graphs, Dual graphs and Euler's formula.
- Networks: Flows, Cuts, Max-Flow Min-Cut theorem and applications.
- Graph Colouring: Vertex colouring, Edge colouring, Chromatic Polynomial.

Teaching and Learning Methods

Classroom lectures, computer assisted learning, and tutorial discussions.

Evaluation Methods

In-Course Assessments	30%
End Semester Examination	70%

Recommended Readings

[1] D.B. West, An Introduction to Graph Theory, PE, 2^{nd} edition, 2015.

[2] R. Diestel, Graph Theory, Springer, 5^{th} edition, 2017.

Course Code	CSC3232
Course Title	Group Project
Credit Value	02 (200 notional hours for project development)
Prerequisites	CSC1223, CSC2222, CSC3132

Objective

To provide opportunity to synthesize knowledge from various areas of learning, and creatively apply it to real world problems.

Intended Learning Outcomes

- build links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to complete a given project task
- plan effectively to present ideas clearly and coherently to a specific audience in both the written and oral forms
- improve collaborative skills through working in a team to achieve common goals
- develop the skills in time management, team co-ordination, project management, and communication.

Contents

Students are assigned to work in project groups, with each project group having 4 to 5 members, under the supervision of a Lecturer who attached with Department of Physical Science. The groups are expected to complete the task within 15 weeks (recommended time of 200 hours for a group) where they will define the project focus, analyze and evaluate the information gathered, prepare an oral presentation, viva and submit a written report.

Teaching and Learning Methods

Group meetings, discussions with supervisors, and presentations.

Evaluation Methods

The members of the evaluation panel for the final oral presentation and viva-voce are appointed by the head of the department with the approval of the Faculty Board. The final report is evaluated by the project supervisor.

Project Report	40%
Oral Presentation	30%
Viva-voce	30%

Recommended Readings

[1] A. Stellman and J. Greene, Applied Software Project Management, 2005.
[2] I. Evans, Achieving Software Quality through Teamwork, 2004.

Course Code	ACU3212
Course Title	Management and Entrepreneurial Skills
Credit Value	02 (30h Theory + 70h Independent learning)
Prerequisites	None

Objective

To provide knowledge on basic understanding of principles of management and entrepreneurial skills and develop the ability to apply them in industries.

Intended Learning Outcomes

- define the basic management theories
- explain the evolution of management in various eras
- discuss the managerial roles, levels, functions of management
- apply managerial skills in IT organizations
- develop entrepreneurial skills in future

Contents

- Management: Definition of Management, Types of Managers, Level of managers, Managerial skills and Rolls, Evolution Theories of Management.
- Functions of Management: Planning, Organizing, Directing and Controlling.
- Entrepreneurship: Definition of Entrepreneurship, Challenges faced by the entrepreneurs in Sri Lanka, Types of Entrepreneurs, Small scale Entrepreneurs, Women Entrepreneurs.

Teaching and Learning Methods

Class room lectures, self-learning and discussion.

Evaluation Methods

In-Course Assessments	30%
End Semester Examination	70%

Recommended Readings

[1] R.L. Daft, New Era of Management, 10^{th} edition, 2012.

[2] R.W. Griffin, Management: Principles and Applications, 10^{th} edition, 2013.

[3] M. Armstrong, Armstrong's Handbook of Human Resource Management Practice, 12^{th} edition, 2012.

Course Code	ACU3222
Course Title	Research Methodology and Scientific Writing
Credit Value	02 (30h Theory + 70h Independent learning)
Prerequisites	None

Objective

To provide the theoretical and practical skills to analyze, design, implement, and present, orally and in written form, a scientific research in the area of computer science.

Intended Learning Outcomes

- analyze the relevant literatures for the selected research problem critically
- design a scientific method to solve the selected research problem
- utilize knowledge in mathematics and computer science to implement the proposed methods, produce the results and evaluate them.
- apply knowledge in scientific writing and research methodology to write a scientific report.

Contents

- Introduction: Introduction to research, Building blocks of science in research, Various steps in scientific research.
- Concepts and techniques: Concept of applied and basic research, Quantitative and Qualitative research techniques, Hypothesis development, Review of advantages and disadvantages of various data collection methods and their utility, Stability measures, Statistical techniques, Application of Statistical software package in research.
- Scientific Writing: Purpose of the written report, Structure and components of research report, Mechanism of writing a research report, Tables, Figures and Caption, Citations and References, Patents, presentation techniques, preparing slides.

Teaching and Learning Methods

Classroom lectures, group discussions, and presentations.

Evaluation Methods

In-Course Assessments	30%
End Semester Examination	70%

Recommended Readings

[1] C.R. Kothari, Research Methodology Methods and Techniques, New Age International Publishers, New Delhi, 2004.

[2] D.H. Mc Burney, Research Methods, Thomson Asia Pvt. Ltd. Singapore, 2002.

[3] J. Zobel, Writing for Computer Science, 3rd edition, 2014.

Course Code	CSH3143
Course Title	Knowledge Representation and Programming in Logic
Credit Value	03 (30h Theory + 30h Practical + 90h Independent learning)
Prerequisites	PMA1113

Objective

To provide knowledge in various techniques of knowledge representation and reasoning and to introduce programming in the PROLOG language.

Intended Learning Outcomes

- make use of knowledge in a standard representation
- utilize standard approaches to perform inference/reasoning in represented knowledge.
- model simple application domains in a logic-based language
- explain the reasoning algorithms for decision making.
- demonstrate skills in writing programs using PROLOG

Contents

- Knowledge Representation: Prepositional logic, Predicate logic, First order logic, Rules, Production system, Semantic nets, Frames, Conceptual dependency, Scripts, Description logic, Ontology Engineering, Fuzzy logic.
- Inference and Reasoning: Arguments, Validity, Forward and Backward Chaining, Rule-based Expert systems, Logical reasoning, Theorem proving by resolution.
- PROLOG: Structure of a Prolog program, Prolog interpreter, Unification, Simple programs, Backtracking, Cuts, and negation, Built-in predicates, Arithmetic expressions and operations, Lists, Recursion, Application of real world problems.
- Practical implementation of above concepts using PROLOG.

Teaching and Learning Methods

Classroom lectures, laboratory lectures, individual assignments, tutorial discussions, and practical demonstrations.

Evaluation Methods

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks= $(2 \times Theory + 1 \times Practical)/3$

Recommended Readings

[1] F.V. Harmelen, V. Lifschitz and B. Porte, Handbook of Knowledge Representation, Elsevier Science, 2008.

[2] M. Fitting, First Order Logic and Automated Theorem Proving, Springer, 2^{nd} edition, 2013.

[3] I. Bratko, PROLOG programming for artificial intelligence, 4^{th} edition, 2011.

Course Code	CSH3153
Course Title	Human Computer Interaction
Credit Value	03 (30h Theory + 30h Practical + 90h Independent learning)
Prerequisites	CSC1113

Objective

To provide knowledge to design and construct user-friendly user interfaces.

Intended Learning Outcomes

- discuss the basics of human computational abilities and limitations
- describe basic theories, tools, techniques of HCI and the interaction design paradigms
- design interactive computing systems for human with user-friendly interfaces
- identify the human factors which impact the system usability
- utilize HCI concepts to design and evaluate interfaces in web-based and desktop based applications.

Contents

- Introduction: Basic Computer Interaction Factors, Cognitive, Social, Physical, Environmental, Ergonomic Factors.
- Design: Good Design Principles, Visual and Information Design, Prototyping, Forms, Menus, Windows, Wizards, Navigations, Colours, Graphics, Ribbons, Dropdown List, Font Size, Buttons, CSS, Storyboard, Responsive Design, Conceptual Design, Task Analysis.
- Usability: Usability and Accessibility Principles and Guidelines, Localization, Internationalization.
- Evaluation: Chi-Squared Test, Heuristic Evaluation, User less and User Based Evaluation, Performance Test.
- Devices and Computing: Wearable and Gesture Computing, Augmented and Virtual Reality.
- Practical: Implementation of HCI concepts in web-based and desktop-based applications.

Teaching and Learning Methods

Classroom Lectures, laboratory lectures, individual assignments, tutorial discussions, and practical demonstrations.

Evaluation Methods

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks= $(2 \times Theory + 1 \times Practical)/3$

Recommended Readings

[1] S. Tech, Human-Computer Interaction: The Fundamentals Made Easy!, Janet Finlay, 2016.

[2] B. Shneiderman, Designing the User Interface: Strategies for Effective Human-Computer Interaction, Pearson, 6^{th} edition, 2016.

Course Code	CSH3163
Course Title	Advanced Database System
Credits	03 (45h Theory + 105h Independent learning)
Prerequisites	CSC1223

Objective

To provide knowledge on advanced physical database system design principles, distributed databases, and emerging technologies.

Intended Learning Outcomes

- explain basics of physical file structures, indexing and hashing used in database systems
- translate SQL queries into query plan tree for applying optimisation techniques
- identify tuning and physical design issues of database systems
- demonstrate the operations of transaction management techniques with examples
- discuss the concepts and principals of distributed databases and data mining and other emerging technologies of database

Contents

- File Structures, Indexing Files, and Hashing Techniques: Files, Blocks, and records, File types, Hashing, Single-level and multi-level indexes, ISAM and B+-trees, Multiple key indexes.
- Query Processing and Optimization: Evaluation of Relational operators, Introduction to query optimization, Heuristic and cost based optimizations.
- Physical database design and Tuning: Index selection, Database tuning.
- Transaction Management: Transaction Processing Concepts, Schedules, Serializability.
- Concurrency Control Techniques: Two-phase locking, Time-stamp ordering.
- Database Recovery Techniques: Recoverable schedules, Cascading schedules.
- Distributed Databases: Distributed database concepts and Architecture, Distributed database design, Fragmentation.
- Emerging Technologies: Data mining, Data Warehousing, Mobile Databases, Multimedia databases and GIS.

Teaching and Learning Methods

Class lectures, individual and group assignments, and tutorial discussions.

Evaluation Methods

In-Course Assessments	30%
End Semester Examination	70%

Recommended Readings

[1] R. Elmasri and S.B. Navathe, Fundamentals of Database Systems, Pearson, 7^{th} edition, 2015.

[2] R. Ramakrishnan and J. Gehrke, Database Management Systems, McGraw-Hill, 3^{rd} edition, 2002.

Course Code	CSH3242
Course Title	Theory of Computation
Credit Value	02 (30h Theory + 70h Independent learning)
Prerequisites	None

Objective

To provide the basic concepts in theoretical computer science, and the formal relationships among machines, languages and grammars.

Intended Learning Outcomes

- describe the mathematical foundations of computation including automata theory
- demonstrate the understanding of key notions, such as algorithm, computability, decidability, and complexity
- explain mathematical proofs for computation and algorithms.
- design finite automata, pushdown automata, Turing machines, formal languages, and grammars

Contents

- Introduction to the theory of computation: Basic concepts and definitions, Set operations, Partition of a set, Equivalence relations, Properties on relation on set, Proving Equivalences about Sets, Central concepts of Automata Theory.
- Finite Automata and Regular Expressions: Regular Expression, Operations on Regular expressions, Conversion from FA and regular expressions, Deterministic Finite Automata (DFA), Minimization of DFA, Non-Deterministic Finite Automata (NDFA), Equivalence of Deterministic and Non-Deterministic Finite Automata, Equivalence between DFA,NFA, NFA-$\vee$.
- Context-Free Grammars: Chomsky Normal Forms, Greibach normal Forms, Minimization of CFG's.
- Pushdown Automata (PDA): Deterministic and Non-Deterministic (PDA), Formal definition of NPDA, Transition functions of NPDA, NPDA Execution, Accepting Strings with NPDA, Equivalence of PDAs and CFG.
- Turing Machine: Programming Techniques for Turing Machines, Formal definition of TM's, TM's as acceptors, TM's as transducers, Recognizing Languages with TM's, Sorting with TM's, Programming in TM's, Unsolvable problems about TM and grammars, P and NP classes, NP completeness.

Teaching and Learning Methods

Classroom lectures, homework, and tutorial discussions.

Evaluation Methods

In-Course Assessments	30%
End Semester Examination	70%

Recommended Readings

[1] A.M. Natarajan and A. Tamilarasi, Theory of Computation, 2008.

[2] J. Martin, Introduction to languages and the theory of computation, 4^{th} edition, 2010.

Course Code	CSH3254
Course Title	Parallel Computing
Credit Value	04 (45h Theory + 30h Practical + 125h Independent learning)
Prerequisites	CSC1113, CSC1123

Objective

To provide knowledge on characteristics of parallel architecture and parallelism of the standard algorithms.

Intended Learning Outcomes

- describe the terminology, concepts and importance of parallel computing
- explain how various parallel hardware designed and achieve parallelism
- design various parallel algorithm for existing serial algorithmic problems
- analyse efficiency of a parallel algorithm to determine its computational bottlenecks and to optimize the performance
- evaluate the types of application for which parallel programming is useful
- utilize modern parallel computing languages to implement given parallel algorithms

Contents

- Introduction: Terminology, Parallelism, Importance of parallelism, Real world problems, Moore's Law, Power Wall, History of parallel computing.
- Parallel Architectures: Flynn's Classification, SIMD, Pipelines, MIMD, Multicore, VLIW, Superscalar, GPU, Shared and Distributed memory, Interconnection networks for parallel computers.
- Parallel algorithm Design: Decomposition, Agglomeration, Communication, Mapping, Dependency graphs, Granularity, Divide and conquer, Recursion.
- Basic Communications: One-to-all broadcast, All-to-one reduction, All-to-all broadcast, All-to-all reduction, All-reduce, Prefix sum, Scatter, and Gather.
- Parallel Algorithm Analysis: Asymptotic Analysis, Overhead, Speedup, Efficiency, Cost-Optimal, Computation on matrices, Sorting, Graph algorithms, Search algorithms, Numerical algorithms.
- Practical: Parallel implementation of the above concepts using Openmp/MPI/CUDA.

Teaching and Learning Methods

Classroom lectures, laboratory lectures, individual assignments, tutorial discussions, and practical demonstrations.

Evaluation Methods

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks=$(3 \times Theory + 1 \times Practical)/4$

Recommended Readings

[1] A. Grama, A. Gupta, G. Karypis, and V. Kumar, Introduction to parallel computing, 2^{nd} edition, Addison-Wesley, 2003.

[2] Z.J. Czech, Introduction to Parallel Computing, 1^{st} edition, Cambridge University Press, 2017.

Course Code	CSH3263
Course Title	Advanced Computer Networks
Credit Value	03 (45h Theory + 105h Independent learning)
Prerequisites	CSC2212

Objective

To provide knowledge in essential technologies and underlying theories of advanced computer networks

Intended Learning Outcomes

- describe the concepts of error detection and correction in computer networks
- demonstrate switching techniques in computer networking
- illustrate the basic techniques of wireless networking, IP Addressing, and subnetting
- identify the components required to build different types of networks
- analyze security issues in the latest advancements in networking technologies

Contents

- Error Detection and Correction: Frames, Data Link Protocols, Error Types, Error Detection, Error Correction, Flow Control, MAC, ARP, Ethernet.
- Switching: Bridges, Switches, Packet Switching, Circuit Switching, Switching Architectures, Broadcast Domain, Collision Domain, Congestion Control, Flow Control, VLAN.
- Routing: Network Layer and Its Services, IP Addressing, Subnetting, Router, Routing, Routing Principles, Routing Algorithms, basic Routing Protocols, IPv6, QoS.
- Connection Less Communication: Introduction to Transport Layer, Datagram, Reliable Data Transfer, Automatic Repeat Request, Go Back N ARQ, Selective Repeat ARQ.
- Connection Oriented Communication: TCP Protocol, Round Trip Time, Flow Control, Congestion Control.
- WAN: Overview, ISDN, Frame relay, PPP.
- Wireless Networking: Radio Frequency, Channel Allocation, Antenna, Modifications of Physical and Data Link layers, Mobile IP, Wi-Fi, Bluetooth Protocol.

Teaching and Learning Methods

Classroom lectures, laboratory lectures, and tutorial discussions.

Evaluation Methods

In-Course Assessments	30%
End Semester Examination	70%

Recommended Readings

[1] A.S. Tanenbaum and D.J. Weatherall, Computer Networks, 5^{th} edition, 2010.

[2] W. Stallings, Data and Computer Communications, Pearson, 10^{th} edition, 2013.

[3] B.A. Forouzan, Data Communication and Networking, McGraw-Hill Education, 5^{th} edition, 2012.

Course Code	CSH3273
Course Title	Artificial Intelligence
Credits	03 (45h Theory + 105h Independent learning)
Prerequisites	CSH3143

Objective

To provide sound knowledge in artificial intelligence concepts and techniques.

Intended Learning Outcomes

- discuss the core concepts and algorithms of Artificial Intelligence including searching
- define the characteristics of an intelligent agent and Characterize and contrast the standard agent architectures
- demonstrate the operations of search and NLP methods
- describe capabilities and limitations of today's robot systems, including their sensors and the crucial sensor processing that informs those systems
- change real world problems into a form solvable by AI techniques.

Contents

- Introduction to AI: Basic concepts, definition, application areas, Intelligent agents, Problems and Problem Solving, Solution for AI Problems, Problem Representation, solution spaces.
- Basic Search Strategies: Problem solving by search, Simple, Factored representation, uninformed search algorithms, Tree search and graph search, Heuristics and informed search (hill-climbing, generic best-first, A*), Genetic algorithms, searching in different environments, adversarial search, search reduction, constraints and satisfaction, mean-ends analysis, Space and time efficiency of search, Two-player games (introduction to minimax search), Constraint satisfaction.
- Planning: Representation, types of planning systems, heuristics in planning.
- Agents: Agent architectures, Agent theory, Rationality, game theory, Decision-theoretic agents, Software agents, personal assistants, and information access, Collaborative agents, Learning agents, Multi-agent systems.
- NLP: Language models, Text classification, Information retrieval and extraction.
- Robotics: State-of-the-art robot systems, sensors and sensor processing, Robot control. architectures.

Teaching and Learning Methods

Class room lectures, self-learning, computer assisted learning, individual and group discussion, and presentations.

Evaluation Methods

In-Course Assessments	30%
End Semester Examination	70%

Recommended Readings

[1] S. Russell and P. Norvig, Artificial intelligence: a modern approach, Pearson, 3^{rd} edition, 2009.

[2] G.F. Luger, Artificial Intelligence- Structures and Strategies for Complex Problem Solving, 6^{th}edition, 2009.

LEVEL 4

Course Code	CSH4112
Course Title	System Analysis and Design
Credit Value	02 (30h Theory + 70h Independent learning)
Prerequisites	CSC2222

Objective

To provide fundamental concepts and trends of Systems Analysis and Design methods and practical techniques to analyze and design an information system.

Intended Learning Outcomes

- explain the principles, methods and techniques of systems development.
- describe how systems analysts interact with users, management, and other information systems professionals.
- construct various Unified Modelling Language (UML) diagrams
- propose a phased system development methodology to implement a systems development project for a realistic problem.

Contents

- Introduction: Information systems, Properties of a system, Elements of a system, Stakeholders, Types of Information Systems, System analysis and design concepts, Traditional and modern approaches to system analysis, System analyst, System Development Life Cycle, Requirement analysis, Feasibility study.
- System Modelling: System design approaches, Application architecture and modelling, Modelling Methods, UML, Functional Modelling, Data dictionary, Context Diagram, DFD, Data Modelling, ER diagram, Behavioral Modelling, State Transition Diagram,Object Oriented Modelling, Use Case Diagram, Sequence Diagram.
- System Design: Data Design, Architecture Design, Interface Design, Component-Level Design, Deployment Design, Design Quality attributes.
- Project Management: Introduction, Causes of failed projects, project manager, Project management tools and techniques.
- Quality Assurance and Implementation: Ensuring data quality, Six sigmas, Quality assurance through software engineering, Implementing information system, System testing process.

Teaching and Learning Methods

Class room lectures, self-learning, individual and group discussions, and presentations.

Evaluation Methods

In-Course Assessments	30%
End Semester Examination	70%

Recommended Readings

[1] J.L. Whitten and L.D. Bentley, Systems Analysis and Design Methods, 7^{th} edition, Tata McGraw-Hill, 2007.

[2] K.E. Kendall and J.E. Kendall, Systems Analysis and Design, 9^{th} edition, 2013.

Course Code	CSH4123
Course Title	Bioinformatics
Credit Value	03 (30h Theory + 30h Practical + 90h Independent learning)
Prerequisites	STA1113, STA1213

Objective

To provide brief knowledge on algorithms used in Bioinformatics and System Biology, the computational techniques in biology.

Intended Learning Outcomes

- identify appropriate bioinformatics database for data collection
- demonstrate sequence analysis and string matching algorithms
- describe the concepts of biological data visualization, sequence analysis and genomics
- discuss the bioinformatics and theory of evolution and protein structures
- perform bioinformatics computing using standard tools

Contents

- Introduction: Cell, Genetics, DNA, RNA, Protein, Gene, Genome, Chromosomes.
- Biological Databases: Sequence, Genomic, Structural Databases, Genebank, RCSB.
- Biological Data Visualizations: Sequence Visualization tools and Techniques, Data Annotation.
- Sequence Analysis: DNA, RNA and Amino Acid Sequences, String Matching Algorithm, Dynamic Programming, Longest Common subsequences, Partial Digest Problem, Local, Global, Pairwise and Multiple Alignments, FASTA, BLAST, ClustalW Algorithm, Motif, Motif Finding Algorithm..
- Phylogeny: Theory of Evolution, Tree of Life, Phylogenetic Tree, Distance, Morphological, Molecular based Method, Clustering Method-UPGMA, Maximum Likelihood method.
- Proteomics: Primary, Secondary, and Tertiary Structures, Secondary Structure Prediction Methods-Propensity, Machine Learning, Hidden Markov Model, 3D Structure Prediction, Homology Modelling.
- Genomics: Gene Expression, Gene Annotation, Gene Expression Analysis, Microarray Analysis, Principal Component Analysis, Clustering, next Generation Sequencing, Drug Design, Emerging Trends.
- Practical: Python, Bioinformatics Databases, Bioinformatics tools.

Teaching and Learning Methods

Classroom lectures, laboratory lectures, individual assignments, tutorial discussions, and practical sessions.

Evaluation Methods

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks=$(2 \times Theory + 1 \times Practical)/3$

Recommended Readings

[1] J.xiong, Essential Bioinformatics, Cambridge University Press, 1^{st} edition, 2006.

[2] P. Compeau and P.A. Pevzner, Bioinformatics algorithms: an active learning approach, 2^{nd} edition, 2015.

[3] N.C. Jones and P.A. Pevzner, An introduction to bioinformatics algorithms, MIT Press, 1^{st} edition, 2004.

Course Code	CSH4133
Course Title	Digital Image Processing
Credit Value	03 (45h Theory + 105h Independent learning)
Prerequisites	None

Objective

To provide the principles, models and applications of Image processing and computer vision, and give deeper knowledge of mechanisms and algorithms in Imaging.

Intended Learning Outcomes

- define the terminology used in digital image processing
- describe the fundamental techniques for enhancing images in both spatial and frequency domain
- explain the basic algorithms of noise removal, image segmentation and colour transformation.
- utilize image processing and compute vision techniques to detect objects in images
- apply image processing algorithm or combinations of them, or modifications of them in real life image processing problems.

Contents

- Introduction: Elements of visual perception, Image Acquisition, Image Hardware and Software, Image representation, Image Sampling and Quantization, Basic Relationships between Pixels.
- Image Enhancement in the Spatial Domain: Arithmetic Operations, Set and Logical Operations, Spatial Operations, Vector and Matrix Operations, Image Transforms, Intensity Transformations, Histogram Processing, Spatial Filters (Smoothing, Sharpening).
- Image Enhancement in the Frequency Domain: Introduction to the Fourier Transform and Frequency Domain, Filtering in the Frequency Domain (Smoothing, Sharpening).
- Image Restoration: Noise Models, Noise Reduction by Spatial filtering and Frequency domain filtering.
- Colour Image Processing: Colour Fundamentals, Colour Models, Colour Transformations, Colour Image Smoothing and Sharpening.
- Morphological Image Processing: Dilation, Erosion, Opening, closing, Basic Morphological algorithms.
- Image Segmentation: Point, Line, and Edge Detection, Thresholding, Region-Based Segmentation.
- Computer vision: Shape representation, Automated Visual inspection, Object recognition, Segmentation and matching, Motion analysis, Optical flow, Applications of Computer Vision.

Teaching and Learning Methods

Classroom lectures, laboratory lectures, tutorial discussions, and practical demonstrations.

Evaluation Methods

In-Course Assessments	30% (Practical examinations)
End Semester Examination	70%

Recommended Readings

[1] R.C. Gonzalez and R.E.Woods, Digital Image Processing, Pearson, 4^{th} edition, 2017.

[2] W. Burger and M.J. Burge, Principles of Digital Image Processing: Fundamental Techniques, Springer, 2009.

Course Code	CSH4144
Course Title	Machine Learning
Credit Value	04 (45h Theory + 30h Practical + 125h Independent learning)
Prerequisites	STA1113, CSH3273

Objective

To provide a complete introduction to machine learning, supervised, un supervised and semi-supervised issues and algorithms.

Intended Learning Outcomes

- describe terminology and basic concepts used in machine learning
- demonstrate the models and algorithms related to supervised and unsupervised learning processes
- explain why a particular machine learning technique is appropriate in a given problem
- evaluate the performance of a simple learning system on a real-world dataset
- utilize the standard programming languages like Python to implement machine learning algorithms

Contents

- Introduction to Machine Learning: Machine intelligence and applications, Input, Instances and attributes, Preparing input, Gathering data, Sparse data, Attribute types, Missing values and inaccurate values.
- Decision Tree Learning: Learning trees from training examples, Entropy and information gain, ID3 algorithm.
- Supervised Learning: Rule-based learning, Naive Bayes, k-nearest neighbour, Neural networks, Support vector machines.
- Unsupervised Learning: K-means clustering, Gaussian mixture models (GMMs), EM algorithm and its application to clustering, Hierarchical clustering, Semi-supervised learning.
- Experimental Setup and Evaluation: Training and testing, Cross-validation, Confusion matrices and ROC graphs.
- Practical: Implement machine learning algorithms using Python.

Teaching and Learning Methods

Classroom lectures, tutorial discussions, and practical demonstrations.

Evaluation Methods

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks= $(3 \times Theory + 1 \times Practical)/4$

Recommended Readings

[1] C.M. Bishop, Pattern recognition and machine learning, Springer, 2011.
[2] D. Barber, Bayesian Reasoning and Machine Learning, 2012.
[3] T. Mitchell, Machine Learning, McGraw Hill, 1997.

Course Code	CSH4152
Course Title	Cryptography
Credits	02 (30h Theory + 70h Independent learning)
Prerequisites	CSC1123, PMA1213, CSC2122

Objective

To provide concepts and various techniques of cryptography and its applications.

Intended Learning Outcomes

- discuss the methods of classical cryptography and the importance for modern cryptography.
- explain the importance of prime numbers in cryptography and explain their use in cryptographic algorithms
- apply various security mechanisms derived from private-key encryption, message authentication, and hash functions to computers and computer networks
- demonstrate how public key infrastructure supports digital signing and encryption.

Contents

- Introduction and Classical Cryptography: Cryptography and Modern Cryptography, Historical Ciphers and Their Cryptanalysis, Principles of Modern Cryptography, Perfectly Secret Encryption, One-Time Pad, Shannon's Theorem.
- Private-Key (Symmetric) Cryptography: Private-Key Encryption, Concrete Approach, Asymptotic Approach, Defining Computationally Secure Encryption, Stream Ciphers, Block Ciphers, Modes of Operation, Message Authentication Codes, Hash Functions and Applications, DES, AES.
- Public-Key (Asymmetric) Cryptography: Preliminaries and Basic Group Theory, Primes, Factoring, RSA, Elliptic Curves, Key Distribution and Key Management, Public-Key Encryption, Hybrid Encryption, CDH/DDH-Based Encryption, El Gamal, RSA Encryption, Digital Signatures, RSA Signatures, Protocols, Fiat Shamir Protocol, Schnorr's protocol.

Teaching and Learning Methods

Classroom lectures, laboratory lectures, and tutorial discussions.

Evaluation Methods

In-Course Assessments	30%
End Semester Examination	70%

Recommended Readings

[1] J. Katz and Y. Lindell, Introduction to Modern Cryptography, 2^{nd} edition, 2008.

[2] C.P. Pfleeger, S.L. Pfleeger and J. Margulies, Security in Computing, Prentice-Hall, 5^{th} edition, 2015.

[3] W. Stallings, Cryptography and Network Security: Principles and Practice, 6^{th} edition, 2013.

Course Code	CSH4162
Course Title	Compiler Design
Credit Value	02 (30h Theory + 70h Independent learning)
Prerequisites	CSH3242

Objective

To provide the major concept areas of language translation and compiler design and enrich the knowledge in various phases of compilation process.

Intended Learning Outcomes

- explain the concepts and different phases of compilation with compile time error handling
- develop appropriate parser to produce parse tree representation of the input
- design lexical analyzer for a sample language
- generate intermediate code for statements in high level language

Contents

- Introduction to Compilers: Translators, Compilation and Interpretation, Language processors, Phases of Compiler, Compiler Construction Tools, Programming Language basics.
- Lexical Analysis: Need and Role of Lexical Analyzer, Lexical Errors, Symbol recognition, Expressing Tokens by Regular Expressions, Converting Regular Expression to DFA, LEX-Design of Lexical Analyzer for a simple Language, Conversion algorithm for NFA to DFA.
- Syntax Analysis: Need and Role of the Parser, Context Free Grammars, Grammar transformation, Top Down Parsing, Recursive Descent Parser, LR parsing, Construction of SLR Parsing Table, Introduction to LALR Parser, Error Handling and Recovery, Design of a syntax Analyzer for a Simple Language.
- Syntax Directed Translation and Run Time Environment: Syntax directed Definitions, Construction of Syntax Tree, Bottom-up Evaluation of S, Attribute Definitions, Design of predictive translator, Type Systems, Storage Organization, Storage Allocation, Parameter Passing, Symbol Tables, Static and Dynamic Storage Allocation, Compile time addressing, Heap.
- Code Optimization and Generation: Principal Sources of Optimization, DAG, Optimization of Basic Blocks, Global Data Flow Analysis, Efficient Data Flow Algorithms, A Simple Code Generator Algorithm.

Teaching and Learning Methods

Classroom lectures and tutorial discussions.

Evaluation Methods

In-Course Assessments	30%
End Semester Examination	70%

Recommended Readings

[1] R.K. Maurya, Compiler Design, 2011

[2] D. Grune and K.V. Reeuwijk, Modern Compiler Design, Springer, 2^{nd} edition, 2012.

[3] S.S. Muchnick, Advanced Compiler Design and Implementation, 1^{st} edition, 1997.

Course Code	CSH4173
Course Title	Numerical Linear Algebra and Finite Element Method
Credit Value	03 (45h Theory + 105h Independent learning)
Prerequisites	AMA1113, PMA2113, CSC2234

Objective

To provide knowledge in numerical methods for solving large systems of linear equations and theoretical background and applications of the Finite Element Method

Intended Learning Outcomes

- discuss the fundamental concepts in Numerical Linear Algebra
- apply the matrix factorization algorithms to solve system of linear equations
- examine the convergence of iterative methods to solve system of linear equations
- analyze the convergence of algorithms for solving Eigenvalue problems
- describe the principles and concepts related to Finite Element Methods
- apply Finite Element methods to solve engineering problems such as truss analysis and simple heat conduction problems

Contents

- Direct Methods for Linear Systems: Sparse Matrices and their representation Gauss Method, LU factorization, Elementary Hermitian matrices and Triangular Factorization
- Matrix Analysis and Iterative methods for Linear systems: Positive definite matrices, Norms and Spectral Radius, Condition and Condition number, Iterative Methods
- Eigen Value Problems: Hessenberg form Householder's Method, Power Method, QR Algorithm
- Introduction to FEM: Basic Concepts of FEM, Weak form, Integral formulations, Weak formulation, Variational Methods of approximation
- Finite Element Analysis of 1-D Problems: Second-order Boundary value problems, Basic steps of Finite Element method, Heat transfer and Fluid Mechanics applications, Bending of Beams, Euler Bernoulli beam element, Plane truss, Euler- Bernoulli frame elements.

Teaching and Learning Methods

Classroom lectures, smaller tutorial groups and seminars.

Evaluation Methods

In-Course Assessments	30%
End Semester Examination	70%

Recommended Readings

[1] Gene H. Golub and Charles F. Van Loan, Matrix Computations Johns Hopkins University Press, Baltimore, MD, USA, fourth edition, 2012.

[2] William Ford, Numerical Linear Algebra with Applications: Using MATLAB, Academic Press, 2014

[3] J.N.Reddy An introduction to the Finite Element Method, 3rd edition, 2006

Course Code	CSH4216
Course Title	Research Project
Credit Value	06 (600 notional hours for Research project development)

Objective

To develop skills on designing, implementing and reporting of scientific investigations.

Intended Learning Outcomes

- analyse critically existing literatures
- identify the research problem
- determine suitable methodology to solve the research problem
- apply various aspects of scientific theories to solve computational problems
- write a coherent scientific report
- present the results of original research to a broad audience either by poster or oral presentation

Contents

- Student should do an individual research project for 6 credits under the guidance and supervision of a Senior Lecturer.
- Supervisor should be selected by the student by discussing the research proposal and submit it to the head of the department for the approval after the proposal presentation.
- At the end of the research, student should submit a report for the evaluation and should do the viva-voce and oral presentation.
- During of the first semester of the Level four students are required select the research topic with the guidance of the supervisor and present the proposal for approval.
- Monthly Meeting with Supervisor and write Monthly Progress Report.
- The research will be carried out throughout the Level four and it is evaluated at the end of the Level four.

Teaching and Learning Methods

Supervisor meeting, discussions, and presentations.

Evaluation Methods

The members of the evaluation panel for the viva-voce and oral presentation are appointed by the head of the department with the approval of the Faculty Board. The project report is evaluated by the supervisor.

Project Report	50%
Oral Presentation	25%
Viva-voce	25%

Recommended Readings

[1] E.B. Wilson, An Introduction to Scientific Research, 1991.

[2] W.C Booth, G.G Colomb, and J.M. Williams, The Craft of Research. University of Chicago Press, 2003.

Course Code	CSH4226
Course Title	Industrial Training
Credit Value	06 (600 notional hours)

Objective

To provide opportunities for students to apply the computing knowledge, develop and consolidate practical computing skills, and develop an understanding of the relevant profession and to promote cooperation and to develop synergetic collaboration between industry and the university in promoting a knowledgeable society.

Intended Learning Outcomes

- improve their self-confidence and computing skills
- develop their negotiation, leadership and teamwork skills
- describe the management and business practices, the responsibilities of an employee, ethical issues and operational safety
- apply learning methods such as design and problem solving to develop technical, interpersonal and communication skills, both oral and written

Contents

The student will be allocated an industrial supervisor. In addition, a academic supervisor will be appointed by the department. The student visits the relevant industry to discuss with the industrial supervisor about any project or assignment/tasks. They try to learn the systems - objectives, organization, administrative process, progress of ongoing projects, problems faced by, practical issues if any, etc. in the industry. They record all the work done and knowledge gained by maintaining a Daily Diary. The academic supervisor will provide ongoing support to the student. The academic supervisor will visit typically two to three times during the training period to ensure that the training objectives are being met and that progress is satisfactory.

Teaching and Learning Methods

There are no mandatory formal teaching arrangements for this module: however it is normally expected that the host company will provide appropriate training as may be required to support the student during their work. The students should communicate the assigned academic supervisor every week via email to discuss the progress. Students are expected to demonstrate quantifiable understanding and personal development both during and at the conclusion of the placement.

Evaluation Methods

The members of the evaluation panel for the final oral presentation are appointed by the head of the department with the approval of the Faculty Board. The daily diary is evaluated by the industrial supervisor. The final report is evaluated by the academic supervisor.

Daily diary	30%
Final Report	40%
Oral Presentation	30%

Appendix B

Detailed Syllabus

Bachelor of Science Honours in Environmental Science

LEVEL 1

Course Title	**Fundamentals in Environmental Chemistry**
Course Code	**ENS1112**
Credit Value	2 (30h Theory+70h Independent learning)

Aim

To provide basic knowledge on environmental chemistry to understand the role of chemistry in environment

Intended Learning Outcomes

- Illustrate the nature of the chemical bonds, molecules and compounds
- Explain the types of solutions, solvents and their chemical nature
- Extend the chemical reactions and stoichiometry
- Discuss the basic chemical components of living things – proteins, carbohydrate, lipids and nucleic acids
- Discuss the chemical basis of spheres

Course Contents

Introduction to environmental chemistry, matter and materials, atoms and elements, chemical bonds, molecules and compounds, chemical reactions, equations and stoichiometry, acid bases and salts, solution and solvents, organic chemistry – organic contaminants in the environment, environmental biochemistry, chemical basis of spheres, introduction to green chemistry.

Teaching and Learning Methods

Lectures with whiteboard and marker, presentations, use of LMS, video clips, and open-book studies.

Evaluation Methods

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

References

John, W. (2003) *Environmental chemistry.* 1^{st} Ed. London: Psychology Press.

Stanley, E.M. (2011) *Fundamentals of environmental chemistry.* 3^{rd} Ed. NY: CRC Press.

Course Title	**Analysis of Chemical Elements and Compounds**
Course Code	**ENS1121**
Credit Value	1 (30h Practical+20h Independent learning)

Aim

To develop the basic laboratory skills in qualitative analysis of chemical elements and compounds.

Intended Learning Outcomes

- Demonstrate the acid base titration
- Demonstrate the skills in qualitative analysis organic compounds
- Develop the skills to identify the cations and anions in a compound
- Demonstrate the methods of elemental and functional group analysis of organic compounds
- Develop the skills to find out the melting point of an organic compound

Course Contents

Introduction to handling of laboratory equipment and glassware, acid-base titration, qualitative analysis of anions and cations, elemental and functional group analysis of organic compounds, identify the melting point of compounds.

Teaching and Learning Methods

Demonstrations of practical/s and practicing with analysis procedures.

Evaluation Methods

In-course Assessment (Practical assignments)	40%
End-semester Examination (Practical)	60%

References

Frederick, G.M. and Saundres, B.C. (1960) *Practical organic chemistry.* 4^{th} Ed. NY: Longman Inc.

Murthy, C.P (2008) *University chemistry.* Volume 1. India: New Age International.

Course Title	**Cell and Molecular Biology**
Course Code	**ENS1132**
Credit Value	2 (25h Theory+10h Practical+65h Independent learning)

Aim

Understand the basics of cell and molecular biology and acquire knowledge for the future perception within the contexts of environmental science.

Intended Learning Outcomes

- Illustrate the ultra-structures of cellular organelles and cell junctions
- Discuss DNA replication and protein synthesis of prokaryotes and eukaryotes
- Explain the cell division patterns and types with respect to plant and animal cells
- Demonstrate the techniques for visualizing cellular structures and chromosomes
- Discuss the application of molecular biology in Environmental Science

Course Contents

Theory: Cell Biology (cell organization and cell structure, chemical constituents of cells), differences in plant and animal sub-cellular organelles (nucleus, nucleolus, mitochondria, chloroplast, ribosome, lysosome, vacuoles, centrioles, flagella and cilia, golgi bodies and dictiozomes), structure and function of cell membrane, transport of molecules through cell membrane, cell membrane receptors and cell junctions, cell cycle, cell divisions (mitotic and meiotic), genetic material and DNA replication (chromosome structure and gene organization in prokaryotes and eukaryotes), semiconservative model an overview of bacterial and eukaryotic DNA replication, prokaryotic and eukaryotic protein synthesis (initiation, elongation and termination factors), mutagenesis and hormonal changes (chromosomal aberrations, point mutations, introduction to gene sequencing and bioinformatics).

Practical: Microscopy and staining techniques, cell measurements and counting, cell and cell organelles, cell division (mitosis and meiosis), karyotyping and mutations, introduction to molecular laboratory accessories.

Teaching and Learning Methods

Lectures with whiteboard marker, presentations, use of LMS, video clips, and group activities and discussions.

Evaluation Methods

Theory:

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

Practical:

End-semester Examination (Practical)	100%

Final marks = {(5×Theory)+(1×Practical)}/6

References

Harvey, L., Arnold, B., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell, J. (1999) *Molecular Cell Biology.* 4^{th} Ed. W.H.Freeman.

Raven, P. and Jhonson, G. (2002) *Biology.* 6^{th} Ed. McGraw-Hill.

Course Title	**Plant Biology**
Course Code	**ENS1142**
Credit Value	2 (20h Theory+30h Practical+50h Independent learning)

Aim

To provide conceptual knowledge on the identification and classification of plants on the aspect of plant diversity as part of scientific environmental investigations.

Intended Learning Outcomes

- Summarize the evolutionary and phylogenetic relationships among the diverse groups of plants
- Demonstrate the skills to identify the different groups of algae, bryophytes, pteridophytes, gymnosperms and angiosperms using their characteristic features
- Outline the growth of plants, photochemical and biochemical reactions during photosynthesis and respiratory pathways in plants
- Explain the absorption and transportation/translocation mechanism of water and nutrients in plants
- Discuss the water stress on plants and the use of anti-transpirant

Course Contents

Theory: Phylogeny relationships of the major groups of plants, morphology and reproduction of angiosperms, taxonomic study of angiosperms, economic importance of plants, plant growth and development, photosynthesis and gas exchange, respiration, plant water relations, anti-transpirants and mineral nutrition, assimilation and its deficiency and toxicity symptoms in plants.

Practical: Study the morphological characters of plants, observe the different modifications, field collection and herbarium techniques, study the importance families and their characters, physiological and anatomical differences between C_3 and C_4 plants, different types of stomata in plants, physiological process of plants.

Teaching and Learning Methods

Lectures with whiteboard and marker, tutorials, presentations, use of LMS, group activities, video clips and field visits.

Evaluation Methods

Theory:

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

Practical:

End-semester Examination (Practical)	100%

Final marks = {(2×Theory)+(1×Practical)}/3

References

Gottlieb, H. (1914) *Physiological plant anatomy.* London: Macmillan.

Khan, A. (2001) *Plant anatomy and physiology.* India: Kalpaz Publications.

Peter, H.R., Ray, F.E. and Susan, E.E. (2005) *Biology of Plants* 7^{th} Ed. NY: W.H. Freeman.

Purves, W.K., David, E.S., Orians, G.H. and Hell, H.C. (1998) *Life: The Science of Biology.* 7^{th} Ed. NY.

Course Title	**Fundamentals of Animal Biology**
Course Code	**ENS1153**
Credit Value	3 (30h Theory+45h Practical+75h Independent learning)

Aim

Understand the importance of animal biology in term of diversity, evolution and environmental adaptations.

Intended Learning Outcomes

- Outline animal systematics
- Identify animals from protozoans to mammals
- Discuss the major characteristics of each phylum
- Analyze evolutionary links of the animal kingdom in relation to plate tectonics
- Compare environmental adaptations of major taxa
- Discuss the economic importance of Sri Lankan fauna

Course Contents

Theory: Introduction to levels of organization and orientation, systematics, ontogeny, concept of species, evolution and phylogenetic relationship among different phyla in the animal kingdom, animal adaptations to different environment (habit and habitat), environmental importance such as diseases, environmental indicators, economic importance of animals (eco-tourism), geological time scale, zoogeography, endemism and endemic animals of Sri Lanka.

Practical: Identification of animals with specimens and drawings, non-chordates (unicellular animals, poriferance, coelenterates, platyhelminthes, nematodes, annelids, arthropods, molluscs and echinoderms), chordates (urochordata, cephalochordate), vertebrates (fish, amphibians, reptiles, birds and mammals), field visits to nearby ecosystems to identify as many animals as possible, understanding zoogeography with plate tectonics.

Teaching and Learning Methods

Lectures with whiteboard and marker, presentations, use of LMS, video clips, documentaries, discovery/scientific movies, group activities and discussions, practical, tutorials and assessments, and field visits.

Evaluation Methods

Theory:

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

Practical:

End-semester Examination (Practical)	100%

Final marks = {(2×Theory)+(1×Practical)}/3

References

Barnes, R.D., Ruppert, E.E. and Fox, R.S. (2003). *Invertebrate Zoology.* 7^{th} Ed. Brooks Cole.

Donald L. (2001) *Vertebrate Biology.* Boston: McGraw-Hill.

Young, J.Z. (1983) *The life of Vertebrates.* 3^{rd} Ed. UK: Oxford University Press.

Course Title	**Basic Mathematics**
Course Code	**ENS1162**
Credit Value	2 (30h Theory+70h Independent learning)

Aim

To provide the students with the basic knowledge on advanced mathematical operations.

Intended Learning Outcomes

- Outline the basic principles and components of trigonometry
- Identify the components of complex numbers
- Solve the problems using Indices and logarithms
- Outline the basic concepts of limits and its useful applications
- Solve the problems of integration and differential equations

Course Contents

Basic Mathematics (basic trigonometry, real numbers and complex numbers), indices and logarithms, co-ordinate systems, differentiations, maxima and minima, integration, solution of simple differential equations.

Teaching and Learning Methods

Lectures with whiteboard and marker, use of LMS, and textbooks.

Evaluation Methods

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

References

Bostock, L. and Chandler, S. (1988) *Mathematics – The core course for A-Level*. Great Britain: The Bath Press.

Bostock, L. and Chandler, S. (1990) *Pure Mathematics*. UK: Stanley Thornes (Publishers) Ltd.

Course Title	**Fundamentals of Information Technology**
Course Code	**CCCU1113**
Credit Value	3 (30h Theory+30h Practical+90h Independent learning)

Aim

To provide the basic concepts in information technology to solve simple real word problems and knowledge of information technology components, software and to use internet and email.

Intended Learning Outcomes

- Explain terms and concepts of information technology
- Summarize the characteristics and representations of data
- Define the essential elements of the computer's architecture
- Compare different operating systems
- Name components of computer networks and its model
- Solve simple problems using information technology

Course Contents

Theory: Introduction to computer systems (evolution of computers, classification of modern computers), representation of data (number systems, binary arithmetic, signed integer representation, floating point representation), computer hardware (input/output devices, CPU organization, storage devices, expansion cards, and system interfaces), computer software (Operating systems, utility programmes, application software), algorithm, pseudo code, flowchart, concepts of programming, web design tools/HTML, viruses, malware, computer network (use of network, communication media, network devices, types of networks), boolean algebra and digital logic (boolean expressions, simplification and Karnaugh maps, logic gates), system maintenance and troubleshooting (PC maintenance tools, troubleshooting guidelines, upgrading a system).

Practical: Microsoft Word, Excel, PowerPoint, and operating systems (Windows and Linux), introduction to Matlab, HTML, internet and email, role of IT in society, e-learning, e-banking, social issues, ethics and standards in computing, intellectual property right.

Teaching and Learning Methods

Theory, tutorial discussions and computer-based practical sessions

Evaluation Methods

Theory:	
In-course Assessment	30%
End-semester Examination	70%
Practical:	
In-course Assessment (Practical)	40%
End-semester Examination (Practical)	60%

Final mark = {(2×Theory)+(1×Practical)}/3

References

Linda, N. and Lodur, J. (2015) *Essentials of Computer Organization and Architecture.* 4^{th} Ed. USA: Jones & Bartlett Learning.

Mueller, S. (2015) *Upgrading and Repairing PCs.* 22^{nd} Ed. Que Publishing.

Course Title	**English Language I**
Course Code	**ACU1113**
Credit Value	3 (45h Theory+105h Independent learning)

Aim

To provide necessary language skills to read, write, listen and speak in English in formal and informal academic and professional contexts.

Intended Learning Outcomes

- Acquire the fundamental knowledge on the use of the four skills – speaking, listening, reading and writing
- Identify the semantic and pragmatic forms and meanings for contextual application
- Demonstrate efficiency and effectiveness in both receptive and expressive skills
- Create distinct style and rhetoric orally, aurally, graphically, and grammatically
- Apply language competencies to language performance with contextual relevance

Course Contents

At the intermediate level: reading skills, identifying main points, understanding vocabulary, introducing the mechanics of writing, introducing vocabulary in and around the university environment, developing sentences and paragraphs, transferring graphic, pictorial information into writing, preparing to write an essay or a project, describing objects, interviewing, giving instructions, making short speeches, listening to discriminate sounds, listening for specific information, listening and responding to telephone conversion, introducing structures, question formation, articles, preposition, pronouns, quantifier, word class, active and passive, topics to be selected from student's field of interest, submission of individual projects.

Teaching and Learning Methods

Classroom lectures, self-learning, computer assisted language learning, individual, and group discussion and presentation.

Evaluation Methods

In-course Assessment (Listening and speaking)	30%
End-semester Examination (Reading, writing and language structures)	70%

References

Alison, P., Eric, G. and Lewis, L. (2013) *Oxford English for Careers Technology for Engineering and Applied Sciences: Student Book*. UK: Oxford University Press.

Miles, C., Craig, T. and Sally, L. (2016) *Cambridge English Skills: reading. Writing, listening and speaking from Elementary Advanced*. UK: Cambridge University Press.

Murphy, R. (2012) *Essential English Grammar*. UK: Cambridge Publications.

Course Title	**Environment and Agriculture**
Course Code	**ENS1212**
Credit Value	2 (30h Theory+70h Independent learning)

Aim

To enable the students to understand the impact of agriculture and its effect on the environment and viceversa.

Intended Learning Outcomes

- List the different agroecological zones demarcated within the country and its characteristics and suitability for agriculture
- Explain the concepts and the practical approaches towards environmentally friendly agriculture
- Discuss the influence of climate on crop production and livestock production and apply the knowledge for commercialised agriculture
- Apply the knowledge of adaptation and mitigation measures of climate change on food security
- Explain zoonosis and zoonotic diseases in human with relation to livestock farming (management)

Course Contents

Agro-ecological zones, farming system, traditional versus modern farming techniques, protected agriculture, precision farming, organic farming, organic fertilizers and organic pesticides, bio-fertilizers and bio-pesticides, indicators for sustainable agriculture, integrated pest management, integrated nutrient management, impact of climate change on agriculture, impact of agriculture on environment, impact of livestock on natural resources and environment, livestock as vectors of diseases, integrated farming.

Teaching and Learning Methods

Presentations using multimedia, textbook studies, video clips, documentary CDs, presentations by the students, and use of LMS.

Evaluation Methods

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

References

Balachandra, P. and Sudhakara R.B. (2006) *Energy, Environment and Development:A Technological Perspective.* New Delhi: Narosa.

Raymond and Poincelot (1986) *Toward a More Sustainable Agriculture.* 1^{st} Ed. USA: AVI Publishing Co, inc.

Senaratne, A., Perera, N. and Wickramasinghe, K. (2009) *Mainstreaming Climate Change for Sustainable Development in Sri Lanka: Towards A National Agenda for Action.* Sri Lanka: Institute of Policy Studies of Sri Lanka.

Course Title	**Soil Science**
Course Code	**ENS1223**
Credit Value	3 (30h Theory+45h Practical+75h Independent learning)

Aim

To provide the knowledge on principles of environmental soil science and to develop the skills adopting the practices in effective soil fertility management.

Intended Learning Outcomes

- Identify the minerals and rocks
- Discuss the processes of weathering and soil formation and the properties of soils
- Discuss the causes and effects of problem soils
- Explain the appropriate reclamation techniques for problem soils
- Develop the skills on soil fertility management and conservation
- Analyze physical, chemical and biological properties of soils

Course Contents

Theory: Minerals and rocks (formation, classification and properties), rocks of Sri Lanka, rock weathering and soil formation, soil physical, chemical and biological properties, soil profile, soil taxonomy, soils of Sri Lanka, importance of soil fertility parameters, evaluation/assessment of soil fertility, soil problems and reclamation techniques, soil pollution and its effects, reclamation options for soil pollution, agronomic and mechanical soil conservation methods, soil conservation act, behavior/fate of fertilizers and amendments in soils.

Practical: Study the physical properties of minerals and rocks, soil sampling equipment, collection and preparation of soil sample, analyze the soil properties, properties of soil contaminants.

Teaching and Learning Methods

Lectures, presentations, use of LMS, discussions and field-based studies, and practical lessons with discussions and Case studies.

Evaluation Methods

Theory:

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

Practical:

End-semester Examination (Practical)	100%

Final marks = {(2×Theory)+(1×Practical)}/3

References

Dharmakeerthi, R.S., Kumaragamage, D. and Indraratne, S.P. (2007) *Manual of Soil Sampling and Analysis*. Sri Lanka: Soil Science Society of Sri Lanka.

Khopkar, S.M. (2004) *Environmental Pollution: Monitoring and control*. 1st Ed. New Delhi: New Age International.

Kolay, A.K. (1993) *Basic Concepts of Soil Science*. New Delhi: Wiley Eastern Limited.

Course Title	**Environmental Sanitation**
Course Code	**ENS1232**
Credit Value	2 (25h Theory+15h Practical+60h Independent learning)

Aim

To provide knowledge to understand the sanitary issues in environment, different health and legal aspects of environmental sanitation and the role of environmental sanitation in effective environmental management.

Intended Learning Outcomes

- Identify the sanitary issues in rural and urban environment
- Summarize the causes for the sanitary and health issues in the environment
- Explain the communicable diseases due to poor sanitary practices
- Apply the concepts in environmental sanitation for effective environmental management
- Formulate the strategies and solutions for the sanitary issues

Course Contents

Theory: Introduction to environmental sanitation/health and its importance to the community, identifying the rural and urban sanitary issues related to the disposal and management of wastewater and solid waste – such as spread of communicable diseases (due to such poor sanitary practices especially at cattle farms, hospitals, etc.), diseases transmitted by vectors (insects, flies, mosquitoes, rats and rodents, etc.), epidemic-endemic-pandemic-sporadic diseases, mode of infection and transmission and its eradication methods, developing environmental strategies to improve urban and rural sanitation via planning and designing of a proper sanitary water supply scheme, proposing a proper rural and urban waste management system at low cost, introducing green building concept to improve indoor sanitation.
Practical: Field visits and reports in assessing the local and national sanitary issues in the field.

Teaching and Learning Methods

Lectures with whiteboard and marker, presentations, use of LMS, tutorial discussion, open-book studies, field visits, practical demonstrations, handouts, and lecture notes.

Evaluation Methods

Theory:

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

Practical:

In-course Assessment (Practical reports)	100%

Final marks = {(Theory×5)+(Practical×1)}/6

References

Baljeet, S.K. (2001) *Environmental sanitation* 2^{nd} Ed. New Delhi: S. Charles & company.

Das, P.C. (2011) *Environmental Biology* 1^{st} Ed. New Delhi: AITBS.

Course Title	**Principles of Economics**
Course Code	**ENS1242**
Credit Value	2 (30h Theory+70h Independent learning)

Aim

To provide the basic conceptual knowledge on the microeconomics and macroeconomics.

Intended Learning Outcomes

- Explain the principles of microeconomics and macroeconomics
- Explain the consumer behaviour relating to the theories of demand and supply
- Illustrate the cost concepts
- Show the concept of marginality graphically
- Explain the welfare theory

Course Contents

Microeconomics and welfare theory (introduction to economics, market economy), demand (consumption), supply – production (markets and the price mechanism), nature of demand and supply curves, schedules, consumer behavior, price determination, utility, marginality concepts, welfare theory, nature of cost curves, principles of macroeconomics.

Teaching and Learning Methods

Lectures with whiteboard and marker, handouts and lecture notes, and tutorials

Evaluation Methods

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

References

Ahuja, H. (2013) *Modern Microeconomics*. 5^{th} Ed. New Delhi: S. Chand and Company Ltd.

David, C.C. (1998) *Macroeconomics*. Gary Burke.

Robert, S.P. and Daniel, L.R. (2000) *Microeconomics*. 5^{th} Ed. USA: Prentice Hall, Upper Saddle River, New Jersey.

Robert, H.F. (2008) *Microeconomics* and behavior. USA: McGraw-Hill/Irwin.

Samuelson, P.A. and William, D.N. (1992) *Economics*. 19^{th} Ed. USA: McGraw-Hill.

Course Title	**Earth and Atmospheric Sciences**
Course Code	**ENS1253**
Credit Value	3 (45h Theory+105h Independent learning)

Aim

To provide knowledge on earth and atmospheric science and enable the students to apply the knowledge on environmental changes within the context of environmental science.

Intended Learning Outcomes

- Outline the earth system
- Describe the structure of earth
- Explain the phenomenon of earth system changes
- Describe the forms of meteorological changes
- Evaluate the types of meteorological measurement techniques
- Illustrate the harmful impacts of atmospheric changes

Course Contents

The earth (origin of the earth, earth structure and the solar system, earth quakes, volcanoes, thermal and electrical properties of earth), hydrosphere (hydrological cycle), the oceans (physical changes due to temperature, salinisation and living organisms, physical properties of sea water and pure water, ocean currents, ocean waves and tides), atmosphere (chemical composition of the atmosphere, upper atmosphere, radiation energy balance, clouds formation and classification, atmospheric optics), meteorology (wind, monsoons, thunder storms, cyclones, tornadoes, hurricanes, lightning and thunder, lightning protection), meteorological instruments and observation, measurement of meteorological parameters, world climate, climate records, climate variability and forecasting.

Teaching and Learning Methods

Lectures with whiteboard and marker, presentations, use of LMS, group discussions, and video clips.

Evaluation Methods

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

References

Christina, R. (2008) *Earth Science: Decade by Decade.* NY: Facts on File.

Michael A. and Ailsa, A. (1999) *A Dictionary of Earth Sciences.* 2^{nd} Ed. UK: Oxford University Press.

Parkinson, C.L, Ward, A. and King, M.D. (2006) *Earth Science Reference Handbook-A Guide to NASA's Earth Science Program and Earth Observing Satellite Missions.* Washington, DC: NASA.

Course Title	**Fundamentals in Environmental Microbiology**
Course Code	**ENS1263**
Credit Value	3 (40h Theory+15h Practical+95h Independent learning)

Aim

To provide knowledge in microbiology and to develop skills in basic micro biological techniques within the context of environmental science.

Intended Learning Outcomes

- Identify the microorganisms based on morphological characters
- Demonstrate the practical skills in fundamental microbiological techniques and acquire the habit of good lab practices
- Demonstrate the microbiological techniques related to isolation of microorganisms
- Develop the knowledge about basic biochemical and molecular identification methods of microorganism
- Explain the microbial growth and the factors influencing the microbial growth
- Explain the interactions of microorganisms with human and their applications in environmental management, agriculture, food production and various industries

Course Contents

Theory: Microbial community in the environment, cell wall of bacteria and Gram staining mechanism, microbiological technique related to isolation and cultivation storage of culture biochemical, morphological and molecular identification of bacteria, culture media, anaerobic culture technique, bacterial growth curve and measurement of growth, air-borne microorganisms, soil microorganism, food microorganism and water-born microorganism, role of microorganisms in food processing, agriculture, environment and industry role of soil microorganisms in soil fertility, food spoilage.

Practical: Introduction to microbiological equipment, sterilization techniques in microbiology, plate preparation, isolation methods, study of airborne microbes, methylene blue reduction test in milk, and enumeration of bacteria from water sample by MPN method, measurement of microbial growths, staining technique in microbiology.

Teaching and Learning Methods

Lectures, presentations, use of LMS, tutorial discussions, group discussions, Open-book studies, field visits, practical demonstrations, video clips, handouts, and lecture notes.

Evaluation Methods

Theory:

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

Practical:

In-course Assessment (Practical reports)	40%
End-semester Examination (Practical)	60%

Final marks = {(Theory×8)+(Practical×1)}/9

References

Barrow, G.I. and Felthman, R.K.A. (1993) *Cowman and Steel for the identification of medical bacteria.* 3^{rd} Ed. London: Cambridge University Press.

Bisen, P.S. and Verma, K. (1998) *Hand Book of Microbiology.* 1^{st} Ed. New Delhi, India: CBS Publisher.

Susan, G.K. and Frederick, J.P. (2008) *Basic microbiological technique.* 4^{th} Ed. NY: Star Pub Co.

Course Title	**Social Harmony and Active Citizenship**
Course Code	**ACU1212**
Credit Value	2 (100h Notional learning)

Aim

To provide basic knowledge in social concepts, human rights and the importance of social harmony in a multicultural and multiethnic society and to identify their own cultural traits through engagement with people from different cultures to work with the society through different projects and contribute for the sustainable development in regional, national and global perspectives.

Intended Learning Outcomes

- Define peace building processes in terms of cultivation of peace culture
- Explain the need for the harmony among different ethnic groups for the sustainable development
- Develop the motivation to work as a team with the community with understanding
- Recognize as socially and environmentally responsible citizen
- Evolve themselves to work in the community level projects

Course Contents

Steps to peace building, activity based session to enhance and build social harmony, political reform and devolution of powers, sustainable peace process, participation of the grass root level society in the peace process, cohabitation among political parties and forces, effectively handling pressure groups. Introduction about Active citizens: learning journey of active citizens, role of active citizens in universities and colleges, understanding individual, culture, society and citizen, local and global active citizenship, understanding our place in society and the world: local and global citizenship, planning, delivery and need assessment for environmental projects, influencing skills (dealing with people in power, understanding conflicts, conflict resolution, gender sensitization, avoiding misunderstandings), introduction to non-violent communication, understanding yourself, understanding the culture that you grow up in, understanding how to get to know people that are different from you, How to dialogue with others, understanding how your society is structured, recognizing how some people need help and support, creating a project, developing a team, working together in team.

Teaching and Learning Methods

Learning by doing themselves with the guidance of facilitators.

Evaluation Methods

In-course Assessments (Peer evaluation)	50%
Proposal presentation	20%
Final presentation	30%

References

Bush, K. (2003) *The Intra Group Dimensions of Ethnic Conflict in Sri Lanka.* NY: Palgrave Macmillan.

Packham, C. (2008) *Active Citizenship and Community Learning.* Learning Matters.

Winslow, D. and Michael, D.W. (2004) *Economy Culture and Civil Wars in Sri Lanka.* Bloomington: Indiana University Press.

LEVEL 2

Course Title	**Biodiversity and Conservation**
Course Code	**ENS2112**
Credit Value	2 (25h Theory+15h Practical+60h Independent learning)

Aim

To understand the importance/s of biodiversity and its conservation in environmental management.

Intended Learning Outcomes

- Explain the concept of conservation of biodiversity
- Develop the knowledge of biodiversity conservation methods of these fauna and flora
- Develop the sustainable ecosystem using the knowledge on biodiversity and conservation
- Explain the threats to biodiversity and the species extinction.
- Outline the legislative procedures in biodiversity and conservation

Course Contents

Theory: Introduction to biodiversity (in terms of genetic diversity, species diversity and ecosystem diversity), values, importance and sustainable uses of biodiversity, threats to biodiversity globally and locally, conservation strategies of biodiversity (*In-situ* and *ex-situ* conservation, special concern to Sri Lanka), red listing (global and national conservation activities), national and international legislations for biodiversity conservation, introduction to national and global regulatory mechanisms for the conservation of biodiversity, introduction to biodiversity related field techniques (scientific method, evidence-based conservation, and biodiversity assessment and monitoring, environmental education, participatory rural appraisal), concept of biodiversity hotspots (promotion or demotion), biodiversity index and species richness.

Practical: Measuring biodiversity, biodiversity assessment, floral sampling techniques, advanced field techniques and software in biodiversity studies.

Field excursions – to a national park to explore the biodiversity conservation and management practices and practical experience of biodiversity related field techniques.

Teaching and Learning Methods

Lectures with whiteboard and marker, presentations, use of LMS, video clips, group activities and discussions, field visits and activities, Tutorials and assessments.

Evaluation Methods

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

References

Das, P.C. (2011) *Environmental Biology.* 1^{st} Ed. New Delhi: Aitbs Publishers.

Gaston, K.J. and Spicer, J.I. (1998) *Biodiversity: An Introduction.* UK: Blackwell Science.

Hill, D. *et al.* (2005) *Handbook of Biodiversity Methods Survey, Evaluation and Monitoring.* NY: Cambridge University Press.

Sodhi, N.S. and Ehrlich, P.R. (2010) *Conservation Biology for All.* UK: Oxford University Press.

Sodhi, N.S., Gibson, L. and Raven, P.H. (2013) *Conservation Biology: Voices from the Tropics.* UK: Wiley-Blackwell, Oxford.

Course Title	**Food, Nutrition and Environment**
Course Code	**ENS2123**
Credit Value	3 (40h Theory+15h Practical+105h Independent learning)

Aim

To provide knowledge to understand proper diet pattern and nutrition to build up healthy community.

Intended Learning Outcomes

- Explain the biochemical functions and metabolism of nutrition
- Describe nutrition profile of food sources, preservation methods and effects of processing on nutrition
- Design nutrition interventions based on their knowledge in nutrition and healthy diet pattern for the prevention of nutrition related disorders
- Relate the environment with food quality and nutritional related health issues
- Demonstrate the practical skills in basic laboratory-oriented analysis of food and field based studies
- Evaluate the nutritional status of community by nutritional assessment methods

Course Contents

Theory: Macro and micro nutrition, nutrition metabolism lipoprotein, nutritional values of food and effects of processing/cooking, nutritional problems in public with special reference to Sri Lanka, remediation and control, nutritional programs in Sri Lanka, non-communicable disease, food facts for healthy life style, balanced diet, BMI (Body Mass Index), food fortification, food adulteration, food anti-oxidant, functional food, fermented food, food pyramid, assessing nutritional status in community and assessment methods, nutritional status indicators, nutritional surveillance, food and environment (link between environment, food quality and diseases, nutrition related health problems such as malnutrition, infectious disease and contamination due to environmental degradation), quality changes of food due to environmental ill health, food web and food chain.

Practical: Testing for carbohydrates, lipids, and protein compounds, vitamins, qualitative test for adulterants in fresh milk, determinations of vitamin C, measurement of brix value of food sample, determination of phosphorus, fermented food production, measurement nutritional status of pre-schoolchildren (anthropometric measurements), field visits, prepare nutritional assessment reports.

Teaching and Learning Methods

Lectures with whiteboard and marker, presentation, tutorial discussion, group discussions, open-book studies, practical demonstrations, poster presentation by students, handouts and lecture notes, use of LMS, and field visit.

Evaluation Methods

Theory:

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

Practical:

In-course Assessment (Assignments/Practical reports)	20%
End-semester Examination (Practical)	80%

Final marks = {(Theory×8)+(Practical×1)}/9

References

Carolyn, D.B., Johanna, T. and Dwyer, D.H. (2013) *Handbook of nutrition and food.* 3^{rd} Ed. USA: CRC Press.

Rahman, S. (2007) *Handbook of food preservation.* 2^{nd} Ed. USA: CRC Press.

Wikeramanayake, T.W. (2002) *Food and Nutrition.* 2^{nd} Ed. Sri Lanka: Hector Kobbekaduwa Agrarian Training Institute.

Course Title	**Analytical Chemistry**
Course Code	**ENS2132**
Credit Value	2 (25h Theory+10h Practical+65h Independent learning)

Aim

To develop theoretical and practical skills in analytical chemistry within the contexts of environmental science.

Intended Learning Outcomes

- Outline the basic principles and theories in analytical chemistry
- Explain different types of quantitative analysis techniques in analytical chemistry
- Compare the merits and demerits of different analytical techniques
- Demonstrate different types on laboratory experiments in analytical chemistry
- Explain the advanced analytical techniques

Course Contents

Theory: Titrimetry, gravimetric analysis, introduction to analytical separations (distillation, extraction, chromatography), electro chemical methods of analysis – potentiometry, coulometry, voltammetry, and conductometry), radio chemical method of analysis (isotopic analysis, activation analysis, radio carbon dating), spectroscopic method of analysis – UV-visible and infrared spectrophotometry, atomic absorption spectroscopy, atomic emission spectroscopy, molecular photoluminescence spectroscopy.

Practical: Titrimetric analysis, spectroscopic analysis

Teaching and Learning Methods

Lectures, presentations, use of LMS, laboratory experiments with discussions, laboratory visits.

Evaluation Methods

Theory:

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

Practical:

End-semester Examination (Practical)	100%

Final marks = {(5×Theory)+(1×Practical)}/6

References

Christian, G.D. (2004) *Analytical chemistry.* 6^{th} Ed. New Delhi: New Delhi Wiley India.

Kealey, D. and Haines, P.J. (2002) *Instant Notes Analytical Chemistry.* 1^{st} Ed. New Delhi: New Delhi Viva Books.

Skoog, D.A., West, D.M. and Holler, F.J. (2004) *Fundamentals of Analytical Chemistry.* 8^{th} Ed. New Delhi: Delhi Cengage Learning.

Verma, R.M. (1994) *Analytical Chemistry: Theory and Practice.* 3^{rd} Ed. New Delhi: CBS Publishers.

Course Title	**Animal Behavior**
Course Code	**ENS2142**
Credit Value	2 (25h Theory+15h Practical+60h Independent learning)

Aim

To understand the animal behavior and population dynamics for effective environmental management and conservation.

Intended Learning Outcomes

- Discuss the various behavioral patterns in organisms
- Demonstrate the ethological experiments
- Develop the skills to understand the nature of animal behavior and prepare ethogram
- Develop the skills in population estimation and monitoring techniques
- Apply the knowledge of wild animals' behavior for wildlife conservation and management

Course Contents

Theory: Introduction to behavior with Tinbergen's four questions, understanding animal behavior with reference to nervous and endocrine systems, intrinsic and learned behavior, courtship, sexual selection, mating systems, predator-prey behavior and altruism with reference to specially established and case studies, scientific methods to study animal behavior in the field.

Practical: Behavioral experiments, setup laboratory experiments to study behaviors, field visits to natural areas to study animal behavior (observation and recording ethogram), population dynamics (construction of life tables, Mark and recapture method).

Teaching and Learning Methods

Lectures with whiteboard and marker, presentations, use of LMS, video clips, group activities and discussions, practical, tutorials and assessments, and field visits and activities.

Evaluation Methods

Theory:

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

Practical:

End-semester Examination (Practical)	100%

Final marks = {(5×Theory)+(1×Practical)}/6

References

Aubrey, M. and Dawkins, M.S. (1995) *An Introduction to Animal Behaviour.* 4^{th} Ed. UK: Cambridge University Press.

Hill, D. *et al.* (2005) *Handbooks of Biodiversity methods, Survey Evaluation and monitoring* 1^{st} Ed. UK: Cambridge University Press.

Krebs, J.R. and Davies, N.B. (1993) *An Introduction to BehaviouralEcology.* 3^{rd} Ed. UK: Blackwell Science Ltd.

Manning, A. and Dawkins, M.S. (2012) An *introduction to Animalbehaviour.* 6^{th} Ed. UK: Cambridge University Press.

Mark, R. (1995) *Animal Behaviour: An Introduction to Behavioral Mechanisms, Development and Ecology.* 2^{nd} Ed. Malden: Balckwell Science.

Course Title	**Forest Environmental Biology and Management**
Course Code	**ENS2152**
Credit Value	2 (30h Theory+70h Independent learning)

Aim

To develop an understanding of the biology of forest and its management.

Intended Learning Outcomes

- Explain the basic concepts of forest ecology
- Identify forest and vegetation types in Sri Lanka, their importance and main plant species
- Identify main issues and characteristics in the forest sector of Sri Lanka
- Learn basic aspects of plantation forestry and agroforestry
- Extend forest conservation and management

Course Contents

Introduction to forest ecology (basic concepts in ecology, population and species ecology), major forest and other vegetation types in Sri Lanka (functions with special reference to environmental role, conservation and management), characteristics of forestry sector of Sri Lanka (policy, forest cover, drivers of degradation of forest and deforestation), plantation forestry (tree species for plantation forestry, plantation forestry and environment, basic concepts in establishment and management plantation forests, measuring trees and forests, agroforestry practices, species for agro-forestry).

Teaching and Learning Methods

Lectures with whiteboard and marker, presentations, use of LMS, video clips, group activities and discussions, tutorials, and field visits.

Evaluation Methods

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

References

Thomas, E.A. and Harold, B. (2001) *Forest Measurements.* NY: McGraw-Hill Education.

Hamilton, G.L. (1988) *Forest Mensuration Handbook.* Periodical Expert Book Agency.

Shivastawa, M.B. (1997) *Introduction to Forestry.*

Course Title	**Resource and Environmental Economics**
Course Code	**ENS2162**
Credit Value	2 (30h Theory+70h Independent learning)

Aim

To provide conceptual knowledge on the basic theories of environmental economics, techniques in environmental valuations, development of basic theoretical underpinnings of resource economics and management to produce the graduates as environmental science professionals.

Intended Learning Outcomes

- Explain the basic theories and concepts of resource and environmental economics
- Illustrate the models in resource and environmental economics for environmental management
- Explain the principles of economics of pollution
- Summarize the attributes of environmental assets and apply the knowledge of environmental valuation techniques for assessing the environmental assets
- Extend the decision-making criteria using benefit cost analysis and apply the knowledge to take decisions on new development project approval

Course Contents

Market failure - government intervention, market failure as a cause of environmental degradation, potential market economic solutions to stimulate environmental conservation, applying microeconomic theory to the management of natural resources (resource classification, models for optimal management of renewable and non-renewable resources), bio-economic models, common property and externalities, economics of pollution, environmental valuation (methods and techniques), Introduction to project evaluation, economic analysis of projects.

Teaching and Learning Methods

Lectures with whiteboard and marker, use of LMS, computer-based learning, tutorials, and small group discussions, Field based assignments.

Evaluation Methods

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

References

Bergstrom, J.C. and Randall, A. (2010) *Resources Economics: An Economic Approach to Natural Resource and Environmental Policy.* 3^{rd} Ed. UK: Edward Elgar Pub.

Callan, S.J. and Thomas, J.M. (2012) *Environmental Economics and Management: Theory, Policy and Applications.* 6^{th} Ed. USA: South-Western College Pub.

Kolstad, C.D. (2010) *Environmental Economics.* 2^{nd} Ed. UK: Oxford University Press.

Pearce, D.W. and Turner, R.K. (1990) *Economics of Natural Resources and the Environment.* Washington: Johns Hopkins University Press.

Course Title	**Sustainable Development for Environment**
Course Code	**ENS2172**
Credit Value	2 (30h Theory+70h Independent learning)

Aim

To understand the concepts in sustainable development and environmental policies.

Intended Learning Outcomes

- Outline the concepts in Sustainable Development (SD) and its evolutionary process
- Illustrate the demographic aspects of SD
- Evaluate the current status of the sustainable development goals
- Explain the importance of natural resources for SD
- Formulate strategies for sustainable environmental management

Course Contents

Evolutionary process of SD, sustainable development goals (SDGs), demographic aspects of SD, concepts in institutional aspects of SD, role of natural resources in sustainable development, economic development and planning, concept of allocations with special reference to Sri Lanka, green methodologies, carbon foot print, life cycle analysis, banking initiatives, green jobs.

Teaching and Learning Methods

Lectures with whiteboard and marker, presentation, use of LMS, textbook studies, referring central bank reports and other relevant reports, and students' presentation.

Evaluation Methods

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

References

CEA (2006). *Guidance for Implementing the Environmental Impact Assessment (EIA) Process.* 4^{th} Ed. Sri Lanka: Central Environmental Authority (CEA).

David, R. (1995) *Sustainable development: An introductory guide.* Earthscan publication.

Kathy, W.P. (2010) *Natural Resources and Sustainable Development.* Viva books.

Course Title	**English Language II**
Course Code	**ACU2113**
Credit Value	3 (45h Theory+105h Independent learning)

Aim

To provide necessary language skills to read, write, listen and speak in English in formal and informal academic and professional contexts at the advanced level.

Intended Learning Outcomes

- Acquire the advanced knowledge on the use of the four skills – speaking, listening, reading and writing
- Identify the semantic and pragmatic forms and meanings for diverse application
- Demonstrate efficiency and effectiveness in both receptive and expressive skills
- Create distinct style and rhetoric orally, aurally, graphically, and grammatically
- Apply language competence to language performance with contextual relevance

Course Contents

At the advanced level: exposure to the significant structures for developing the advanced language skills through integration with communicative competence at a higher level, advanced reading skills (reading for details, contextual understanding, intensive reading, making inference, summarizing), advanced writing skills (application of advanced structures and grammatical items – phrases and clauses, sentences and paragraphs, texts and discourses, controlled writing – transforming visual, oral and aural information into writing, communicating in writing – writing notes, memos, personal/official letters, report writing), advanced listening (listening for specific information, for gist of the passages, for comprehension, for making inferences, note taking, and reproducing), advanced speaking (describing people/events/pictures, asking for information, giving directions/instructions, making requests/complains, using model dialogues/improvisations/reading to stimulate conversations and small group discussion), project (writing essays).

Teaching and Learning Methods

Classroom lectures, self-learning, computer assisted language learning, individual and group discussions, and presentations.

Evaluation Methods

In-course Assessment (Listening and speaking)	30%
End-semester Examination (Reading, writing and language Structures)	70%

References

Eric, G. and Lewis, L. (2013) *Oxford English for Careers Technology for Engineering and Applied Sciences: Student Book.*

Gill, R. (2006) *Mastering English Literature.* 3^{rd} Ed. UK: MacMillan Education.

Miles, C. (2008) *Cambridge English Skills: Real Listening and Speaking.* UK: Cambridge University Press.

Martin, H. (2005) *Advanced English Grammar.* UK: Cambridge University Press.

Course Title	**Applied Hydrology and Water Resource Management**
Course Code	**ENS2213**
Credit Value	3 (40h Theory+15h Practical+95h Independent learning)

Aim

To provide the knowledge on fundamental principles of hydrology and its applications in the aspects of water resource management.

Intended Learning Outcomes

- Develop the theoretical understanding in the principles of hydrology
- Identify and examine the issues related to water resources
- Explain water resources management problems to suggest sustainable solutions
- Evaluate the field level issues related to hydrology and water resources in local context
- Analyze the suitability of micro irrigation techniques for different regions
- Justify Integrated Water Resource Management (IWRM) as a sustainable water resource management tool

Course Contents

Theory: Hydrology (definition, hydrologic cycle, processes contributing to the hydrologic cycle), water balance (conservation equation), runoff measurement, hydrograph analysis, runoff prediction, flooding, reservoir and flood routing and watersheds/drainage-basins, watershed management, aspects of irrigation, water resource conservation, integrated water resource management

Practical: Aerial estimation of average precipitation, introduction to modelling in applied hydrology, visit to meteorological station and study the met-instruments.

Teaching and Learning Methods

Lectures with whiteboard and marker, presentations, use of LMS, group activities and discussions, and field activities.

Evaluation Methods

Theory:

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

Practical:

In-course Assessment (Practical reports)	100%

Final marks = {(8×Theory)+(1×Practical)}/9

References

Fetter, C.W. (2014) *Applied Hydrology.* USA: Pearson New International Ed.

Neil, S.G. (1996) *Water Resources and Management.* USA: McGraw-Hill.

Paul-Wosh, C., Kabat, P. and Molten, J. (2008) *Adaptive and Integrated Water Management.* Springer.

Ven, T.C. (1964) *Hand book of the applied hydrology, a compendium of water resources technology.* McGraw-Hill.

Course Title	**Applied Ecology and Community Environment**
Course Code	**ENS2222**
Credit Value	2 (30h Theory+70h Independent learning)

Aim

To develop the application of science of ecology to the real environment via insight learning.

Intended Learning Outcomes

- Explain the ecosystem functions, ecological niche and ecological successions
- Explain the ecological processes with respect to climate variations
- Apply the knowledge of ecology to aquatic and terrestrial ecosystem's management
- Discuss the basic knowledge of ecology to understand the concept of applied ecology
- Formulate strategies to overcome the issues of ecosystem degradation

Course Contents

Introduction to community, ecosystem, biomes and biosphere, ecosystem functions, energy flow in an ecosystem, limiting factors, zonation and productivity of major habitats, ecological niche, ecological succession and processes, applied ecology (application of science of ecology to the real world, habitat ecology, restoration, reclamation, and regeneration of degraded ecosystem), community ecology, deals with the whole array of interacting species in a community, population growth and regulation, population management, aspects of applied ecology (ecosystem restoration, habitat management, rangeland management, protected area management, conservation biology, agro-ecosystem management, ecology of human society, field visits to local ecosystems).

Teaching and Learning Methods

Lectures with whiteboard and marker, presentations, use of LMS, video clips, group activities and discussions, tutorials and assessments, and field visits and activities.

Evaluation Methods

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

References

Krebs, C.J. (2008) *Ecology.* 6^{th} Ed. USA: Pearson International Ed.

Osborne, P.L. (2000) *Tropical Ecosystems and Ecological Concepts.* 1^{st} Ed. UK: Cambridge University Press.

Course Title	**Environmental Disaster Management**
Course Code	**ENS2233**
Credit Value	3 (45h Theory+105h Independent learning)

Aim

To understand the importance/s of the concept of natural disasters and their management.

Intended Learning Outcomes

- Summarize the types of natural and anthropogenic disasters
- Explain the causes for the above disasters
- Illustrate the process of disaster management cycle
- Develop the ameliorative measures to handle the emergency situation
- Apply the knowledge of preparedness and response of natural disaster incidence
- Identify and assess key implementation issues and requirements in disaster management

Course Contents

Introduction and dimensions of natural and anthropogenic disasters, types of disasters (flood, landslide, garbage dump landslide, cutting failure landslide, drought, cyclones, earthquake, tsunami, volcano, fire, lightning strikes, severe thunderstorm, tornado, industrial hazard, air hazard, maritime hazard, epidemic, explosion, air raids, civil or internal strife, chemical accidents, radiological emergency, oil spills, nuclear disaster, forest fire, coastal erosion), characters of disasters, factors causing disasters, disaster management cycle, institutional arrangements for disaster management, Standard Operating Procedures (SOPs), prediction of disasters, emergency management, disaster management and mitigation efforts, important acts/legal provisions, disaster kit.

Teaching and Learning Methods

Lectures with whiteboard and marker, presentations, use of LMS, video clips, group activities and discussions, tutorials and assessments, field-based studies, and case studies.

Evaluation Methods

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

References

CFE-DM, (2014) *Sri Lanka Disaster Management Reference Hand Book.* Sri Lanka: Center for Excellence in Disaster Management and Humanitarian Assistance (CFE-DM).

Carter, W. (2008) *Disaster Management, Disaster Manager's Hand book.* Philippines: Asian Development Bank.

Pinkowski, J. (2008) *Disaster Management Hand book.* USA: CRC Press.

Course Title	**Energy and Environment**
Course Code	**ENS2242**
Credit Value	2 (25h Theory+15h Practical+60h Independent learning)

Aim

To provide the knowledge regarding the energy resources, technologies and impact on the environment.

Intended Learning Outcomes

- Identify and classify the energy resources
- Discuss the energy resources in the past and future
- Illustrate the energy development and conservation techniques
- Explain the impacts of energy consumption on the environment
- Evaluate the efficiency of energy consumption

Course Contents

Theory: Need of energy and its transition, growing energy need with economic growth and development, over use of energy, types of energy sources – renewable and non-renewable, fossil fuels, carbon cycle including terrestrial and marine, carbon sequestration, environmental consequences due to over exploitation of fossil fuels, sustainability of non-renewable energy sources, switching to alternative energy sources for environmental protection, solar energy — solar thermal electric power, tidal and wave power, wind energy, geothermal energy, nuclear power, hydroelectric power, biomass energy, biogas, implications for energy plans and energy policy for the conservation and sustainability, non-renewable energy sources.

Practical: Field visits, case studies/assignments based on Sri Lankan scenario.

Teaching and Learning Methods

Lectures with whiteboard and marker, presentations, use of LMS, open-book studies, group discussions, poster presentation, and problem based learning

Evaluation Methods

Theory:

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

Practical:

In-course Assessment (Practical reports)	100%

Final marks = {(5×Theory)+(1× Practical)}/6

References

Demirel, Y. (2016) *Energy: Production, Conversion, Storage, Conservation, and Coupling.* 2^{nd} Ed. Springer.

Toossi, R. (2009) *Energy and the environment.* Los Angeles, CA: Verve Publishers.

Course Title	**Ecotourism**
Course Code	**ENS2252**
Credit Value	2 (20h Theory+30h Practical+50h Independent learning)

Aim

To understand the concept of ecotourism as a means of environmental management/conservation and income generation for national development.

Intended Learning Outcomes

- Apply the knowledge to evaluate the impacts of ecotourism on the environment
- Discuss the forms of tourism that provide healthy interaction opportunities for tourists and locals
- Demonstrate local culture, art, handicrafts, monuments and other natural and man-made tourist resources and protect them from over-commercialization and over-exploitation
- Formulate research ideas on different aspects of community-based tourism and tourism projects
- Summarize environmental awareness, conservation and sustainable use of natural resources and importance of ecotourism

Course Contents

Theory: Introduction to ecotourism, mass tourism, environment and climate, identification of different environment and climatic zones in Sri Lanka, targets of ecotourism in Sri Lanka, protected areas (forest reserves, national parks, sanctuaries, beaches, sanctuaries in Sri Lanka and its important cultural activities), marketing and hotel management (marketing tourism, designing and managing environmentally friendly restaurants and lodges), training local people (as guides and managers), increasing number of visitors and managing high number of visitors, encourage high spending, increasing sympathy for nature, plant and wild life of the area, Communication (preparing handouts, posters, guidelines, audiovisual products, websites, and information centers), positive and negative impacts on wildlife, vegetation, ancient monuments, pollution, littering, constructions, carbon foot print importance of solar power and other alternative energy sources, water bottles, electric cars for transport of tours

Practical: Field visits to hotel industries, protected areas, sacred and other tourist attractive areas.

Teaching and Learning Methods

Lecture with whiteboard and marker, Presentation, use of LMS, Field visits, Group discussions, Video clips, Case studies.

Evaluation Methods

Theory:

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

Practical:

In-course Assessment (Practical reports)	100%

Final marks = {(2×Theory)+(1×Practical)}/3

References

Ballantyne, R. and Packer, J. (2013) *International handbook on ecotourism.* Cheltenham: Edward Elgar Publishing.

Fennell, D.A. (1999) *Ecotourism: An introduction.* London, NY: Routledge.

Fennell, D.A. (2015) *Ecotourism.* 4^{th} Ed. Oxon Routledge.

Wickramasinghe, K. (2009) *Ecotourism for sustainable forest management in Sri Lanka.* Sri Lanka: Institute of Policy Studies of Sri Lanka.

Course Title	**Environmental Pollution and Control**
Course Code	**ENS2263**
Credit Value	3 (40h Theory+15h Practical+95h Independent learning)

Aim

To provide an introduction to environmental pollution and build awareness of the strategies used to manage and control pollution.

Intended Learning Outcomes

- Discuss the basics and the sources of environmental pollution
- Interpret contemporary pollution issues
- Summarize the chemistry of environmental pollution
- Evaluate the degree of harmful effects of each pollutant identified
- Demonstrate laboratory experiments on identification of level of pollution
- Propose appropriate control measures of environmental pollution

Course Contents

Theory: Pollution, pollutants and environmental pollution, global episodes of environmental pollution, types of environmental pollution, air pollution (classification and properties of air pollutants, emission sources, mechanisms, air pollution monitoring and control devices and ambient air quality standards), water pollution (classification and characterization of water pollutants, ecology of water pollution biology of polluted water, bio-indicators of water pollution, environmental significance of water pollution), radioactive pollution, thermal pollution, noise Pollution, light pollution.

Practical: Field excursions to polluted environments/ecosystems, air sampling methods, laboratory experiments on characterization of polluted water samples.

Teaching and Learning Methods

Lectures with whiteboard and marker, multimedia presentations, use of LMS, field visits, group discussions, video clips, and case studies.

Evaluation Methods

Theory:

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

Practical:

In-course Assessment (Practical reports)	100%

Final marks = {(8×Theory)+(1×Practical)}/9

References

Jeffrey, P.J., Vesilind, A.P. and Ruth, F.W. (1997) *Environmental Pollution and Control*. UK: Butterworth-Heinemann.

Khopkar, S.M. (2004) *Environmental Pollution: Monitoring and control*. 1^{st} Ed. New Delhi: New Age International.

Rao, C.S. (1991) *Environmental Pollution Control Engineering*. New Delhi: New Age International. 4^{th} Ed. Elsevier Science and Technology Books.

Course Title	**Communication and Soft Skills**
Course Code	**ACU2212**
Credit Value	2 (30h Theory+70h Independent learning)

Aim

To excel in communication and soft skills for productivity and personality development

Intended Learning Outcomes

- Explain the necessary knowledge and skills required for efficient and effective communication
- Identify the knowledge and skills for personality development
- Find the problems and challenges to overcome barriers for communication and soft skills
- Show excellence in communication using critical and creative skills

Course Contents

Introduction to communication and soft skills, the patterns and the process, downward and upward communication, horizontal and vertical communication, one-way and two-way communication, multi-directional communication, communications for management, efficiency and effectiveness in communication, forms (oral and written communication), verbal and non-verbal communication, para-language code, signals, symbols, icons, gestures, active listening and speaking, writing for your people, publishing and editing, levels (inter personal communication and public communication), planning and Organization of communication (establishment of objectives, information search, identification, collection, organization and presentation), analytical skills, resource allocation, delegation, timing, co-ordination, motivation (instrumental and inspirational, internal and external), motivational communication (instructions, reporting and recommendations), performance appraisal and styles of control, staffing (interview techniques, communication in training and development, feedback, and industrial relations), leadership (supportive leadership, directive leadership, achievement oriented leadership and participative leadership), public relations and marketing communication (negotiating and conflict resolution skills: opening the process, negotiations types, conduct of Negotiation and problem solving skills, balancing personal and professional life, communication during egotiations, bargaining, teamwork, flexibility and adaptation, and time management, decisiveness, responsibility and accountability).

Teaching and Learning Methods

Classroom lectures, self-learning and discussion, individual and group presentation, field visits and project assignment and reporting.

Evaluation Methods

In-course Assessments (Formative Assessment)	30%
End-semester Examination (Summative Evaluation)	70%

References

Dixon, T. and Ohara, M. (2010) *Communication Skills.* University of Ulster.

Garcia, H.F. (2012) *The Power of Communication: Skills to Build Trust, Inspire Loyalty, and Lead Effectively.* USA: Pearson Education.

Mitra, B.F. (2011) *Personality Development and Soft Skills.* UK: Oxford University Press.

LEVEL 3

Course Title	**Geographic Information System and Remote Sensing**
Course Code	**ENS3113**
Credit Value	3 (30h Theory+30h Practical+90h Independent learning)

Aim

To provide knowledge of theory and applications of Geographical Information Systems (GIS).

Intended Learning Outcomes

- Outline the theoretical understanding in the fundamentals of GIS
- Identify useful applications of GIS in natural resource management
- Classify different types of data formats in GIS
- Apply the skills in geospatial information science analysis applicable to various disciplines
- Create meaningful outputs from GIS software platforms

Course Contents

Theory: Fundamentals and components of GIS, basic principles of cartography, spatial data properties and structure, vector and raster data, introduction to GPS and its use, using smart phones as GPS, introduction to ArcMap (data analysis, measuring queries, buffering and neighborhood functions, spatial statistics, network analysis, spatial data modelling and analysis, georeferencing, digitizing, symbology, labeling, overlaying, queries), KML files, converting Google maps to ArcGIS, concept of Remote Sensing (RS), types of sensors and satellites, exploring RS images in the web, classification of remote sensing systems, overview of RS applications in environmental science, RS and GIS (integration and the linkages), applications of RS and GIS in the EIA process.

Practical: ArcMap (understanding the functions overlaying, buffering and querying), learning to use GPS in field situations, comprehensive training on the use of ArcMap (georeferencing, fundamentals of geodatabase/spatial analysis), learning to use images available in the web, analyzing RS images using ArcMap, interpretation of RS images, preparation of reports.

Teaching and Learning Methods

Lectures with whiteboard and marker, use of LMS, presentations, computer-based practical with demonstration and tutorial discussions.

Evaluation Methods

Theory:

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

Practical:

End-semester Examination (Practical)	100%

Final marks = {(2×Theory)+(1×Practical)}/3

References

Atkinson, P.M. (1999) *Advances in remote sensing and GIS analysis.* New Delhi: Wiley Pvt. Ltd.

Barrett, E.C. and Curtis, L.F. (1999) *Introduction to Environmental Remote Sensing.* 4^{th} Ed. UK: Stanley Thornes.

Thomas, L.M. and Ralph, K.W. (1994) *Remote sensing and image interpretation.* 3^{rd} Ed. NY: Wiley & Sons, Inc.

Course Title	**Wildlife Conservation and Management**
Course Code	**ENS3122**
Credit Value	2 (25h Theory+15h Practical+60h Independent learning)

Aim

To develop the knowledge and skills in wildlife biology for effective wildlife management and conservation.

Intended Learning Outcomes

- Discuss what is wildlife and population ecology
- Apply the knowledge of wildlife biology for the effective management of wildlife
- Explain the inbreeding depressions contributing to risk of species extinction
- Apply the knowledge and techniques for wildlife monitoring and habitat evaluations
- Demonstrate the skills for investigating human-animal conflicts and find the solutions
- Outline the strategies for wildlife conservation

Theory: Goals of wildlife management, wildlife ecology estimation of population, innate capacity for increase in numbers, population growth and regulation, r and K selected populations, competition and predation, conservation theory (concept of the minimum viable population, rescue and recovery of near extinction), *In-situ* and *ex-situ* conservation of wildlife, effects of fragmentation, restoration, reclamation, and regeneration of degraded wildlife habitats, forest corridors, reintroduction, translocation, management of nature reserve, national and international wildlife convention strategies, wildlife conservation in Sri Lanka, elephants, leopard, primates, sea turtles, crocodiles, urban wildlife, wildlife harvesting, methods of control, fire as a management tool, methods of estimating population size

Practical: Field visits to national parks, length and height measurements of wild animals, population monitoring techniques, habitat evaluation and management strategies for national parks, sanctuaries and habitats of large mammals and reptiles, Study of human-animal conflicts, adaptation and mitigation, survey methods (radiometry, remote sensing).

Teaching and Learning Methods

Lectures with whiteboard and marker, presentations, use of LMS, video clips/ documentaries/discoveries/scientific movies, group activities and discussions, practical/s, tutorials and assessments, field visits, and inter-university collaborations.

Evaluation Methods

Theory:

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

Practical:

End-semester Examination (Practical)	100%

Final marks = {(5×Theory)+(1×Practical)}/6

References

Adams, C.E. and Lindsey, K.J. (2010) *Urban wildlife management.* 2^{nd} Ed. FL: CRC Press.

Kaul, B.L. (1996) *Advanced In Fish and Wildlife Ecology and Biology.* New Delhi: Daya Publishing House.

Sinclair, A.R.E., John, F.M. and Caughley, G. (2006) *Wildlife ecology, conservation, and management.* Wiley-Blackwell.

Uragoda, C.G. (1994) *Wildlife conservation in Sri Lanka: a history of Wildlife and Nature Protection Society of Sri Lanka, 1894-1994.* Sri Lanka: Wildlife and Nature Protection Society of Sri Lanka.

Course Title	**Environmental Policies and Law**
Course Code	**ENS3132**
Credit Value	2 (30h Theory+70h Independent learning)

Aim

To understand the environmental policies and the law adopted in the country.

Intended Learning Outcomes

- Outline the concept and principles of environmental law and their salient features
- Explain the acts, ordinances and the amendments of each environmental legislation/legal framework of Sri Lanka
- Develop/design new environmental legal frameworks for the environmental resource management
- Critically analyses and evaluate the current environmental policies in Sri Lanka
- Formulate strategies to deal with sustainable environmental management

Course Contents

Principles and concepts of environmental law, practice and enforcement of environmental law in Sri Lanka, introduction to the Act and statutes related to environmental conservation and Management (National Environmental Act, forest ordinance, plant protection ordinance, food ordinance, water hyacinth ordinance, fauna and flora protection ordinance, mine and mineral acts, state gem corporation, control of pesticides act, regulation of fertilizer act, soil conservation act, coastal conservation act, waste management, hazardous waste regulations act, atomic energy authority act, fisheries act, marine pollution prevention act, national resources, energy and Science authority act, rainwater harvesting act), Environmental Protection License (EPL) scheme, environmental ethics, international conventions and protocols on environment, major environmental Policies of Sri Lanka, contents of environmental policies and their importance in sustainable environmental management.

Teaching and Learning Methods

Lecture with whiteboard and marker, presentation, use of LMS, group discussions.

Evaluation Methods

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

References

UNEP, *Judges and Environmental Law, Judiciary, HandBook of Sri Lankan.* Sri Lanka.

CEA, *http://www.cea.lk/web/en/acts-regulations* [Online].

Laws of Sri Lanka, *http://www.srilankalaw.lk/Volume-VI/national-environmental-act.html* [Online].

Course Title	**Solid Waste Management**
Course Code	**ENS3143**
Credit Value	3 (40h Theory+15h Practical+95h Independent learning)

Aim

To develop the knowledge and skills of solid and hazardous wastes management for effective environmental management.

Intended Learning Outcomes

- Define solid and hazardous waste and identify the different types based on its characteristics
- Discuss the principles of integrated solid waste management
- Explain the waste minimization techniques
- Illustrate the design of hazardous waste storage, treatment, disposal technologies
- Propose the appropriate problem-based solution to issues

Course Contents

Theory: Identifying the types of solid wastes, its generation, health and environmental issues related to poor management of solid wastes, methods of disposal options (such as composting, incineration, land filling, etc.), transport facilities, engineered design of sanitary landfills (land fill cover, liner systems, design of leachate control systems, gas migration controls, etc.), principles of material/energy recovery systems and recycling plants, designing integrated solid waste management system, Identifying hazardous wastes based on its physical and chemical characteristics, generation, environmental issues, hazardous waste minimization techniques, hazardous waste storage and transportation facilities, methods of treatment disposal options (land fill, deep well injection, incineration, etc.), design of hazardous waste landfills (site selection, double liner systems, design of leachate control, etc.), design of hazardous waste site remediation techniques.

Practical: Executed via field visits, case studies/assignments based on Sri Lankan scenario.

Teaching and Learning Methods

Lectures with whiteboard and marker, presentations, use of LMS, open-book studies, field visits, group discussions, poster presentations, and problem based learning.

Evaluation Methods

Theory:

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

Practical:

In-course Assessment (Practical reports)	100%

Final marks = {(8×Theory)+(1×Practical)}/9

References

George Tchobanoglous, F.K. (2002) *Handbook of Solid Waste Management.* 2^{nd} Ed. McGraw Hill Professional.

George Tchobanoglous, H.T.S.A.V. (1993) *Integrated solid waste management.* Part II. 2^{nd} Ed. Michigan: McGraw-Hill.

Course Title	**Environmental Biotechnology**
Course Code	**ENS3153**
Credit Value	3 (40h Theory+15h Practical+95h Independent learning)

Aim

To provide knowledge on the principles of biotechnology, recent advancements of biotechnological aspects and the applications within the context of analyzing the environmental problem and utilizing for solutions.

Intended Learning Outcomes

- Explain the concept of recombinant DNA technology in generating Genetically Modified Organism (GMO)
- Discuss the concept of transgenic plant and their potential benefits in agriculture
- Apply the knowledge of biotechnology in pollution monitoring and abatements
- Describe biotechnological methods in environmental pollution management, biomining and metal leaching
- Explain the biotechnical principles in the production of eco-friendly bio products
- Develop the skills in practical approaches of environmental biotechnology at the field level

Course Contents

Theory: Role of biotechnology in agriculture and food production, medicine environment and industries, recombinant DNA technology, transgenic plant development, GMO-concepts, issues, merits and limitations, biotechnological methods of pollution detection – general bio assay, cell and molecular biological assay, biosensor, biotechnological methods in pollution abatements, bioremediation methods, biodegradation with genetically engineered organisms integrated approach in waste management, bio-mining, bioleaching, bio-absorption, metal leaching, extraction, eco-friendly bio products – bio pesticide, bio fertilizer, bioplastics, microbial conversion of biomass/biogas energy, production of non-conventional fuels (methane, hydrogen, alcohols and algal hydrocarbons), use of microorganisms in petroleum augmentation and recovery, microorganisms and microbial products.
Practical: Isolation and antagonistic effect of *Tricoderma*, application of microbes in beverage production, isolation of *Rhizobium* species and observe the nodule formation, biowaste management (cultivation of mushroom), bioassay of pollution (Geno toxicity assay methods, General bioassay using plant and animal system, ELIZA and electrophoresis technique for pollution detection).

Teaching and Learning Methods

Lectures with whiteboard and marker, presentations, use of LMS, tutorial discussion, poster presentations, group discussions, open-book studies, field visits, practical demonstrations, handouts and lecture notes.

Evaluation Methods

Theory:

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

Practical:

In-course Assessment (Practical reports)	100%

Final marks = {(Theory×8)+(Practical×1)}/9

References

Chatteji, A.K. (2007) *Introduction to environmental biotechnology.* 2^{nd} Ed. New Delhi: Prentice hall.

Vans, G.M, and Furlong, J.C. (2011) *Environmental Biotechnology: Theory and Application.* Wiley-Blackwell.

Wang, L. *et al.* (2010) *Environmental Biotechnology.* 1^{st} Ed. NY: Humana Press.

Course Title	**Industrial Chemistry and Pollution Monitoring**
Course Code	**ENS3162**
Credit Value	2 (25h Theory+15h Practical+60h Independent learning)

Aim

To understand the chemistry of industrial processes and pollution monitoring methods for effective environmental management.

Intended Learning Outcomes

- Outline basic principles and concepts of industrial chemistry
- Explain the industrial manufacturing processes in context with environmental concern
- Categorize different types of pollutants in the respective industries
- Interpret the harmful effects of pollutants in the respective industries
- Discuss existing techniques in controlling and monitoring industrial pollution
- Explain the cleaner production practices on environmental pollution control

Course Contents

Theory: Location theory of industries, industrial chemistry (theoretical fundamentals of chemical industry, evolution of chemical industry), processes and management of resource and waste in the industries (cement, ceramics, glasses, fertilizers, soap, paint and varnishes, paper industry, tanning industry, dye and pesticides, plastic and polythene industry), hierarchy of industrial waste management, cleaner production technology, green industries concept, Environmental Management System (EMS) concept.
Practical: Sampling techniques (air, water and soil), laboratory analysis of water quality indicators.

Teaching and Learning Methods

Lectures with whiteboard and marker, use of LMS, presentations, field visits, group discussions, handouts, video clips, and case studies.

Evaluation Methods

Theory:

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

Practical:

In-course Assessment (Practical reports)	100%

Final marks = {(5×Theory)+(1×Practical)}/6

References

James, A.K. (1997) *Riegel's Handbook of industrial Chemistry.* 9^{th} Ed. New Delhi: CBS Publishers.

Manahan, S.E. (2011) *Fundamentals of Environmental Chemistry.* 3^{rd} Ed.

Course Title	**Career Guidance**
Course Code	**ACU3112**
Credit Value	2 (30h Theory+70h Independent learning)

Aim

To provide an overall view of the career prospective and guidance.

Intended Learning Outcomes

- Develop attitudes of the outside of the world
- Find carrier option and goals
- Apply soft and survival skill in carrier development
- Identify the expectation of private employer
- Select suitable carrier opportunity by analysing job bank and data base
- Create effective resume

Course Contents

The world of work (unemployment in Sri Lanka, recent demographic, economic and social changes of Sri Lanka and how they affect the graduate labour market), private sector culture – emphasis on attitudes the role of scientists in various employment sectors, the expectations of private sector employer from new graduate employees, career guidance employment search, image Projection (Social graces, public relations, career development and survival skills of young graduates), personality development, leadership, team work, human relations, elective communication, problem solving, stress management, presentation Techniques (bio-data, facing interviews, assertiveness).

Teaching and Learning Methods

Classroom lectures, self-learning and discussions.

Evaluation Methods

Self and peer evaluation during group activities	50%
Project:	
Proposal presentation	10%
Final re-presentation	20%
Report	20%

References

Nikes, S. and Haris-Bowisbey (2006) *Career development intervention in the 21st century.* 2nd Ed.

Whitney, S. and Power, S. (2017) *Guide your career.*

Course Title	**Statistics for Environmental Science**
Course Code	**ENS3213**
Credit Value	3 (30h Theory+30h Practical+90h Independent learning)

Aim

To develop the knowledge and skills in statistical analysis and to interpret the analytical output related to the field of environmental science.

Intended Learning Outcomes

- Outline the basic concepts of statistics
- Apply discrete and continuous probability distributions to various issues
- Test the hypothesis using selected statistical techniques
- Apply the concept of simple and multiple linear regression
- Interpret the output obtained from appropriate statistical analysis
- Develop the skills in manipulating raw data to perform statistical analysis executed

Course Contents

Theory: Population and samples, measures of central location and dispersion, frequency distributions, histograms, plots (stem and leaf, and box-plots), concepts of probability sample space, calculation of probability for discrete and continuous events, normal distributions, sampling distribution of sample means (large and small samples), t-distribution, z-distribution and chi-squared distribution, t-tests, simple and Multiple Linear Regression, correlation coefficient, introduction to analysis of variance (ANOVA), Introduction to non-parametric statistical tests, contingency tables, log-linear models, Wilcoxon test, rank correlations.

Practical: Introduction and usages of statistical packages (Minitab, SPSS, and R), descriptive statistics, probability distribution, z-test, t-tests, regression analysis, ANOVA, mean comparison, chi-square test.

Teaching and Learning Methods

Lectures with whiteboard and marker, presentations, use of LMS, computer-based practical/s, and tutorial discussions.

Evaluation Methods

Theory:

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

Practical:

In-course Assessment (Practical assignments)	40%
End-semester Examination (Practical)	60%

Final marks = {(2×Theory)+(1×Practical)}/3

References

Hoshmand, R. (1997) *Statistical Methods for Environmental and Agricultural Sciences.* 2^{nd} Ed. CRC Press, ISBN 0-8493-3152-8

Jeffrey, J.A.K. (1989) *Statistical Analysis for Decision Making.* California: Allyn and Bacon.

Wonnacott, T.H. (1990) *Introductory Statistics.* 5^{th} Ed. John Wiley & Sons.

Course Title	**Environmental Impact Assessment and Environmental Audit**
Course Code	**ENS3222**
Credit Value	2 (30h Theory+70h Independent learning)

Aim

To develop an understanding and basic practical skills of EIA as a tool for effective environmental management/monitoring.

Intended Learning Outcomes

- Discuss the surveillance and supervision effects or impact monitoring compliance monitoring environmental auditing, ex-post evaluation in environmental impacts assessment
- Explain the major steps involved in designing an EIA
- Compare different types of techniques applies in EIA
- Develop an EIA report for a new venture
- Use of environmental audit as a part of EIA report in terms of environmental management

Course Contents

Introduction to EIA, development of projects and their impact on the environment, concept of EIA, objectives of EIA, advantages and limitations of EIA, problems of EIA, EIA process, preparation of Terms of Reference (TOR), conducting environmental scoping methods used in EIA, methods in impact analysis (questionnaires, matrices, checklists, network analysis and overlays), public participation in EIA, alternatives in EIA, economic valuation of environmental impacts, extended benefit cost analysis, monitoring plan, social impact assessment (SIA), Strategic Environmental Assessment (SEA), legal framework for EIA, case studies of EIA, brief introduction on environmental audit for industrial process and quality control, environmental audit and monitoring plan, preparation of mini EIA report for development projects, Environmental Protection License (EPL) for different type of industries.

Teaching and Learning Methods

Lectures with whiteboard and marker, presentations, use of LMS, group discussions, case studies, and prototype design of EIA.

Evaluation Methods

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

References

CEA. (2006) *Guidance for Implementing the Environmental Impact Assessment (EIA) Process.* 4^{th} Ed. Sri Lanka: Central Environmental Authority (CEA).

Course Title	**Marine Environment and Management**
Course Code	**ENS3232**
Credit Value	2 (25h Theory+15h Practical+60h Independent learning)

Aim

Developing an appreciation for the theoretical and practical aspects of marine environment within the confinements of the field of environmental science.

Intended Learning Outcomes

- Identify the specificity of various marine ecosystems and its zones
- Discuss the importance and specificity of coastal marine environment and management
- Develop the skills and knowledge to determine the marine water chemistry
- Demonstrate the basic knowledge and skills to identify and classify the various marine organisms
- Outline the various usage, effects and impacts related to marine environment

Course Contents

Theory: Introduction to the marine environment, structure of ocean basins, role of marine life in its environment (pelagic, neritic and oceanic [hydrothermal vents], benthic, supra-littoral, eulittoral, sub-littoral [intertidal], coastal (sea shore, rocky and sandy, coral reefs, mangroves, dunes, beaches, lagoons, and estuaries), ocean waves (tsunami), tides and currents, marine water chemistry, marine planktons (phyto/zooplanktons, marine algae, sea grass, salt marsh and mangroves), marine animals (chordates and non-chordates): Marine pollution and management, effects of *El Niño*, carbon cycle and global warming on the marine environment.

Practical: Will involve field visits to coastal marine environments, identifying, and recording adaptations of the marine organisms (planktons, algae, plants and marine animals), determination of physiochemical properties of marine water sample.

Teaching and Learning Methods

Lectures with whiteboard marker, presentations, use of LMS, video clips/documentaries/discoveries/scientific movies, group activities and discussions, practical/s, tutorials and assessments, field visit and inter-university collaborations.

Evaluation Methods

Theory:

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

Practical:

End-semester Examination (Practical)	100%

Final marks = {(5×Theory)+(1×Practical)}/6

References

Barnes, R.S.K. and Hughes, R.N. (1999) *An Introduction to Marine Ecology.* 3^{rd} Ed. UK: Blackwell Science.

Garrison, T.S. (2016) *Oceanography: An Invitation to Marine Science.* 9^{th} Ed. USA: Orange Coast College. Brooks Cole.

Course Title	**Wastewater Treatment**
Course Code	**ENS3242**
Credit Value	2 (25h Theory+15h Practical+60h Independent learning)

Aim To develop knowledge on effective wastewater treatment methods on both municipal and industrial context as part of the means of environmental management

Intended Learning Outcomes

- Describe the strength of wastewater based on characteristics and indicators
- Illustrate the appropriate wastewater treatment methods/techniques
- Assess the efficiency of water treatment based on the quality of influent and effluent
- Recommend treatment methods for selected industrial wastewater
- Assess the methods for sludge disposal in environmentally safer manner

Course Contents

Theory: Introduction to the characteristics of municipal and industrial wastewater, indicators used to measure the strength of water quality – BOD, COD, suspended solids, nutrients, inorganic ions, and pH, conventional wastewater treatment techniques – aeration, sedimentation, rapid mixing, flocculation, coagulation, filtration, disinfection, turbidity removal, taste and odor control, water treatment processes such as primary (screening, grit removal, skimming, sedimentation), secondary (activated sludge, trickling filters, rotating biological contactors, lagoons, oxidation ponds, stabilization ponds), and tertiary (nutrient removal, adsorption, disinfection etc.), treatment and disposal of sludge, on-site household/industrial wastewater treatment options – site evaluation and establishment of soakage pits, leaching field, and evaporation methods, nature of industrial wastewater, application of treatment techniques based on the characteristics of industrial wastewater for different industries such as slaughterhouse, paper and pulp, textile, tannery, chemicals and pharmaceuticals, introduction to advanced water treatment techniques.

Practical: Field visits to a municipal sewage water treatment plant and an industrial wastewater treatment plant to assess the wastewater treatment techniques undertaken.

Teaching and Learning Methods

Lectures with whiteboard and marker, multimedia presentations, use of LMS, open-book studies, field visits, in-class group discussions, and problem based learning

Evaluation Methods

Theory:

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

Practical:

In-course Assessment (Tutorials/Assignments)	100%

Final marks = {(5× Theory)+(1× Practical)}/6

References

Drinan, J.E. and Spellman, F. (2012) *Water and wastewater treatment: A guide for the non-engineering professional.* CRC Press.

Jern, N.G.W. (2006) *Industrial Wastewater Treatment.* UK: Imperial College Press.

Metcalf and Eddy. (2014) *Wastewater Engineering: Treatment and Resource Recovery.* 5^{th} Ed. NY: McGraw-Hill.

Course Title	**Seminar**
Course Code	**ENS3251**
Credit Value	1 (50h Notional learning)

Aim

To make the undergraduate to become more conversant in various topics related to environmental issues, conservation and management.

Intended Learning Outcomes

- Develop the skill in identifying and analyzing the problems related to natural resource management and the environmental issues
- Demonstrate the leadership qualities in participating different roles such as chairperson, presenter and the discussants

Course Contents

Use of logical, analytical and critical thinking for the problem identification, investigation via gathering and analyzing data, validation, conclusion/s, recommendations and producing final documentation in the form of hard bound report.

Evaluation Methods

Two senior staff members will do continuous evaluation for 15 weeks for their presentation skills, taking the different roles and the ability to take part in discussions, controlling the members in the forum and the capability of facilitating discussion on a particular topic. Final report will be evaluated by two senior staff members.

No End-semester Examination.

Continuous evaluation	60%
Final report	40%
Total Marks	100%

Course Title	**Biomolecules and Bio-separation Techniques**
Course Code	**ENS3262**
Credit Value	2 (25h Theory+15h Practical+60h Independent learning)

Aim

To provide knowledge about biomolecules and effects of pollutants on them at cellular level and understand the analytical techniques of biomolecules within the context of environmental science.

Intended Learning Outcomes

- Identify the biomolecules in living organisms and the effects of environmental pollutants on biomolecules
- Explain the principle of various types of bio separation technique
- Select the suitable bio separation techniques in separating and analyzing of environmental pollutants
- Utilize the knowledge in molecular and cellular based pollution monitoring
- Apply the concepts of bio separation technique in bio waste utilization, bioprocessing and bio refinery

Course Contents

Theory: Biochemistry of biomolecules, effect of environmental pollutants on biomolecules at cellular level, bio-separation techniques relevant to environmental study (process, characteristics, precipitation, crystallization, filtration, centrifugation, cell disruption), lyophilization, extraction, chromatography (principles and methods), electrophoresis (characterization of protein and nucleic acid PAGE, SDS-PAGE electrophoresis), determination of molecular weight, quantification of protein, applications of bio-separation technique in environmental studies.

Practical: Practices of qualitative and quantitative analysis of biomolecules emphasis on proteins and DNA, gel electrophoresis-PAGE, SDS-PAGE electrophoresis, enzyme assays, column chromatography, differential centrifugation, paper and thin layer chromatography, protein quantification, bioprocessing of bio waste (chitosan extraction from shell, lactic acid extraction), field visits.

Teaching and Learning Methods

Lectures with whiteboard and marker, presentations, use of LMS, tutorial discussions, and group discussions

Evaluation Methods

Theory:

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

Practical:

In-course Assessment (Practical reports)	100%

Final marks = {(Theory×5)+(Practical×1)}/6

References

Satinder, A. (2000) *Handbook of Bioseparations.* Elsevier.

Subramanian, G. (1998) *Bioseparation and Bioprocessing.* Wiley-VCH, 1998.

Ward, P. (2012) *Bioprocessing.* Springer Science & Business Media.

Wilkinson, K.J. and Lead, J.R. (2007) *Environmental Colloids and Particles: Behaviour, Separation and Characterizations.* John Wiley & Sons.

Yang, S., El-Ensashy, H. and Thongchul, N. (2013) *Bioprocessing Technologies in Biorefinery for Sustainable Production of Fuels, Chemicals, and Polymers.* John Wiley & Sons.

Course Title	**Environmental Toxicology**
Course Code	**ENS3273**
Credit Value	3 (40h Theory+15h Practical+95h Independent learning)

Aim

To provide knowledge on environmental toxicants and their movement and effects in the environment.

Intended Learning Outcomes

- Classify the toxicants based on toxicity level, mode of action and the metabolism in human
- Explain the ways of movement and distribution of toxicants in the environment
- Explain the concept of dose-response relationship
- Discuss the human health hazards of agrochemicals base on exposure duration and concentration
- Apply the knowledge on scientific experimental methods in laboratory research related to toxicology
- Summarize knowledge on the safety measures before, on-site, after the application of pesticide to the environment

Course Contents

Theory: Toxins in environment (classifications and types), pesticides and environmental toxicology (effect of pesticide in environment, pesticide residue, chemicals contamination in post-harvest handlings of inorganic, organic natural, organic synthetic pesticide), classifications in mode of action (axonal and synaptic action in nerve system), botanical pesticide and their potential applications, active ingredients, effects of neem derivatives on insects control, insecticide metabolism, pest resistance, safety issues, movement, fate and distribution of toxicants in the environment, measurement of toxicity based on exposure duration, effects of toxicants on environment, air, water soil, plants and living organisms, bio-magnification, classification and measurement of toxicity based on exposure duration, dose-response relationship, LD_{50} and ED_{50}, absorption, translocation and metabolism of toxicants in human, toxic syndrome in human (carcinogenic, teratogenic and mutagenic effects).

Practical: Study the agrochemical properties from label (toxicity level, color, mode of action), observe the morphological characters of pests and parasite, analysis of toxic components in food, soil and water (pesticide residues analysis in fruits and vegetables), determination of food adulterants, additives and chemicals, estimate the mycotoxins in food, botanical pesticide preparation and its application, determination of LD_{50} value of mosquito larva, ED_{50} and growth inhibition assay of agrochemicals, field visits.

Teaching and Learning Methods

Lectures with whiteboard and marker, presentation, tutorial discussions, group discussions, open-book studies, practical demonstrations, poster presentation by students, handouts, lecture notes, use of LMS, and field visits.

Evaluation Methods

Theory:

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

Practical:

In-course Assessment (Practical reports)	100%

Final marks = {(Theory×8)+(Practical×1)}/9

References

Dileep, K.S. (2012) *Pesticide Chemistry and Toxicology.* 1^{st} Ed. New Delhi: Bentham Science Publishers.

Ming-Ho, Y. Tsunoda, H. and Tsunoda, M. (2016) *Environmental Toxicology: Biological and Health Effects of Pollutants.* 3^{rd} Ed. CRC Press.

Wright, D.A. and Welbourn, P. (2002) *Environmental Toxicology.* 1^{st} Ed. Cambridge University Press.

Course Title	**Management and Entrepreneurial Skills**
Course Code	**ACU3212**
Credit Value	2 (30h Theory+70h Independent learning)

Aim

This course provides basic thinking about the Entrepreneurship to understand and work with the IT based industries.

Intended Learning Outcomes

- Identify various challenges of entrepreneurship and critically discuss characteristics of entrepreneurs
- Explain the difference between an idea and an opportunity and to evaluate business ideas
- Perceive the role of entrepreneurship within the society and personal life
- Develop an appreciation for opportunity, how to recognize it, and how to evaluate it
- Identify the ways in which entrepreneurship manifest itself

Course Contents

Introduction, resource-based perspective in the entrepreneurship (environment and entrepreneurship, entrepreneurial culture, enterprising), process-oriented perspective in entrepreneurship (creativity in entrepreneurship, innovation, opportunity exploitation, the Startup stage, mentorship, coaching and counseling), planning and managing an entrepreneurial venture, marketing, financing the entrepreneurial venture, output-oriented perspective in the entrepreneurial (evaluating and measuring the firm's success).

Teaching and Learning Methods

Classroom lectures, self-learning and discussions.

Evaluation Methods

In-course Assessment (Formative Assessment)	30%
End-semester Examination (Summative Evaluation)	70%

References

Kariv, D. (2011) *Entrepreneurship: An International Introduction.*

Hisrich, R. (2012) *Entrepreneurship.* 9^{th} Ed.

LEVEL 4

Course Title	**Project Planning and Management**
Course Code	**ENS4112**
Credit Value	2 (30h Theory+70h Independent learning)

Aim

To provide a basic understanding of project planning and management and the concepts behind each phase of project life cycle.

Intended Learning Outcomes

- Explain the concepts in project management
- Illustrate the phases/life cycle of a project
- Identify alternate projects to solve environmental issues
- Adapt the framework for effective management of projects confined to environmental management and protection
- Apply softwares for managing the projects

Course Contents

Introduction to project management concepts and practice, understand the phases/life cycle of a project, project identification, project selection, project appraisal, project planning (estimating costs, time — cost tradeoffs), the pricing process and risk, cost control, resource profile and levelling, quality management concepts, human resource and communication, project monitoring and control, project procurement, risk management plan, project performance/completion and success, applications of Microsoft Project software.

Teaching and Learning Methods

Lectures with whiteboard and marker, presentation, use of LMS, case studies, group discussions.

Evaluation Methods

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

References

Gido and Clements (2004) *Successful project management.* 2^{nd} Ed. New Delhi: Vikas Publishing House Pvt. Ltd.

Maylor, H. (2003) *Project management.* 3^{rd} Ed. New Delhi: Pearson Education Ltd.

Orr, A.D. (2004) *Advanced project management.* South Asian Ed. New Delhi: Kogan Page India.

Young, T.L. (1993) *Implementing projects.* First Indian Ed. New Delhi: Sterling Publishers Pvt. Ltd.

Young, T.L. (1999) *The handbook of project management.* 1^{st} South Asian Ed. New Delhi: VinodVasishtha for Kogan Page India Private Limited.

Course Title	**Cleaner Production (CP)**
Course Code	**ENS4122**
Credit Value	2 (20h Theory+30h Practical+50h Independent learning)

Aim

Understanding the importance of Cleaner Production (CP) strategy in environmental management for the sustainable development

Intended Learning Outcomes

- Identify appropriate strategies for different industrial and environmental problems based on a system analysis perspective
- Explain different unit operations and process in an industrial production process in order to minimize pollution
- Discuss the CP towards green industrial development

Course Contents

Theory: Definition of CP, evolution of environmental strategies from reactive to proactive CP techniques, comparison of CP vs end-of-pipe method, CP practices (good housekeeping, input substitution, better process control, on-site recycling), procedures for the implementation of CP techniques to industries, benefits, and barriers, CP towards sustainable development for the green industrial development, role of international organizations and stakeholder in developing CP, materials balance, life cycle assessment, waste audit procedure.

Practical: Students are required to complete an assessment to produce CP strategy for a selected industry.

Teaching and Learning Methods

Lectures with whiteboard and marker, presentations, use of LMS, open-book studies, group discussions, poster presentation, and problem based learning.

Evaluation Methods

Theory:

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

Practical:

In-course Assessment (Assignments)	100%

Final marks = {(2×Theory)+(1×Practical)}/3

References

Biagio, F. (2015) *Advances in Cleaner Production.* UK: Nova Science Publishers Inc.

Nilsson, L. (2007) *Cleaner production.* Sweden, Uppsala: Baltic University Press.

Course Title	**Research Methods and Experimental Design**
Course Code	**ENS4133**
Credit Value	3 (40h Theory+10h Practical+100h Independent learning)

Aim

To acquire and develop the knowledge on the theory of scientific reasoning, research and ethics for taking up and conducting effective applied environmental research projects, scientific writing, presentation and referencing skills in research proposals, articles, thesis, and papers.

Intended Learning Outcomes

- Identify research problems related to environmental issues
- Identify the experimental design for the environmental research
- Apply the sampling techniques in different types of research
- Develop the skills in manipulating raw data to perform statistical analysis executed via various software tools
- Interpret the output obtained from appropriate statistical analysis
- Develop the skill for scientific writing

Course Contents

Theory: Scientific method of research, research process, identification of research problem related to resource and environmental management, research proposal writing, principles of experimental designs and application, multidisciplinary research, evaluation research, sampling techniques, questionnaire construction, data collection methods, RRA and PRA surveys, observations, data analysis, interpretation of statistical outputs, scientific writing and literature citation, ethics of environmental research, experimental design (hypothesis testing in ANOVA, CRD, RCBD, LSD, mean separations, factorial experiments).

Practical: Handling ANOVA, mean separation, and factorial experiments using statistical packages.

Teaching and Learning Methods

Lectures with whiteboard and marker, presentations, students' presentation, textbook studies, referring textbooks, field level activity with rural people, use of LMS, and computer-based practical/s.

Evaluation Methods

Theory:

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

Practical:

In-course Assessment (Practical)	100%

Final marks = {(8×Theory)+(1×Practical)}/9

References

Pannerselvam, R. (2004) *Research Methodology.* India: Prentice-Hall.

Ranjit, K. (2005) *Research Methodology: A step-by-step guide for beginners.* 2^{nd} Ed. Sage Publication Ltd.

Samita, S. (2006) *Basic Designs in Agricultural Experiments: Fundamentals and Practice.* PGIS, University of Peradeniya.

Course Title	**Limnology and Wetland Management**
Course Code	**ENS4142**
Credit Value	2 (25h Theory+15h Practical+60h Independent learning)

Aim

To develop an appreciation for the theoretical and practical aspects of Limnology and to understand the importance of functionality of the inland waters and wetlands for its sustainable management.

Intended Learning Outcomes

- Demonstrate for reproducing the hypsographic curves, shore line development and estimation of area and volume of lakes and reservoirs
- Develop the technical skills for determining physiochemical properties of freshwater ecosystem and GIS applications
- Discuss the inland fisheries and ornamental fish breeding with respect to conservation and economy
- Describe the aquatic community abundance, distribution, interactions and influencing factors
- Explain the importance of wetlands and its management techniques

Course Contents

Theory: Limnology (introduction to inland waters, basic principles, origin and types of lakes), abiotic and biotic factors of inland water bodies, nutrition cycling, trophic status, primary and secondary productivity, plankton identification, abundance distribution and diversity indices, plankton (phytoplankton and zooplankton, sustainable/socio-economic development of inland fisheries (food fish culture and ornamental fish culture)), lakes and reservoirs as signals of climate change, wetland management (introduction to wetlands (composition, systemic processes, functions), types of wetlands, wetland Types in Sri Lanka, development threats and alternatives, wetland conservation and development strategy, role of man-made wetlands in environmental management.

Practical: Introduction to lake survey and field techniques (Lake Morphometry), analysis of abiotic and biotic factors of inland water body, plankton identification, quantification and diversity indices, and fish biology.

Teaching and Learning Methods

Lectures with whiteboard and markers, presentations, use of LMS, video clips/documentaries/discoveries/scientific movies, group activities and discussions, practical/s, tutorials and assessments, field visit and inter-university collaborations.

Evaluation Methods

Theory:

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

Practical:

End-semester Examination (Practical)	100%

Final marks = {(5×Theory)+(1×Practical)}/6

References

Andrew, S.C. (2003) *Paleolimnology. The History and Evolution of Lake Systems.* UK: Oxford University Press.

Osborne, P.L. (2000) *Tropical Ecosystems and Ecological Concepts.* UK: Cambridge University Press.

Wetzel, R. (2001) *Limnology, Lake and River Ecosystems.* 3^{rd} Ed. USA: Elsevier Academic Press.

Course Title	**Advanced Water Treatment**
Course Code	**ENS4152**
Credit Value	2 (20h Theory+30h Practical+50h Independent learning)

Aim to extend in-depth knowledge in advanced water treatments techniques carried out for water reuse as part of the means of conservation and resource sustainability.

Intended Learning Outcomes

- Define the significance and need of advanced water treatment techniques
- Distinguish the types of membranes based on the efficiency and energy consumption
- Discover the issues pertaining to the membrane filtration
- Appraise the suitable pre-treatment methods based on the contaminants of concern to ensure smooth operation of membrane
- Design appropriate physico-chemical treatment options coupled with membrane filtration for high quality water reuse

Course Contents

Theory: Introduction to advanced water treatment techniques, advantages of advanced water treatment over conventional water treatment, introduction to membrane technology in water treatment, types of membranes (low pressure, high pressure, passive membranes), efficiency of membrane systems, issues related to membrane filtration (membrane fouling, disposal of brine), different types of physico-chemical techniques such as adsorption – activated carbon adsorption, biosorption, ion exchange, removal of nutrients, heavy metals etc., prior to membrane filtration, removal of persistent organic pollutants, divalent and monovalent ions for the water reuse, dual membrane systems used in municipal water treatment plants for high quality water reuse, sea water desalination.

Practical: Determination of general water quality parameters, study the removal of organics and inorganics by adsorption and ion exchange techniques, determination of adsorption efficiency of the adsorbents based on isotherm and kinetics experiments, adsorption of other contaminants of concern using bio sorbents.

Teaching and Learning Methods

Lectures with whiteboard and marker, multimedia presentations, in-class group discussions, problem based tutorial discussions, open-book studies, use of LMS, and field visits.

Evaluation Methods

Theory:

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

Practical:

In-course Assessment (Practical assignments)	100%

Final marks = {(2×Theory)+(1×Practical)}/3

References

Drinan, J.E. and Spellman, F. (2012) *Water and wastewater treatment: A guide for the non-engineering professional* [Electronic version]. CRC Press.

Mulder, M. (1996) *Basic Principles of Membrane Technology* [Electronic version]. London: Kluwer Academic Publishers.

Wachinski, A.M. (2013) *Membrane Processes for water reuse* [Electronic version]. NY: McGraw Hill.

Course Title	**Groundwater Management**
Course Code	**ENS4163**
Credit Value	3 (45h Theory+105h Independent learning)

Aim

Development of basic understandings and knowledge on the science of groundwater management in the local and global contexts.

Intended Learning Outcomes

- List the types of aquifers and the aquifer characteristics of groundwater
- Explain the laws in hydrology and their applicability in groundwater management
- Assess the drawdown of groundwater level with extraction of water from wells
- Explain the methods of artificial recharge of groundwater
- Justify the reasons for salt water intrusion and the reasons for saline water in different regions
- Explain the causes for Groundwater pollution and choose the remedial measure for minimizing the pollution level

Course Contents

Groundwater flow, porosity and specific yields, vertical distribution of soil, transmissivity and storage coefficient and their physical significance, tracer techniques in groundwater, types of aquifers (confined and unconfined), basic differential equation and its physical significance in confined and unconfined aquifers, drinking water treatment processes facilities, design of water treatment processes facilities, recharge of groundwater, salt water intrusion into the groundwater (status of Northeast of Sri Lanka and coastal aquifers and its remediation), economic aspects in groundwater management.

Teaching and Learning Methods

Lectures with whiteboard and marker, presentations using multimedia, textbook studies, tutorial discussions, presentations by the students based on field-based assignments, and use of LMS.

Evaluation Methods

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

References

Brooks, K.N., Ffolliott, P.F. and Magner, J.A. (2003) *Hydrology and Management of Watersheds.* 4^{th} Ed. Wiley-Blackwell Publisher.

Fetter, C. (1990) *Applied Hydrogeology.* 2^{nd} Ed. New Delhi: C.B.S. Publishers and Distributers.

Todd, D.K. (2006) *Groundwater Hydrology.* 2^{nd} Ed. New Delhi: Wiley India Pvt. Ltd.

Course Title	**Environmental Microbiology**
Course Code	**ENS4173**
Credit Value	3 (35h Theory+30h Practical+85h Independent learning)

Aim

To understand the microbial community and their functions, impacts and applications in the environment.

Intended Learning Outcomes

- Identify the microbial diversity in the environment and explain the survival
- Explain the interactions and ecological relationship of microorganisms
- Explain the mechanisms of microbial interaction in biofilm
- Apply the methods used to isolate and identify the novel microorganism in environment and their products
- Utilize the microorganism for the benefit of human
- Apply the microbiological knowledge for environmental management, industrial sector, and agriculture and food production

Course Contents

Theory: Microbial diversity in the environment, enzyme assay, nucleic acid assay in microbiology, ecological relationship of microorganism (relationship among microbial population), microbial interaction in biofilm, plant microbes interaction and pathogenic interaction, symbiotic interactions of microorganism with plant, microbes and human, microorganism in waste treatment (aerobic and anaerobic bacterial degradation of organic polymers), microorganism in metal pollution control, microbial degradation of organic pollutants (aerobic and anaerobic degradation of solid waste hydrocarbon), recalcitrant organic pollutants (microbial degradation of pesticide), bio-indication of microorganism (standard criteria, indicator organism, bio-indication of groundwater and surface water quality), scope and applications of environmental microbiology.

Practical: Examination of soil microorganisms via microscopic and cultural assays, enrichment and isolation of bacteria that degrade, 2,4-Dichlorophenoxyacetic acid, microbial examination of water (Coliform MPN test, membrane filter technique), detection of waterborne parasites, biodegradation of phenol compounds, adaptations to metal, study the probiotic characters of probiotic microorganisms, molecular identification of bacteria PCR BLAST sequencing.

Teaching and Learning Methods

Lectures with whiteboard and marker, presentations, use of LMS, tutorial discussions, group discussions, open-book studies, field visits, practical demonstrations, handouts, and lecture notes.

Evaluation Methods

Theory:

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

Practical:

In-course Assessment (Practical reports)	50%
In-course Assessment (Practical assignment)	50%

Final marks = {(7×Theory)+(2×Practical)}/9

References

Mohapatra, P.K. (2008) *Textbook of Environmental Microbiology.* 2^{nd} Ed. New Delhi: I.K. Int Publishing House.

Nancy, K. (2016) *Food Microbiology: In Human Health and Disease.* 1^{st} Ed. Taylor & Francis group.

Pepper, L. and Gerba, C.P. (2004) *Environmental Microbiology: A Lab Manual.* 2^{nd} Ed. Elsevier Academic Press.

Course Title	**Advanced Spectroscopic methods**
Course Code	**ENS4183**
Credit Value	3 (40h Theory+10h Practical+100h Independent learning)

Aim

To develop analytical skills using advanced spectroscopy methods for conducting research projects in environmental sciences

Intended Learning Outcomes

- State UV and visible spectra and absorption laws
- Describe Nuclear Overhauser Effect (NOE) to elucidate the structure of organic compounds
- Demonstrate the methods for the preparation of samples for analysis using spectroscopic methods
- Develop analytical skills to interpret NMR spectra and mass spectra
- Identify the functional groups of organic compounds as per spectroscopic details

Course Contents

Theory: Ultraviolet and visible spectra, absorption laws, chromophores, solvent effects, infrared spectroscopy, preparation of samples, selection rules, use of tables of characteristic group frequencies, absorption frequencies for functional groups, ^{1}H–NMR spectroscopy and ^{13}C–NMR spectroscopy, Pulse and Fourier transform NMR, spin systems of nuclei, 1H chemical shifts, Spin-spin coupling, shift reagents, spin decoupling, Nuclear Overhauser Effect, ^{13}C-NMR, NOESY spectra, (^{13}C–^{13}C), 2D NMR spectroscopy – DEPT, COSY (H-H), HMQC (^{1}H ^{13}C COSY), interpreting NMR spectrum, mass spectroscopy, mass spectrometer, factors controlling fragmentation modes, interpreting mass spectra.

Practical: Structure elucidation of organic compound using these spectroscopic details.

Teaching and Learning Methods

Lectures with whiteboard and marker, multimedia presentations, use of LMS, in-class group discussions, and problem based learning

Evaluation Methods

Theory:

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

Practical:

In-course Assessment (Assignments/Practical reports)	100%

Final marks = {(8×Theory)+(1×Practical)}/9

References

Pavia, D.L., Lampman, G.M., Kriz, G.S. and Vyvyan, J.R. (2009) *Introduction to Spectroscopy.* 4^{th} Ed. Brooks/Cole. Cenage Learning.

Silverstein, R.M., Webster, F.X. and Kiemle, D.J. (2005) *Spectrometric identification of organic compounds.* 3^{rd} Ed. NY: John Wiley & Sons Inc.

Course Title	**Climate Change**
Course Code	**ENS4192**
Credit Value	2 (30h Theory+70h Independent learning)

Aim

To understand the concept of geo-physiology as an effective means for earth system management and environmental consequences.

Intended Learning Outcomes

- Explain the theories behind the earth system science and the characteristics of environmental systems
- Illustrate the process of biogeochemical cycles and their importance in earth subsystems
- Explain the environmental changes in natural and man-made environment
- Describe the human induced climate changes and their environmental impacts
- Design the feedback mechanisms and models for different environmental issues

Course Contents

Earth as a system (justification for the study of Earth systems science), time scales in earth systems science (geologic, biologic and anthropogenic), introduction to Global Environmental Change (GEC) (definitions and the perspectives), natural processes and GEC (geosphere, hydrosphere, biosphere and atmosphere, climate change, geological evolution, oceanographic aspects and biological consequences of GEC), theories in the earth systems science (Gaia theory, systems evolution and change), needs for comprehensive geo-physiological approaches in science, geo-physiological limits, the life support system-towards earth science.

Teaching and Learning Methods

Lectures with whiteboard and marker, presentations, use of LMS, group activities, video clips.

Evaluation Methods

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

References

Freedman, B. (2014) *Global Environmental change.* Netherland: Springer.

Paul, D.S., Oran, R.Y. and Duckman, D. (1992) *Global Environmental Change: Understanding the human dimension.* Washington, DC: National Academies Press.

Course Title	**Environmental Communication**
Course Code	**ENS41(10)2**
Credit Value	2 (25h Theory+15h Practical+60h Independent learning)

Aim

To develop skills on the effective application of theories and communication methodologies so as to effectively produce pieces of journalistic work on critical (socio-) environmental issues in the local and global contexts that need the effective application of (applied) sciences, and socio-administrative attention.

Intended Learning Outcomes

- Define the communication theories
- Explain the modern trends in journalism
- Demonstrate skills on media playing such as videography, documentary making, e-blogging for an effective dissemination to public
- Create advertisements for public relations
- Write and publish articles to scientific community

Course Contents

Theory: Introduction to communication and communication theories (including research methodologies in communication), modern trends in journalism, reporting, writing and editing, media laws and ethics, media planning tools and media playing, print journalism (including newspaper organization and printing), e-journalism (radio, television and web), advertising and public relations (principles of public relations, process of public relations, creating advertisements including advertisement campaigns), communication for development, writing and publication targeted to the scientific community (i.e. producing journal articles, peer reviews, conference presentations, developing book chapters etc. and aspects of plagiarism)

Practical: Writing skills, photo journalism, videography and documentary making, e-blogging as an effective way of disseminating scientific information and presenting skills (the art of presentation) for writing, photo journalism, videography (documentary making) and e-blogging.

Teaching and Learning Methods

Lectures with whiteboard and marker, multimedia presentations, use of LMS, in-class group discussions, computer and software based practical/s, and problem based learning.

Evaluation Methods

Theory:

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

Practical:

In-course Assessment (Practical assignments)	100%

Final marks = {(Theory×5)+(Practical×1)}/6

References

Cox, R. (2013) *Environmental Communication and the public sphere.* 3^{rd} Ed. USA: SAGE Publications Inc.

Hansen, A. (2010) *Environment, Media and Communication.* 1^{st} Ed. London: Routledge.

Course Title	**Metrology**
Course Code	**ENS41(11)3**
Credit Value	3 (40 Theory+ 15h Practical + 95h Independent learning)

Aim

To provide comprehensive knowledge in metrology (measurement science) and its applications.

Intended Learning Outcomes

- Understand the principles of theoretical and practical aspects of metrology
- Identify the importance of measurement traceability and way of maintaining it
- Define complete information on the modality to arrive at the expression of the measurement uncertainty and to give a sound foundation for the compatibility and comparability of measurement results
- Apply the metrology concepts in real measurements
- Illustrate the process of quality management in testing and/or in calibration laboratories

Course Contents

Theory: General description (introduction to metrology, importance of metrology, need of measurements, concepts of true value and reference value, importance of correct measurements in different sectors; industry, consumer protection, international trade, etc.), Traceability of measurement results and impact of metrology (traceability, calibration and its impact of metrology, measurement standards, reference materials, comparability of measurement results.) SI system of units in general (base quantities and units, derived quantities and units, the international system of units (SI), definitions of SI base units, SI base units and fundamental constants and their realizations, SI writing rules.), Concept of measurement uncertainty (importance of measurement uncertainty, measurement error, systematic error, random error, corrections, standard deviation, standard uncertainty, type A evaluated uncertainty, type B evaluated uncertainty, relative uncertainty, probability distribution functions.), Estimation of measurement uncertainty (mathematical model of measurement, combining standard uncertainties, expanded uncertainty, coverage factor, uncertainty budgets, expressing the measurement result, exercises,), Laboratory quality assurance (internal quality control, inter-laboratory comparisons, laboratory accreditation and ISO17025 standard.)

Practical: Mass measurements (appropriateness in handling analytical balance and weights, calibration of analytical balance, reporting results with measurement uncertainty.), Volumetric Measurements (appropriate handling glassware, calibration of pipettes, burettes, volumetric flasks and other laboratory equipment, reporting results with measurement uncertainty.), Metrology infrastructure (the metre convention, CGPM, CIPM, BIPM, National metrology institutes, Regional metrology organizations, APMP, Metrology infrastructure in Sri Lanka.).

Teaching and Learning Methods

Lectures with whiteboard and marker, presentations, group activities and discussions, and laboratory activities.

Evaluation Methods

Theory:

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

Practical:

In-course Assessment (Practical assignments)	100%

Final marks = {(Theory×8)+(Practical×1)}/9

References

BIPM Organization, *The Metre Convention*, CIPM Mutual Recognition Arrangement, www.bipm.org

JCGM (2008) *International vocabulary of metrology - Basic and general concepts and associated terms (VIM)*. JCGM 100:2012

BIPM (2019) *The International System of Units (SI)*, Bureau International des Poids et Mesures, 9th edition.

JCGM (2012) *International vocabulary of metrology - Basic and general concepts and associated terms (VIM)*. JCGM 106:2012.

Course Title	**Industrial Training**
Course Code	**ENS4211**
Credit Value	1 (200h Notional learning)

Aim
To provide the practical exposure and the work experience in the field of environmental science.

Intended Learning Outcomes
- Develop the hands-on skills
- Demonstrate the practicalities in relevant industries of specialization

Course Contents and evaluation procedure:
Students have to follow two months industrial training during the fourth year second semester vacation and submit a report and present their experience. The head of the department make the arrangement to find the relevant industries for the students to obtain the training. The evaluation of this unit will be done by the institution where the student obtains the training and a panel of senior staff at the Department and it is based on:

Attendance and punctuality during training period	10%
Output and the quality of the work done	10%
Reliability without supervision	5%
Industriousness	5%
Enthusiasm	5%
Personality	5%
Leadership	10%
Preparation of report (Training course report)	30%
Presentation of report	10%
Viva-voce	10%

Course Title	**Research Project**
Course Code	**ENS4226**
Credit Value	6 (600h Notional learning)

Aim
To motivate the student to solve any environment related problem scientifically.

Intended Learning Outcomes
- Develop skills on designing, implementing and reporting of scientific investigation/s
- Demonstrate to apply various aspects to scientific theories to solve environmental problems

Course Contents and evaluation procedure:
This module worth 6 credits will be centered on an individual research project conducted by the student culminating in the production and defense of the thesis.
Based on the submission of the proposal, the Head of the department will assign an internal supervisor who must be a Senior Lecturer at the department to function as the supervisor for the project. Depending on the nature of the research, the possibility of having one or more supervisors (even from outside the university) will also be encouraged – so as to facilitate research and learning.
The evaluation of the project will be based on:

Project proposal	10%
Conduct of project	20%
Project Report/Thesis	40%
Oral presentation	15%
Viva-voce	15%

Course Title	**Environmental System Modelling**
Course Code	**ENS4232**
Credit Value	2 (25h Theory+10h Practical+65h Independent learning)

Aim

To develop skills in modelling of environmental system/s and for practical application of principles to manage and solve real-world environmental problems in the context of environmental science.

Intended Learning Outcomes

- Outline the theoretical aspects in system/s modelling
- Translate the complex systems into demonstrable simple forms
- Demonstrate the ability in visualizing, mapping and comprehending systems processes to address environmental issues
- Design simple models related to environmental issues
- Construct the models related to environmental issues using software tools

Course Contents

Theory: Systems thinking (understanding systems, defining a system, connective loops and feedback processes, role of temporal and spatial elements in system dynamics, understanding 'change'), assumptions, hypotheses and theories in the perspective/s of systems thinking, defining models and modelling, the scope of modelling, the philosophy of modelling, modeler versus the model, types of models, basics of modelling, application of systemic thinking in the development of models, role of modelling in present day applied environmental science research, real-world applications of environmental modelling, scope of statistical/numerical modelling in environmental science.

Practical: Mapping modeling processes in flowchart form, basics of spreadsheets (techniques, functions, features and capacities as a modelling platform), introduction to STELLA (experimenting with models constructed in the STELLA platform, building simple models on the STELLA platform, Statistical/numerical modelling.

Teaching and Learning Methods

Lectures with whiteboard and marker, presentations, use of LMS, and divided small group activities, computer-based practical/s.

Evaluation Methods

Theory:

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

Practical:

In-course Assessment (Practical assignments/reports)	100%

Final marks = {(5×Theory)+(1×Practical)}/6

References

Aral, M.M. (2010) *Environmental Modeling and Health Risk Analysis (ACTS/RISK).* Netherlands: Springer.

Richmond, B. (2001) *An introduction to Systems Thinking (a manual on the STELLA™ Software*). USA: High Performance Systems Inc.

Wainwright, J. and Mulligan, M. (2004) *Environmental Modelling.* John Wiley & Sons, Ltd.

Course Title	**Plantation Forestry and Environment**
Course Code	**ENS4242**
Credit Value	2 (30h Theory+70h Independent learning)

Aim

Understanding the importance of plantation forestry as an effective means of environmental management/conservation.

Intended Learning Outcomes

- Identify the characteristics of forest plantation sector of Sri Lanka
- Discuss the species suitability for different climatic zones
- Learn the forest silvicultural treatments used in managing forest plantations
- Discuss the silvicultural systems used in managing forests
- Learn the forest mensuration as a tool for managing forest plantations

Course Contents

Role of plantation forestry, reforestation/afforestation, establishment of forest plantations (Selection of tree species for different climatic zones and uses, forest nursery management, field planting, nutrition and weed management), silvicultural management (clearing, pruning, thinning, harvesting and utilization), silvicultural systems, energy and industrial plantations, measuring trees and stands (age, diameter, height, growth and density of forest stands).

Teaching and Learning Methods

Lectures with whiteboard and markers, presentations, use of LMS, video clips, group activities and discussions, tutorials and assessments, field visits and activities.

Evaluation Methods

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

References

Chaturvedi, A.N. and Kanna, L.S. (1982) *A handbook on Forest Mensuration.* International Book Distributors.

Forest Department, (2007) *Improved Forest Nursery Practices.* Sri Lanka: Forest Resources Management Project.

Julian, E. and John, W.T. (2004) *Plantation Forestry in the tropics.* 3^{rd} Ed. UK: Oxford University Press.

Luna, R.K. (1996) *Plantation Trees.* Dehradun: IBD Publication.

Course Title	**Integrated Weed Management**
Course Code	**ENS4252**
Credit Value	2 (25h Theory+15h Practical+60h Independent learning)

Aim

To understand the integrated approaches to weed management as an environmentally sustainable measure on-par with sustainable environmental management.

Intended Learning Outcomes

- Identify weeds in the terrestrial and aquatic systems and classify them
- Discuss the control methods and their positive and negative impacts on the environment
- Develop Integrated Weed Management (IWM) practices in terrestrial and aquatic environment
- Summarize the advantages of integrated approaches for the sustainable environmental management
- Identify the Invasive Alien Species (IAS) distribution and their level of harmfulness towards the environment
- Develop strategies to control IAS

Course Contents

Theory: Weed (definition, nomenclature and classification, reproduction), effect of environment on weed and crop physiology, competitiveness of weeds and nature of weeds competition, allelopathy, special weed problems and the impacts on the environment, aquatic weeds, poisonous, parasitic and invasive weeds, weed control (physical, chemical, biological, cultural control and integrated pest and weed management), IAS distribution and their impact on the environment.
Practical: Field-based studies, field visits.

Teaching and Learning Methods

Lectures with whiteboard and marker, presentations, textbook studies, report writing and weed album preparation, presentations by the students, and use of LMS.

Evaluation Methods

Theory:

In-course Assessment (Tutorials/Assignments)	10%
In-course Assessment (Quiz I and II)	20%
End-semester Examination (Theory)	70%

Practical:

In-course Assessment (Field visits and reports)	100%

Final marks = {(5×Theory)+(1×Practical)}/6

References

Auld, B.A. and Kim, K.U. (1996) *Weed Managemnet in Rice.* 1^{st} Ed. UK: Oxford and IBH Publishing Pvt. Ltd.

Appendix C

Detailed Syllabus

Bachelor of Science in Information Technology

Bachelor of Science Honours in Information Technology

LEVEL 1

Course Title	Fundamentals of Information Technology
Course Code	IT1113
Credit Value	3 (30h Theory + 30h Practical + 90h Independent learning)

Objective

To provide the basic knowledge on the components of information technology and apply computational tools to solve the real-world problem.

Intended Learning Outcomes

- identify the components of computer systems
- classify the computer network technologies
- explain the functions of computer peripherals
- determine troubleshooting techniques for the common problems in computer systems
- apply knowledge of number system for computational problems
- utilize application software for various task

Contents

General Introduction: History of computing, The computer generation, Classification of computers, **Computer Organization:** Basic components and organization of a computer, input devices and its functions, storage devices output devices and its functions, **Processor and Memory:** processing and memory hardware, Secondary storage, **Numbers System:** Number System, Conversions, Data Representation **Programming:** Programming languages and Language translation, types of Operating system and its functions **Database Management System:** Introduction, Components of a Databases, **Computer Network:** Basic principles, Introduction to data communications, Revolution, Internet and e-mail, e-learning, e-banking, Role of IT in Society, **Emerging Trends:** Future Computers, New Trends in Computing and IT.

Practical: Basic features of application software, MS-DOS/Windows, Unix, Utility programs, Utility packages, Word processing, Spreadsheets and presentations,

Teaching and Learning Methods

Classroom lectures, self-learning and discussion, computer practical demonstration and training.

Evaluation Method

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks = $(2 \times Theory + 1 \times Practical)/3$

Recommended Readings

1. Ralph M. Stair, George W. Reynolds, Fundamentals of Information Systems, 6^{th} Edition, 2012.
2. S.Kanaganathan , Fundamentals of Information Technology, 2006.
3. Anoop Mathew, S. Kavitha Murugeshan , Fundamentals of Information Technology, 2013.

Course Title	Foundation of Mathematics
Course Code	IT1122
Credit Value	2 (30h Theory + 70h Independent learning)

Objective

To provide the knowledge to solve IT related mathematical problems using appropriate techniques.

Intended Learning Outcomes

- solve the operations associated with sets, functions and relations
- convert informal language statements into logical expressions
- relate Boolean logic to computational problems
- construct graphs and trees for IT related problems
- construct automata system for a simple sentence

Contents

Basic Structures: Sets, Relations and Functions.
Logic and Proofs: Propositional Logic, Predicates and Quantifiers, Rules of Inference.
Boolean Algebra: Logic Gates, Karnaugh maps, Simplifications, Graphs and Trees, Modeling.
Computation: Automata and Languages, Turing machines.

Teaching and Learning Methods:

Classroom lectures, self-learning and discussion.

Evaluation Methods

- In-Course Assessments 30%
- End-Semester Examination 70%

Recommended Readings

1. Bernard Kolman, Robert C.Busby, Discrete Mathematical Structures for Computer Science, 2^{nd} Edition, 1987.
2. Kerneeth H. Rosen, Discrete Mathematics and its Applications, 7^{th} Edition, 2012.
3. Judith Gersting, Mathematical Structures for Computer Science, 7^{th} Edition, 2014.

Course Title	Fundamentals of Programming
Course Code	IT1134
Credit Value	4 (30h Theory + 60h Practical + 110h Independent learning)

Objective

To provide adequate knowledge on computer programming techniques and train to design, code and debug programs.

Intended Learning Outcomes

- define the basic structures of programming.
- devise an algorithm to solve problems
- utilize the functions to break down the tasks to solve a problem.
- apply the exception handling techniques in programming.
- construct programs using a high-level language.

Contents

Overview of Programming languages, **Techniques of Problem solving:** Algorithm, Flowchart and Pseudo codes, **Basic Programming:** Introduction of C++ Programming, Structure of a C++ Program, Input / Output Streams, Variable declaration, Arithmetic Operations, Relational Operations, Logical Operations, **Control Structures:** If/ Else, While repetition, For repetition, Switch multiple selections, Do-While, Break and Continue, **Functions:** defining a function, Scope of variables and parameters, Recursion, **Data Storage Schemes:** Arrays, Pointers, Record, Struct, Exception Handling.

Practical: Implementation of all the concepts covered in theory using C++.

Teaching and Learning Methods:

Classroom lectures, self-learning and discussion, computer practical demonstration and training

Evaluation Method

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks = $(2 \times Theory + 2 \times Practical)/4$

Recommended Readings

1. D. S. Malik, C++ Programming: From Problem Analysis to Program Design, 5^{th} Edition, 2011.
2. Bjarne Stroustrup,Programming: Principles and Practice Using C++,2^{nd} Edition, 2014
3. Paul J. Deitel, Harvey Deitel, C++ How to Program, 10^{th} Edition, 2016.

Course Title	Fundamentals of Web Programming
Course Code	IT1144
Credit Value	4 (30h Theory + 60h Practical + 110h Independent learning)

Objective

To provide knowledge on web-based programming techniques to design interactive web pages.

Intended Learning Outcomes

- create web pages using HTML.
- apply adequate formatting for presentation purposes
- utilize special effect to make the expressive, evocative documents
- construct unordered, ordered, and nested lists in HTML document
- build web pages with embedded multimedia components
- modify the form's attributes to make them more usable

Contents

Introduction: the Internet, Web browser, Understanding directories and structures, Understanding URLs, Connecting to the Internet, Customizing browser settings, **Web browser:** Architecture, HTML and the modern Web, A web of structured documents, **Introducing web technologies:** Basic text formatting, Presentational elements, Phrase elements, **Links and navigation:** Creating links, embedding Images, Audio, Video, Adding flash, **Forms and tables:** Tables, Forms, Form controls, Structuring forms, Focus, Frames, **Formatting:** Cascading Style Sheets, Controlling text, Text formatting, Selectors.

Practical: Developing web pages with the concepts covered in theory using HTML and CSS

Teaching and Learning Methods:

Classroom lectures, self-learning and discussion, computer practical demonstration and training.

Evaluation Method

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks = $(2 \times Theory + 2 \times Practical)/4$

Recommended Readings

1. Jon Duckett, Beginning HTML, XHTML, CSS, and JavaScript, 2010.
2. P. J. Deitel, H. M. Deitel, Internet & World Wide Web How To Program, 5^{th}Edition, 2011.
3. Faithe Wempen, HTML5 Step by Step, Microsoft Corporation, 2011.

Course Title	Essentials of Statistics
Course Code	IT1152
Credit Value	2 (30h Theory + 70h Independent learning)

Objective

To understand the relationship between probability and statistics and the importance of each in modeling practical problems.

Intended Learning Outcomes

- find the mean, median and mode of a given sample of data.
- apply the binomial theorem to independent events and Bayes' theorem to dependent events.
- utilize the tools of probability to create simple discrete event simulations.
- analyze system's performance statistically and recommend ways to improve performance.

Contents

Descriptive statistics, Probability theory, Random variables, Discrete probability distribution, Continuous probability distributions, Normal distribution, Hypothesis testing, Sampling and descriptive statistics, Application of mathematics and statistics to IT.

Teaching and Learning Methods:

Classroom lectures, self-learning and discussion.

Evaluation Methods

- In-Course Assessments 30%
- End-Semester Examination 70%

Recommended Readings

1. Michael Baron, Probability and Statistics for Computer Scientists, Second Edition, 2014.
2. Douglas C. Montgomery, George C. Runger, Applied Statistics and Probability for Engineers, Sixth Edition, 2014.
3. W. John Braun, A First Course in Statistical Programming with R, Second Edition, 2016.

Course Title	English Language I
Course Code	ACU1113
Credit Value	3 (45h Theory + 105h Independent learning)

Objective

To provide the necessary language skills to read, write, listen and speak in English in formal and informal academic and professional contexts **at the intermediate level**.

Intended Learning Outcomes

- relate the fundamental knowledge on the use of the four skills – speaking, listening, reading and writing.
- identify the semantic and pragmatic forms and meanings for the contextual application.
- demonstrate efficiency and effectiveness in both receptive and expressive skills.
- create a distinct style and rhetoric orally, aurally, graphically, and grammatically.

Contents

At the intermediate level, Reading skills, Identifying main points, Understanding vocabulary, Introducing the mechanics of writing, Introducing vocabulary in and around the University environment, Developing sentences and paragraphs, Transferring graphic, pictorial information into writing, Preparing to write an essay or a project, Describing objects, Interviewing, Giving instructions, Making short speeches, Listening to discriminate sounds, Listening for specific information, Listening and responding to telephone conversion, Introducing structures, Question formation, Articles, Preposition, Pronouns, Quantifier, Word class, Active and passive, Topics to be selected from student's field of interest, Submission of individual projects.

Teaching and Learning Methods:

Classroom lectures, self-learning, computer-assisted language learning, individual and group discussion and presentation.

Evaluation Methods

- In-Course Assessments (Listening and Speaking) 30%
- End Semester Examination (Reading, Writing and Language Structures) 70%

Recommended Readings

1. Miles Craven, Craig Thaine, and Sally Logan, Cambridge English Skills: reading. Writing, listening and speaking from Elementary Advanced, Cambridge University Press,2016.
2. Alison Pohl, Eric Glendinning, and Lewis Lansford, Oxford English for Careers Technology for Engineering and Applied Sciences: Student Book, Oxford University Press, United Kingdom, 2013.
3. Murphy R., Essential English Grammar, Cambridge Publications, 2012.

Course Title	Object Oriented Design and Programming
Course Code	IT1214
Credit Value	4 (30h Theory + 60h Practical + 110h Independent learning)

Objective

To provide knowledge on object-oriented programming concepts for application development

Intended Learning Outcomes

- distinguish the basic concepts of structured and object-oriented programming.
- convert the real-world objects into the programming paradigm.
- make use of object-oriented concepts in program development.
- relate classes using inheritance hierarchies to minimize the duplication of objects
- design polymorphic objects to improve the reusability of programming.
- design object-oriented solutions for small systems involving multiple objects.

Contents

Introduction: Structured Programming and OOP, Specifying a class, Defining Member Functions, **Constructors and Destructors:** Multi Constructors, Dynamic Constructors, Copy Constructors, Destructors, Static Data Members, Static Member Functions, **Inheritance:** Extending Classes, Defining Derived Classes, Single Inheritance, Making A Private Member Inheritance, Multilevel Inheritance, Multiple Inheritance, Hierarchical Inheritance, Hybrid Inheritance, Virtual Base Classes, Abstract Classes, Constructors In Derived Classes, Member Classes, **Operator overloading and type conversions:** Defining Operator Overloading, Overloading Unary Operators, Overloading, Binary Operators, Overloading Binary Operators Using Friends, Manipulation of Strings Using Operators, Rules for Overloading Operators, Type Conversions, **Pointers, Virtual Functions, and Polymorphism:** Pointers to objects, this pointer, Pointers to derived classes, Virtual functions.

Practical: Developing object-oriented programs using the concepts covered in the theory.

Teaching and Learning Methods:

Classroom lectures, self-learning and discussion, computer practical demonstration and training.

Evaluation Method

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks = $(2 \times Theory + 2 \times Practical)/4$

Recommended Readings

1. David J. Barnes, Object-Oriented Programming with Java: An Introduction, Prentice Hall, 2000.
2. C. Thomas Wu, An Introduction to Object-Oriented Programming with Java, Fifth Edition, TATA McGraw-Hill, 2006.
3. David West, Brett McLaughlin, Gary Pollic, Head First Object-Oriented Analysis and Design, 1st Edition,2011.

Course Title	Database Management Systems
Course Code	IT1223
Credit Value	3 (30h Theory + 30h Practical + 90h Independent learning)

Objective

To provide knowledge about database management and data retrieval for application development

Intended Learning Outcomes

- identify the data, information, and databases in organizations.
- apply appropriate development methodologies of data analysis and design for database.
- determine database requirements for the system implementation
- utilize appropriate modelling techniques for database.
- improve database design using normalization.
- make use of SQL queries to manipulate the data.

Contents

Introduction to Database system, **Information systems:** purpose, use, value, Properties of data (quality, accuracy, timeliness), **Database systems:** Analysis of data, forms and sources, Data collection, Data retention, Information backup and recovery, DBMS architecture, **Data Modeling:** ER & EER, Relational Data Model, **Data Definition and Data Manipulation Language:** Relational Algebra and Calculus, Normalization and Relational Database Design.

Practical: Implementation of Database Management System concepts covered in theory using Query Processing: SQL.

Teaching and Learning Methods:

Classroom lectures, self-learning and discussion, computer practical demonstration and training.

Evaluation Method

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks = $(2 \times Theory + 1 \times Practical)/3$

Recommended Readings

1. Carlos Coronel, Steven Morris, and Peter Rob, Database Systems: Design, Implementation, and Management, Ninth Edition, 2011.
2. Thomas M. Connolly, Carolyn E. Begg, Database Systems A Practical Approach to Design, Implementation, and Management, Fourth Edition, 2005.
3. Elmasri and Navathe, Fundamentals of Database Systems, 7^{th} Edition, 2015
4. Ragu Ramakrishnan, Johannes Gehrke, Database Management Systems, 3^{rd} Edition, 2002
5. Robert Sheldon and Geoff Moes, Beginning MySQL, 2005.

Course Title	Project Management
Course Code	IT1232
Credit Value	2 (30h Theory + 70h Independent learning)

Objective

To provide knowledge on management and technology skills for the development of successful IT-related projects.

Intended Learning Outcomes

- analyse the general issues necessary for the information technology projects
- compare various management methods between the hierarchy of stakeholders
- discuss the unique attributes, diverse nature, monitoring and controlling processes and controlling a project.
- explain the process for creating a work breakdown structure.
- identify the risk factors of an IT Project

Contents

Introduction to Project Management: A Systems View of Project Management, The Context of Information Technology Projects, The Project Management Process, Project Integration Management, Project Scope Management, Project Time Management, **Project Cost Management:** Estimating Costs, Determining the Budget , Controlling Costs, **Project Quality Management:** Planning Quality Management , Performing quality assurance, Tools, and Techniques for Quality Control, Improving IT Project Quality, **Project Human Resource Management:** Keys to Managing People, Developing the Human Resource Plan, Developing the Project Team, **Project Communications Management:** Keys to Good Communications, Planning Communications Management, Managing Communications, Controlling Communications, **Project Risk Management:** Planning Risk Management , Common Sources of Risk on IT Projects, Identifying Risks, Performing Qualitative Risk Analysis, Performing Quantitative Risk Analysis, Controlling Risks, Project Reporting.

Teaching and Learning Methods:

Classroom lectures, self-learning and discussion

Evaluation Methods

- In-Course Assessments 30%
- End-Semester Examination 70%

Recommended Readings

1. Kathy Schwalbe, Information Technology Project Management, 7^{th} Edition, 2014.
2. Jack T. Marchewka, Information Technology Project Management: Providing Measurable Organizational Value,5^{th} Edition, 2016
3. A Guide to The Project management Body of Knowledge (PMBOK@ Guide), 4^{th} Edition.

Course Title	Principles of Computer Networks
Course Code	IT1242
Credit Value	2 (30h Theory + 70h Independent learning)

Objective

To provide knowledge on data communication and computer networks.

Intended Learning Outcomes

- identify the indispensability of the data communication in computer networks
- discuss different networking devices and their functionalities.
- analyze the network requirements for an organization
- explain the concepts of data communication within the network environment.
- distinguish the various multiplexing techniques used in data communication

Contents

Basics of Computer Networks: Computer Network Model, Data Communications, Classification of Computer Networks, The Internet, Protocols and standards, **Network Models:** The OSI Model, Layers in the OSI Model, TCP/IP Protocol Suite, **Transmission Media:** Data and Signals, Analog and Digital Signals, Signal Conversions, Data Rate Limits, **Propagation Methods:** Wavelength Division, Frequency Division and Time Division Multiplexing, Switching Techniques, **Error Control:** Error Detection and Correction Methods.

Teaching and Learning Methods:

Classroom lectures, self-learning and discussion.

Evaluation Methods

- In-Course Assessments 30%
- End-Semester Examination 70%

Recommended Readings

1. Andrew S. Tanenbaum, David J. Wetherall, Computer Networks, 5thEdition, Pearson, 2011.
2. J. F. Kurose and K. W. Ross. Computer Networking: A Top Down Approach, 6^{th}Edition, Pearson, 2013.
3. Behrouz A. Forouzan, Data Communications and Networking, Fourth Edition, McGraw-Hill Professional, 2007.

Course Title	Electronics and Device Interfacing
Course Code	IT1252
Credit Value	2 (15h Theory + 30h Practical + 55h Independent learning)

Objective

To provide knowledge on basic electronics and microcontrollers/microprocessors architectures with programming

Intended Learning Outcomes

- define the role of semiconductor in electronic devices
- explain the use of different electronic components and their functions
- demonstrate the necessary steps and methods used to interface a microcomputer system.
- construct a structured program to accomplish tasks using a microcontroller.
- design simple solutions using microcontrollers.

Contents

Introduction: Introduction to electronics and electronic systems, Alternating and direct current and measurements, **Semiconductor and devices:** Semiconductor, diodes, Transistors, BJT, FET, MOSFET, Rectifier and Filters, Transistor biasing. Small signal transistor amplifiers, **Advanced Application of Devices:** Operational amplifiers, Feedback and Oscillators, clipping clamping and filter circuits, **Digital Electronics:** Digital circuit and combinational logic, Sequential logic and flip-flops. **Microcontroller:** Introduction to data acquisition systems, Introduction to microcontrollers, **Sensors:** displacement, force and weight sensors, optical sensors and radiation detectors, controlling external devices, computers, noise , multiple time average and phase sensitive detection, **Digital and Analog:** interfacing analogue and digital worlds, digital to analogue circuits, analogue to digital conversion circuits, **Microprocessor and Programming:** introduction to microprocessors preliminary concepts, components of a microprocessor , memory, microprocessor programming, Programmable Logic Devices (PLD).

Practical: Electronic components, reading components, soldering, electronic circuit building, micro controller programming with Assembly and C.

Teaching and Learning Methods:

Classroom lectures, self-learning and discussion, electronic practical demonstration and training.

Evaluation Method

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks = $(1 \times Theory + 1 \times Practical)/2$

Recommended Readings

1. Ramesh S. Gaonkar, Thomson Delmar, Fundamentals of Micro controllers and Applications in Embedded Systems with PIC Micro controllers, 1^{st} Edition, 2007.
2. Thomas M. Connolly, Carolyn E. Begg, Database Systems A Practical Approach to Design, Implementation, and Management, Fourth Edition, 2005.
3. Muhammad Ali Mazidi, Sarmad Naimi, Sepehr Naimi, AVR Micro controller and Embedded Systems: Using Assembly and C (Pearson Custom Electronics Technology), 1^{st} Edition, 2010
4. J. C. N. Rajendra, Fundamentals of Electronics, 2008

Course Title	Mathematics for Computing
Course Code	IT1262
Credit Value	2 (30h Theory + 70h Independent learning)

Objective

To provide knowledge on fundamentals of mathematical principles required for the information technology.

Intended Learning Outcomes

- solve systems of linear equations using matrices.
- make use of matrices, differentiation and integration in problem-solving
- explain the concepts of differential calculus, logarithmic and exponential functions
- determine the transformation in 2D and 3D planes using matrices.
- define recursive and structural induction algorithms

Contents

Linear Algebra: Matrices, Vectors, Matrix operations, System of equations, Gaussian Elimination, LU Decomposition, **Differential Calculus:** Limits and Continuity, Integration, Differential coefficients, **Coordinate Geometry:** Coordinates, 2D and 3D coordinate transformation, Equation of line, circle, **Induction and Recursion:** Mathematical Induction, Recursive Definitions and Structural Induction, Recursive Algorithms, Binomial Coefficients and Identities

Teaching and Learning Methods:

Classroom lectures, Tutorials, self-learning & discussion

Evaluation Methods

- In-Course Assessments 30%
- End-Semester Examination 70%

Recommended Readings

1. Ernest Davis, Linear Algebra and Probability for Computer Science Applications, 2012
2. Devi Prasad, Elementary Linear Algebra,2^{nd} Edition, 2012
3. David Lay C, Linear Algebra and Its Applications, 4^{th} Edition, 2012

Course Title	Social Harmony and Active Citizenship
Course Code	ACU1212
Credit Value	2 (100h Notional learning)

Objective

To provide basic knowledge in social concepts, human rights and the importance of social harmony in a multicultural and multi-ethnic society and to identify their own cultural traits through engagement with people from different cultures to work with the society through different projects and contribute for the sustainable development in regional, national and global perspectives.

Intended Learning Outcomes

- define peace building processes in terms of cultivation of peace culture
- explain the need for the harmony among different ethnic groups for the sustainable development
- develop the motivation to work as a team with the community with understanding
- recognize as socially and environmentally responsible citizen
- evolve themselves to work in the community level projects

Contents

Peace Building: Steps to peace building, Activity based session to enhance and build social harmony, Political reform and devolution of powers. Sustainable peace process, participation of the grass root level society in the peace process, cohabitation among political parties and forces, effectively handling pressure groups.
Active Citizens: learning journey of active citizens, role of Active citizens in universities and colleges, Understanding individual, culture, society and citizen, Local and global active citizenship, **Understanding our place in society and the world:** local and global citizenship, Planning, delivery and need assessment for environmental projects.
Influencing Skills: Dealing with people in power, understanding conflicts, conflict resolution, gender sensitization, avoiding misunderstandings, Introduction to nonviolent communication, Understanding yourself, Understanding the culture that you grow up in, Understanding how to get to know people that are different from you, How to dialogue with others, Understanding how your society is structured, Recognizing how some people need help and support, Creating a project, developing a team, Working together in team.

Teaching and Learning Methods:

Learning by doing themselves with the guidance of facilitators.

Evaluation Methods

In-Course Assessments (Peer evaluation)	50%
Proposal presentation	20%
Final presentation	30%

Recommended Readings

1. C. Packham, Active Citizenship and Community Learning, 2008
2. K. Bush, The Intra Group Dimensions of Ethnic Conflict in Sri Lanka, 2003.
3. Winslow, D. Michael, D. W., Economy Culture and Civil Was in Sri Lanka,2004.

LEVEL 2

Course Title	Data Structures
Course Code	IT2114
Credit Value	4 (30h Theory + 60h Practical + 110h Independent learning)

Objective

To provide knowledge on methods of various data representation for effective programming.

Intended Learning Outcomes

- define the basic concepts of data structures.
- distinguish between static and dynamic data structures
- analyse the feasibility of different data structures for various applications
- apply different data structures for sorting techniques.
- improve the efficiency of programming using Tree and Graph data structures
- create various data structure using programming languages to solve computational problems.

Contents

Introduction: Introduction to data Structure, Basic Data structures, Array, **Abstract Data Types:** Stack, Queue, **Dynamic Data Structure:** linked list, Stack with Linked list, **Tree and Graphs:** Trees, Hashing, Graphs, **Sorting and Searching algorithms:** Linear Search, Binary Search, Selection sort, Bubble sort, Insertion sort, merge and quicksort, **Advanced Data Structures and algorithms:** Balanced tree, Heap, Priority queue, Sorting in linear time.

Practical: Implementation of the concepts covered in theory using high level languages.

Teaching and Learning Methods

Classroom lectures, self-learning and discussion, computer practical demonstration and training.

Evaluation Method

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks = $(2 \times Theory + 2 \times Practical)/4$

Recommended Readings

1. Michael T. Goodrich, Roberto Tamassia, Data Structures & Algorithms in Java, 6^{th} Edition, 2014.
2. Elliot B. Koffman, Paul A. T. Wolfgang, Data Structures: Abstraction and Design Using Java, 3^{rd} Edition,2015
3. Sartaj Sahni, Data Structures, Algorithms, and Applications in Java, 2^{nd} Edition,

Course Title	Software Engineering
Course Code	IT2122
Credit Value	2 (30h Theory + 70h Independent learning)

Objective

To provide knowledge on software development process for various software systems

Intended Learning Outcomes

- explain step by step software development process
- compare the various software development process model
- develop diagrammatic representations of software requirements
- identify the software requirements specification of an organization
- evaluate the usability of developed software

Contents

Introduction: Software processes, Software Life Cycle Models, **System modelling:** Context models, Interaction models, Structural models, Behavioural models, Model-driven engineering, **Architectural design:** Architectural design decisions, Architectural views, Architectural patterns, Application architectures, **Design and implementation:** Design patterns, Implementation issues, Open source development, **Objects:** Models, Cohesion, Coupling Data Encapsulation, **Object-Oriented Analysis:** Use-Case modelling, Class Modelling, Dynamic Modelling, **Software testing:** Development testing, Test-driven development, Release testing, User testing, **Software evolution:** Evolution processes, Program evolution dynamics, Software maintenance, Legacy system management.

Teaching and Learning Methods

Classroom lectures, self-learning and discussion

Evaluation Method

- In-Course Assessments 30%
- End-Semester Examination 70%

Recommended Readings

1. Ian Sommerville, Software Engineering, 10^{th} Edition, 2015.
2. Rod Stephens, Beginning Software Engineering, 1^{st} Edition, 2015.
3. Roger S. Pressman, Software Engineering: A Practitioner's Approach, 8^{th} Edition, 2014.

Course Title	Advanced Web Programming
Course Code	IT2133
Credit Value	3 (30h Theory + 30h Practical + 90h Independent learning)

Objective

To provide knowledge on advanced web development programming and technologies to develop dynamic web applications.

Intended Learning Outcomes

- define the working strategies of web application in the Internet
- apply the knowledge of client and server-side scripting
- choose appropriate components for the front end and back end of web application
- build dynamic web applications using content management system
- construct effective web application using latest techniques.

Contents

Websites Design Principles: Understanding the Web Design Environment, **Domain Name System(DNS):** DNS Hierarchy, **Vulnerabilities:** Client Security, Cookies and web beacons, Phishing, Transaction security – certificates and secure connections, Spyware, Viruses, Man-in-the-middle attacks, **Content Management System(CMS):** Defining Data, Information, and Content, Content Has Format, Content Has Structure, Content Management, Major Parts of a CMS, **Cascading Style Sheets:** Links, Backgrounds, Lists, Tables, Outlines, Miscellaneous Properties, Additional Rules, **JavaScript:** How to add a script to your pages, The document object model, Starting to program with JavaScript, Variables, Operators, Functions, Conditional statements, Looping, Events, Built-in objects, Form validation, Form enhancements, JavaScript libraries, **JQuery:** Selectors, Events, Effects, **AJAX:** XML HTTP, Request, Response, **PHP:** Basic Programming elements in PHP , Arrays & Functions , Useful PHP functions & features , Working with HTML forms in PHP , Database integration ,**Maintaining state with PHP:** Cookies & Session management

Practical: Implementation of the concepts covered in theory using the latest web technologies.

Teaching and Learning Methods

Classroom lectures, self-learning and discussion, computer practical demonstration and training.

Evaluation Method

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks = $(2 \times Theory + 1 \times Practical)/3$

Recommended Readings

1. Nicholas C. Zakas, Professional JavaScript For Web Developers, 3^{rd} Edition, 2012
2. Robin Nixon, Learning PHP, MySQL & JavaScript: With jQuery, CSS & HTML5 (Learning Php, Mysql, Javascript, CSS & Html5) , 4^{th} Edition,2014
3. Jon Duckett, JavaScript and JQuery: Interactive Front End Web Development, 2014

Course Title	Visual Programming
Course Code	IT2143
Credit Value	3 (15h Theory + 60h Practical + 75h Independent learning)

Objective

To provide knowledge on visual components to design interactive user-friendly interfaces

Intended Learning Outcomes

- utilize forms, controls, menus and dialog boxes in interface design
- modify visual components properties and code the events
- explain the integration of multiple user controls in a visual application
- implement effective and usable graphical user interfaces
- build visual applications using visual programming environment
- demonstrate database connectivity with visual components

Contents

Introduction to visual programming: Visual Programming common terms, types of visual programming languages, Hardware and software considerations for visual programming, **Program design and development:** development cycle, visual programming concepts, program design tools, Designing, implementing, and programming the graphical user-interface, **Components and their associated constructs:** labels, buttons, lists, text fields, combo boxes, checkboxes, radio buttons, panels, progress bars, menus, frames, windows, applets, and panes, **Event Handling:** Programming and handling components. Mouse & keyboard events, **Application Development:** Constructing complete GUI-based applications in various IT fields, GUI Design issues, linking libraries, Database connectivity

Practical:

Implementing simple visual application with interactive and appropriate visual components using Visual Development Tools.

Teaching and Learning Methods

Classroom lectures, self-learning and discussion, computer practical demonstration and training

Evaluation Method

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks = $(1 \times Theory + 2 \times Practical)/3$

Recommended Readings

1. Andrew Troelsen, Pro C# 2010 and the .NET 4 Platform, 5^{th} Edition, 2010
2. Barbara Doyle, C# Programming: From Problem Analysis to Program Design, 3^{rd} Edition, 2010
3. Gary McLean Hall, Adaptive Code via C#: Class and Interface Design, Design Patterns, and SOLID Principles (Developer Reference), 1^{st} Edition, 2014

Course Title	Computer Graphics
Course Code	IT2153
Credit Value	3 (30h Theory + 30h Practical + 90h Independent learning)

Objective

To provide knowledge on algorithmic and programmatic concepts to represent and manipulate 2D and 3D objects.

Intended Learning Outcomes

- demonstrate the basic principles of computer graphics.
- define object transformation in Two and Three-Dimension.
- explain the different stages in the viewing pipelines
- apply graphics programming techniques to create objects
- construct object representation algorithms.

Contents

Introduction to Computer Graphics: Graphics devices, 2D object representation and filling, Line-drawing algorithms, Circle-generating algorithms, **Area Filling:** Filling Algorithms, 2-D Geometric **Transformation:** Translation, Scaling, Rotation, Composite transformation, 2-D Viewing and Clipping, **3-D Concepts:** Three-Dimensional object representation, Curve representation and Viewing, Projection and Clipping.

Practical: Implementation of the concepts covered in theory using appropriate languages.

Teaching and Learning Methods

Classroom lectures, self-learning and discussion, computer practical demonstration and training.

Evaluation Method

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks = $(2 \times Theory + 1 \times Practical)/3$

Recommended Readings

1. Donald Hearn, Computer Graphics C version, 2^{nd} Edition, 1996.
2. Peter Shirely, Steve Marschner, Fundamentals of Computer Graphics, 3^{rd} Edition, 2009.
3. Donald Hearn, Computer Graphics with Open GL, 4^{th} Edition, 2010.
4. Frank Klawonn, Introduction to Computer Graphics using Java 2D and 3D, 2008.

Course Title	English Language II
Course Code	ACU2113
Credit Value	3 (45h Theory + 105h Independent learning)

Objective

To provide the necessary language skills to read, write, listen and speak in English in formal and informal academic and professional contexts at the advanced level.

Intended Learning Outcomes

- acquire the advanced knowledge on the use of the four skills – speaking, listening, reading and writing.
- identify the semantic and pragmatic forms and meanings for diverse application.
- demonstrate efficiency and effectiveness in both receptive and expressive skills.
- create distinct style and rhetoric orally, aurally, graphically, and grammatically.

Contents

At the advanced level, Exposure to the significant structures for developing the advanced language skills through integration with communicative competence at a higher level, **Advanced reading skills:** Reading for details, contextual understanding, Intensive reading, Making inference, Summarizing, **Advanced writing skills:** application of advanced structures and grammatical items - phrases and clauses, sentences and paragraphs, texts and discourses, Controlled writing - Transforming visual, oral and aural information into writing, Communicating in writing - writing notes, memos, personal /official letters, report writing, **Advanced listening:** Listening for specific information, for gist of the passages, for comprehension, for making inferences, note taking, and reproducing. **Advanced speaking:** describing people/events/pictures, asking for information, giving directions/instructions, making requests/complains, using model dialogues/improvisations/reading to stimulate conversations and small group discussion. **Project:** Writing essays.

Teaching and Learning Methods

Classroom lectures, self-learning, computer-assisted language learning, individual and group discussion and presentation.

Evaluation Methods

- In-Course Assessments (Listening and Speaking) 30%
- End Semester Examination (Reading, Writing and Language Structures) 70%

Recommended Readings

1. Miles Craven, Cambridge English Skills: reading, Writing, listening and speaking – from Elementary – Advanced, 2016.
2. Martin Hewings, Advanced English Grammar, Cambridge University Press, 2005.
3. Gill R, Mastering English Literature, 3^{rd} Edition, 2006.
4. Eric Glendinning, Lewis Lansford, Oxford English for Careers Technology for Engineering and Applied Sciences: Student Book, 2013.

Course Title	Management Information Systems
Course Code	IT2212
Credit Value	2 (30h Theory + 70h Independent learning)

Objective

To provide knowledge on the architecture of information system for efficient management of an organization.

Intended Learning Outcomes

- demonstrate various components of management information systems.
- analyze the features of information systems in various organizations.
- define the ethical, social, and security issues of information systems
- illustrate various information systems to accomplish the management requirement

Contents

Introduction: Information Systems in Organizations, Classification of Information Systems, Information Systems for Strategic Management, Planning for Information Systems, **System Development Process:** Approaches to System Development, System Implementation, System maintenance, Introduction to MIS Risks, System Evaluation, IT Procurement Options, **Emerging Concepts and Issues in Information Systems:** Enterprise Resource Planning, Supply Chain Management, Customer Relationship Management, Key issues in implementation, Case Studies. **Introduction to Data Warehousing:** Types of Data warehouse, Extraction, Transformation & Loading in Data warehouse, Data Mining and its Applications.

Teaching and Learning Methods

Classroom lectures, self-learning and discussion.

Evaluation Methods

- In-Course Assessments 30%
- End-Semester Examination 70%

Recommended Readings

1. Kenneth C. Laudon, Jane P. Laudon, & Mary E. Brabston, Management Information Systems – Managing the Digital Firm, 14^{th} Edition, 2015
2. R. Kelly Rainer and Brad Prince, Management Information Systems, 3^{rd} edition,2015
3. Kenneth, Laudon and Jane Laudon, MIS: Managing the Digital Firm, 2007.

Course Title	Design and Analysis of Algorithms
Course Code	IT2223
Credit Value	3 (30h Theory + 30h Practical + 90h Independent learning)

Objective

To provide the fundamental knowledge to design and analyse the performance of computational algorithms.

Intended Learning Outcomes

- define the concepts developed for algorithm design.
- classify various algorithm design techniques
- analyse the performance of a given algorithm.
- compare the efficiency of algorithms.
- improve the efficiency of algorithms based on the analysis
- construct an efficient algorithm for real-world problems.

Contents

Introduction: Characteristics of algorithms, designing, devising and expressing algorithms, Use and removal of recursion, validation, analysis, testing and profiling, **Mathematics Foundation:** Growth of functions, recurrences, time and space complexity, **Greedy Method:** Graph algorithms such as finding spanning tree and single source shortest path etc. Knapsack problem, job sequencing **Divide and Conquer:** Binary search, Merge sort, Quick sort, **Backtracking:** N-queen problem, sum of subsets, graph colouring, Hamiltonian cycle, Dynamic Programming, **Branch and Bound:** All pairs shortest paths, Optimal binary search trees, travelling salesperson problem, **Graph / Tree Algorithm:** Breadth-first search in graph, Tree traversal on binary tree.

Practical: Implementation of Algorithm Analysis and Design concepts using high-level languages

Teaching and Learning Methods

Classroom lectures, self-learning and discussion, computer practical demonstration and training.

Evaluation Method

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks = $(2 \times Theory + 1 \times Practical)/3$

Recommended Readings

1. Sara Baase, Allen Van Gelder, Computer Algorithms. Introduction to Design and Analysis, 3^{rd} Edition, 2003.
2. Thomas H Cormen, Charles E Leiserson, Ronald L Rivest, Clifford Stein Introduction to Algorithms, 3^{rd} Edition,2009.
3. Anany Levitin , Introduction to the Design and Analysis of Algorithms,3^{rd} Edition, 2011

Course Title	Web Services and Server Technologies
Course Code	IT2234
Credit Value	4 (30h Theory + 60h Practical + 110h Independent learning)

Objective

To provide knowledge on key components and server technologies involved in web services and server administration

Intended Learning Outcomes

- demonstrate the technique used in the data and application integration
- define web service technologies and data integration.
- explain integration of servers with the Internet.
- build Client-Server internet applications using dynamic scripting.
- illustrate the security mechanism developed for the web services.
- construct web services for Internet application

Contents

Introduction: Basics of IP Addressing & LAN, **Fundamentals of Client-Server Architecture:** Distributed system concepts, Message and queuing services, Object broker, Design pattern, Interface management technique, **Server services:** Print, File, DHCP, DNS, FTP, HTTP, Mail, SNMP, Telnet, Integration **Middleware Technologies:** Web service fundamentals, CORBA associated tools and techniques, Fundamental concepts of Component Object Model (COM) and Distributed COM, **Data Mapping and Exchange:** Metadata, Data representation and encoding, XML, DTD, XML schemas, Parsing XML documents, Use of XML in system integration and interface design , XSL, XSLT and XPath, **Web Services:** JAX-RPC, WSDL, XML Schema, and SOAP, **Internet and Network Services:** Managing web and LAN Services, Server System Administration, **Client- Server Application using PHP:** Creating Socket in PHP, Socket Programming in PHP, Working with files in PHP, Dynamic web application using PHP, Multithreaded programming.

Practical: Implementation of web services and server management concepts using appropriate techniques.

Teaching and Learning Methods

Classroom lectures, self-learning and discussion, computer practical demonstration and training.

Evaluation Method

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks = $(2 \times Theory + 2 \times Practical)/4$

Recommended Readings

1. Sathish Kumar Konga, Basic Integrative Programming Technologies: Data Integration Technology/Architectures, 2012.
2. Anders, Mand Michael, Schwartzbach , An Introduction to XML and Web Technologies, Pearson, 2006
3. George Schlossnagle, Advanced PHP Programming A practical guide to developing large-scale Web sites and applications with PHP 5, 2004

Course Title	Operating Systems
Course Code	IT2244
Credit Value	4 (30h Theory + 60h Practical + 110h Independent learning)

Objective

To provide knowledge on integrated structure and functions of system software.

Intended Learning Outcomes

- define the elements of the operating system.
- demonstrate the basic functions of operating systems.
- explain resource management in an operating system.
- describe the differences between a 32-bit and 64-bit operating system.
- compare the architecture of different operating systems
- create programs for inter-process communication.

Contents

Introduction: Concepts and Views of Operating Systems, Different types of Kernels, **Processes Management:** Process States, Scheduling, Interprocess communication and synchronization, Scheduling and deadlock, **Memory Management:** Memory allocation, Segmentation, Paging Loading, Linking, and libraries, Resource allocation, File systems, Consistency, Redundancy, Distributed systems principles, **Evolution of Operating Systems:** Current Operating Systems, 32-bit, 64-bit, **System programming in the UNIX environment:** Review of C Programming, C shell command language, System calls for process management, File access, Case studies on different operating system

Practical: Implementation of interprocess communication using C and Shell scripting.

Teaching and Learning Methods

Classroom lectures, self-learning and discussion, computer practical demonstration and training.

Evaluation Method

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks = $(2 \times Theory + 2 \times Practical)/4$

Recommended Readings

1. Andrew S. Tanenbaum, Modern Operating Systems, 4^{th} Edition, 2014.
2. William Stallings, Operating Systems: Internals and Design Principles, 8^{th} Edition, 2014.
3. Christine Bresnahan, Linux Command Line and Shell Scripting Bible,3^{rd} Edition, 2015.

Course Title	Social and Professional Issues in IT
Course Code	IT2252
Credit Value	2 (30h Theory + 70h Independent learning)

Objective

To provide knowledge to explore the personal and organizational ethics and privacy issues in relation to the application of IT.

Intended Learning Outcomes

- identify the IT professional's responsibility in different contexts.
- define professional, ethical and privacy issues and responsibilities.
- analyze social and legal issues related to software.
- evaluate teamwork concepts and issues.
- discuss the appropriate use of relevant codes, standards and licenses.

Contents

Introduction to Professionalism and Ethics: Ethics of IT professionals, Ethics of organization, Code of Ethics in Computing by Professional bodies, fair use policies, The nature of professionalism, ergonomics, evaluation of ethical arguments, **Computer Crime:** Internet crime, Policies, Case studies, Privacy, Privacy Policies, Crime prevention strategies, Physical and operational Security, Recovery and response, **Social Context and Complications:** Cultural Issues, Gender-based issues, International Issues, IT and life, **Intellectual property:** Copyrights, patents, and trade secrets, Software piracy.

Teaching and Learning Methods

Classroom lectures, self-learning and discussion.

Evaluation Methods

- In-Course Assessments 30%
- End-Semester Examination 70%

Recommended Readings

1. George Reynolds, Ethics in Information Technology, 5^{th} Edition, 2014.
2. William John Brinkman, Ethics in a Computing Culture, 1^{st} Edition, 2012.
3. Joseph Migga Kizza, Ethics in Computing: A Concise Module (Undergraduate Topics in Computer Science), 2016

Course Title	Communication and Soft Skills
Course Code	ACU2212
Credit Value	2 (30h Theory + 70h Independent learning)

Objective

To excel in communication and soft skills for productivity and personality development.

Intended Learning Outcomes

- explain the necessary knowledge and skills required for efficient and effective communication
- identify knowledge and skills for personality development.
- find problems and challenges to overcome barriers to communication and soft skills.
- apply knowledge and skills for solving the problems and challenges.
- achieve excellence in communication using critical and creative skills.

Contents

Introduction: Introduction to Communication and soft skills, the patterns and the process, Downward and Upward communication, Horizontal and vertical communication, One-way and two-way communication, Multi-directional communication, Communications for Management, efficiency and effectiveness in communication, **Forms:** Oral and written communication, Verbal and non-verbal communication, Para-language Code, Signals, Symbols, Icons, Gestures, Active Listening and Speaking, Writing for your people, Publishing and Editing. **Levels:** Interpersonal communication, Public communication. **Planning and Organization of communication:** Establishment of objectives, Information search, identification, collection, organization and presentation, Analytical skills, Resource allocation, Delegation, Timing, Coordination. **Motivation:** Instrumental and inspirational, internal and external. Motivational Communication: Instructions, Reporting & Recommendations, **Performance Appraisal and Styles of Control**. **Staffing:** Interview Techniques, Communication in Training & Development, Feedback, and Industrial Relations. **Leadership:** Supportive Leadership, Directive leadership, Achievement Oriented leadership and Participative leadership. **Public Relations & Marketing Communication, Negotiating and conflict resolution skills:** Opening the process, Negotiations types, Conduct of Negotiation and problem-solving skills, balancing personal and professional life, Communication during Negotiations, Bargaining, Teamwork, flexibility and adaptation, and time management, decisiveness, responsibility and accountability.

Teaching and Learning Methods

Classroom lectures, self-learning and discussion, individual and group presentation, field visit and project assignment and reporting.

Evaluation Methods

- In-Course Assessments 30%
- End-Semester Examination 70%

Recommended Readings

1. Tara Dixon & Martin O'hara, Communication Skills: University of Ulster, 2010
2. Helio Fred Garcia, The Power of Communication: Skills to Build Trust, Inspire Loyalty, and Lead Effectively, 2012.
3. Ellis, R, Communication Skills: Stepladders to success for the Professional, 2002
4. Barun K. Mitra, Personality Development and Soft Skills, 2011

LEVEL 3

Course Title:	Knowledge Based Systems and Logic Programming
Course Code	IT3113
Credit Value	3 (30h Theory + 30h Practical + 90h Independent learning)

Objective

To provide knowledge on various techniques of knowledge-based representation and logic programming.

Intended Learning Outcomes

- represent knowledge in various forms
- explain the necessary techniques of Artificial Intelligence
- develop knowledge-based systems by defining inference engines
- make use of predicate logic for theorem proving
- apply problem-solving techniques for intelligent systems
- solve logic-based problems using logic programming.

Contents

Knowledge representation: Predicate logic, Rules, Semantic nets, Frames, Scripts, Theorem proving, **Expert Systems:** Introduction, Anatomy, Types, Case Studies, **Fuzzy logic:** Fuzzy set, Fuzzy Controllers, Membership Functions, **Fundamental of Artificial Intelligence:** Turing test, Chinese Room Arguments, Four School Thoughts, **Searching Techniques:** Uniformed Search, A*, BFS, DFS, **Classic AI Problems:** River crossing, Water Jug, Monkey and banana, Dog and balls, **Logic programming:** Basic concepts, Syntactic and semantic description.

Practical: Implementation of logical concepts and theorem proving using Prolog.

Teaching and Learning Methods

Classroom lectures, self-learning and presentation, computer practical demonstration and training.

Evaluation Method

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks = $(2 \times Theory + 1 \times Practical)/3$

Recommended Readings

1. R. Akerkar, P. Sajja,Knowledge-Based Systems, 2010.
2. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, Global Edition, 2011
3. Max Bramer, Logic Programming with Prolog 2nd Edition, 2013
4. William F. Clocksin and Christopher S. Mellish, Programming in Prolog: Using the ISO Standard,5th edition, 2013
5. Ivan Bratco, Prolog Programming for Artificial Intelligence, 3^{rd}Edition, 2001.

Course Title:	Computer Security
Course Code	IT3122
Credit Value	2 (30h Theory + 70h Independent learning)

Objective

To provide knowledge on analyzing the vulnerabilities and digital forensics in IT security.

Intended Learning Outcomes

- identify appropriate security mechanism for various network architecture.
- analyze the security schemes for network and mobile computing.
- apply security principals to system design
- build secure authentication systems by use of message authentication techniques.
- illustrate the web-based security mechanism developed for scripting language.

Contents

Introduction to Computer Security: Trends, Attacks, Services, Mechanisms, The OSI Security Architecture, A Model for Network Security, **Symmetric Ciphers:** Classical Encryption Techniques, Block Ciphers and the Data Encryption Standard, Confidentiality Using Symmetric Encryption, **Asymmetric Ciphers:** Public-Key Cryptography and RSA, **Cryptographic Data Integrity Algorithms:** Cryptographic Hash Functions, Message Authentication Codes, Digital Signatures, **Mutual Trust:** Key Management and Distribution, User Authentication Protocols, **Security Threats:** DDOS, Man in Middle, Trojan, DNS Poisoning, **Network And Internet Security:** Vulnerabilities in Ports, Codes and Services, Transport-Level Security, Wireless Network Security, Electronic Mail Security, IP Security, Web Security, **System Security:** Intruders, Malicious Software, Software Updates, Firewalls, Policies, **Digital Forensics:** Crime Scenes, Media, Network and Application Analysis and Interpretations, e-Evidences, Penetration Testing.

Teaching and Learning Methods

Classroom lectures, self-learning and discussion.

Evaluation Method

- In-Course Assessments 30%
- End-Semester Examination 70%

Recommended Readings

1. William Stallings, Cryptography and Network Security, Principles and Practice, 5^{th} Edition, 2013.
2. David Kim, Michael G. Solomon,Fundamentals of Information Systems Security, 2^{nd} Edition, 2013.
3. Michael K Robinson,Digital Forensics Workbook: Hands-on Activities in Digital Forensics,2015
4. Arnes, Andre, Digital Forensics, 1^{st} Edition, 2017

Course Title:	Mobile Communication and Computing
Course Code	IT3133
Credit Value	3 (30h Theory + 30h Practical + 90h Independent learning)

Objective

To provide knowledge on voice and data transfer architecture on mobile communication.

Intended Learning Outcomes

- demonstrate wireless communication and basics of mobile networks.
- define mobile communication systems and architecture.
- analyze various mobile communication technologies.
- identify the mobile computing limitations.
- develop an application for mobile devices with user interaction.
- build simulation-based experiments in a mobile communication scenario

Contents

Introduction: Introduction to MC, novel applications, limitations, and architecture, **GSM:** Mobile services, System architecture, Radio interface, 3G, 4G, Channel allocation, Micro-mobility solutions to the host mobility problem, Routing in mobile, Micro mobility, Protocols, Localization and calling, Handover, Security, and New data services, **Medium Access Control:** Motivation for a specialized MAC (Hidden and exposed terminals,) FDMA, TDMA, CDMA, **Mobile Network Layer:** Mobile IP(Goals, assumptions, IP packet delivery, agent advertisement and discovery, registration, tunneling and encapsulation, optimizations), Dynamic Host Configuration Protocol (DHCP). **Mobile Transport Layer:** Traditional TCP, Snooping TCP, Mobile TCP, Fast retransmit Transmission, Selective retransmission, Transaction oriented TCP. **Mobile Ad hoc Networks (MANETs):** Properties of a MANET, various routing algorithms, security in MANETs. **Protocols and Tools:** Wireless Application Protocol-WAP. (treatment of protocols of all layers), Bluetooth (User scenarios, physical layer, MAC layer, networking, security, link management)

Practical: Implement the mobile communication applications and simulation using mobile platforms and technologies.

Teaching and Learning Methods

Classroom lectures, self-learning and discussion, field visits, computer practical demonstration and training.

Evaluation Method

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks = $(2 \times Theory + 1 \times Practical)/3$

Recommended Readings

1. Jerry D. Gibson, Mobile Communications Handbook, 3^{rd} Edition, 2012
2. Olenewa, J. and Ciampa, M. Guide to Wireless Communications, Course Technology, 3rdEdition, 2013
3. William Stallings, Wireless Communications & Networks (2nd Edition), 2004

Course Title:	Digital Image Processing
Course Code	IT3143
Credit Value	3 (30h Theory + 30h Practical + 90h Independent learning)

Objective

To provide knowledge on concepts processing techniques for digital images

Intended Learning Outcomes

- define the display devices and digital imaging techniques.
- explain various linear and non-linear methods applied for image filtering.
- analyze techniques suitable for image enhancements.
- demonstrate image file formats and compression structures.
- build an image processing algorithm to solve the real-world problems.

Contents

Introduction: display devices and digital image, Image Formation, Sampling, Quantization, Color models, Sensors, **Mathematical Tools:** Arrays and Matrices, Linear and Non Linear Operation, Set and Logical operations, Probabilistic operations, **Point Operation:** Brightness, Contrast, Inverting, binarizing, Auto Contrast, **Intensity Transformation:** Spatial and frequency domain filtering, Smoothing and enhancements, Histogram Processing, Smoothing and Sharpening, Correlation, Convolution, Laplacian, gradient filters, **Image Segmentation:** Edge Detection, Thresholding. Histogram oriented segmentation, region-based segmentation, **Morphological Operations:** Dilation, Erosion, Opening, Closing, Thinning, Thicking, Boundary Extraction, Skeleton, **Color Image Processing:** RGB model, CMYK Model, Color Image Transformations, **Image Compression:** Huffman coding, LZW, Run-Length, Symbol baes compressions.

Practical: Implements the digital image processing concepts covered in the theory

Teaching and Learning Methods

Classroom lectures, self-learning and discussion, computer practical demonstration and training.

Evaluation Method

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks = $(2 \times Theory + 1 \times Practical)/3$

Recommended Readings

1. R. C. Gonzales and R. E. Woods, Digital Image Processing, 3^{rd} Edition, 2016.
2. R. C. Gonzales and R. E. Woods, Digital Image Processing using MATLAB, 2^{nd} Edition, 2010.
3. Chris Soloman, Toby Breckon, Toby Breckon, Fundamentals of Digital Image Processing: A Practical Approach with Examples in Matlab, 1^{st} Edition, 2011

Course Title:	Software Quality Assurance
Course Code	IT3152
Credit Value	2 (30h Theory + 70h Independent learning)

Objective

To provide knowledge on various approaches for software testing and quality assurance in a different scenario

Intended Learning Outcomes

- define quality assurance process in software development.
- apply test cases for software testing.
- summarize the identified defects.
- apply the techniques to improve the quality of the software development.
- construct a software quality plan for a software project
- construct report for the progress of software testing.

Contents

Introduction: The software quality challenge, Software quality, Software quality factors, The components of the software quality assurance system, **Pre-project software quality components:** Contract review, Development and quality plans, **SQA components in the project life cycle:** Integrating quality activities in the project life cycle, Reviews, **Testing:** Concept and Definition, Plan and Design, Execution and Reporting, **Software quality infrastructure components:** Procedures and work instructions, Supporting quality devices, Configuration management, **Management components of software quality:** Project progress control, Software quality metrics, Costs of software quality, **Challenges:** Incident Management, Defect Management, Risk Vulnerability and Threat Management, **Software Quality Expectation:** Information Security, Information Audit, Software Reliability and Process Improvement, Quality testing tools

Teaching and Learning Methods

Classroom lectures, self-learning and discussion

Evaluation Method

- In-Course Assessments 30%
- End-Semester Examination 70%

Recommended Readings

1. Daniel Galin, Software Quality Assurance From theory to implementation, 2004
2. Nina S. Godbole, Software Quality Assurance: Principles And Practice,2016
3. Bill Laboon ,A Friendly Introduction to Software Testing, 2016
4. Solis Tech, Quality Assurance: Software Quality Assurance Made Easy, 2016

Course Title:	Group Project
Course Code	IT3162
Credit Value	2 (200 notional hours for project development)

Objective

To provide an experience in software development process as a team.

Intended Learning Outcomes

- build software as a team.
- apply software engineering models for the development process.
- develop documentation for the project.
- create a presentation in a logical manner.

Contents

Group of students should do a project targeting software development. It should be done under the supervision of the lecturers of the department. At the end of the project, the student should submit the report for the evaluation and do the viva voce presentation. Students expected to make a weekly meeting with their supervisor and submit weekly Progress Report. A group may contain three to five members.

Teaching and Learning Methods

Group discussion, Software Implementation, Project Documentation and Presentation

Evaluation Methods:

- Final report 40%
- Oral presentation 30%
- Code Modification and Viva-Voce Evaluation 30%

Recommended Readings

1. Barkley, E. F., Cross, K. P., and Major, C. H. (2005). Collaborative learning techniques: A handbook for college faculty. San Francisco: Jossey-Bass
2. Sally Fincher, Marian Petre, Martyn Clark, Computer Science Project Work: Principles and Pragmatics, 1st Edition, 2001
3. Mark C. Layton, Agile Project Management For Dummies, 1st Edition,2012
4. Group Project Guidelines, Department of Physical Science, Vavuniya campus

Note: Any special circumstances are decided by the department and implemented with the approval of the Faculty Board of Faculty of Applied Science.

Course Title:	Career Guidance
Course Code	ACU3112
Credit Value	2 (30h Theory + 70h Independent learning)

Objective

To provide knowledge on an overall view of the career guidance and prospective.

Intended Learning Outcomes

- develop attitudes of the outside world of work
- discuss the use of technology in career development
- build better public relations for career advancement
- find their career options and goals
- apply their soft and survival skills in career development
- identify expectation of private employers
- select suitable carrier opportunity by analyzing job banks and databases
- create effective resume

Contents

The world of work: Unemployment in Sri Lanka. Recent demographic, Economic and social changes of Sri Lanka and how they affect the graduate labour market. The private sector culture- emphasis on attitudes The role of scientists in various employment sectors. The expectations of private sector employers from new graduate employees. Career guidance Employment search. **Image Projection:** Social graces, Public relations, Career development and survival skills of young graduates, Personality development, Leadership, Teamwork, Human relations, Elective communication, Problem-solving, Stress management. **Presentation Techniques:** The bio-data, Facing interviews, Assertiveness

Teaching and Learning Methods

Classroom lectures, self-learning and discussion.

Evaluation Method

- In-Course Assessments 30%
- End-Semester Examination 70%

Recommended Readings

1. Niles, S. & Harris-Bowlsbey, J,Career development interventions in the 21^{st} century, 2^{nd} Edition, 2005
2. Seamus Whitney and Ms Suzanne Power, Guide Your Career, 2017

Course Title:	Human Computer Interaction
Course Code	IT3213
Credit Value	3 (30h Theory + 30h Practical + 90h Independent learning)

Objective

To provide knowledge on various design techniques to develop applications with user-friendly interactive components.

Intended Learning Outcomes

- define typical human-computer interaction (HCI) models and styles apply an interactive universal design principle for HCI.
- analyze the requirements of HCI systems such as user models, user support, socio-organizational issues.
- discuss tasks and dialogs of relevant HCI systems based on task analysis and dialog design.
- test a variety of simple methods for evaluating the quality of a user interface.
- build interactive system using HCI techniques

Contents

Foundations of Human-Computer Interaction: The human factor, The computer, The interaction elements, Paradigms, **Design Process:** Interaction design process, HCI in software process, Design rules, Evaluation techniques, Universal design, **User support, Models and theories:** Cognitive models, Socio-organizational issues and stakeholder requirements, Communication and collaboration Models, Task analysis, Dialog notations and design, Models of the system, Modeling rich interaction, **Interactions:** Direct, Virtual Environment , Menu, Form, Dialog Box commands and Social media Collaboration, **Hypertext and Multimedia:** Groupware and Computer-supported Collaborative Work, Ubiquitous Computing, Hypertext, Multimedia and the World Wide Web, **Emerging technologies and HCI:** Groupware, Ubiquitous Computing, Virtual and Augmented Reality

Practical: Implementation of HCI concepts covered in the theory

Teaching and Learning Methods

Classroom lectures, self-learning and discussion, computer practical demonstration and training.

Evaluation Method

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks = $(2 \times Theory + 1 \times Practical)/3$

Recommended Readings

1. A. Dix, J. Finlay, G. D. Abowd, R. Beale. *Human computer interaction*, 3^{rd} Edition, 2004.
2. Preece, J., Rogers, Y., & Sharp, H. *Interaction design: Beyond human-computer interaction*, 4^{th} Edition, 2015.
3. Solis Tech,Human-Computer Interaction: The Fundamentals Made Easy, 2016

Course Title:	Advanced Database Management Systems
Course Code	IT3223
Credit Value	3 (30h Theory + 30h Practical + 90h Independent learning)

Objective

To provide knowledge on advanced concepts in database management used in various types of organizational databases

Intended Learning Outcomes

- apply the principles of query optimization to a database schema
- formulate a transaction management strategy for a database.
- design a distributed database for a network environment
- apply concurrency control and recovery mechanism for transaction management.
- build queries in MySQL with satisfaction of enterprise rules.
- create programs to connect a database embedded in high-level programming languages.

Contents

Advanced data representation models: EER & Object Oriented data model, ODMG standard, NIAM, GOOD, ORM, Storage and File Structures, Database Buffer, Indexing and Hashing, Multiple-Key Access, Static Hashing, Dynamic Hashing, **Query Processing & Optimization:** Semantic Query Optimization, **Database Transactions and Recovery Procedures:** Transaction Processing Concepts, **Database Security:** Access Privileges, Multilevel Security, And Statistical Database Security, **Distributed Databases:** Reliability and Commit protocols, Fragmentation and Distribution, View Integration, Distributed database design, Distributed algorithms for data management, Heterogeneous and Federated Database Systems, **Deductive Databases:** Recursive Queries, Prolog / Datalog Notation, Basic inference Mechanism for Logic Programs, Deductive Database Systems, Deductive Object-Oriented Database Systems, **Data Warehousing and Data Mining:** Decision-Support Systems, Data Warehousing, Data Mining, Association Rules

Practical: Implementation of Advanced Database concepts, connectivity and queries using SQL.

Teaching and Learning Methods

Classroom lectures, self-learning and discussion, computer practical demonstration and training.

Evaluation Method

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks = $(2 \times Theory + 1 \times Practical)/3$

Recommended Readings

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, Database System Concepts, 6^{th} Edition, 2011.
2. Ramez elmasri, Shamkant B.Navathe, Fundamentals Of Database Systems, 7^{th} Edition, 2015.
3. C. Coronel, S. Morris, and P. Rob, Database Systems: Design, Implementation, and Management, 9^{th} Edition, 2011.

Course Title:	E-Commerce
Course Code	IT3232
Credit Value	2 (15h Theory + 30h Practical + 55h Independent learning)

Objective

To provide knowledge on the current development of the e-technologies which are used in e-commerce, e-business, e-banking, and e-learning.

Intended Learning Outcomes

- differentiate between e-learning, distance learning, and mixed learning.
- identify the advantages and disadvantages of technology choices for different e-operations.
- demonstrate awareness of ethical, social and legal aspects of e-commerce
- analyze features of existing e-commerce and propose future directions for a specific business.
- explore the skills and concepts needed to manage e-government projects and programs effectively.
- build an e-commerce application using e-technologies

Contents

Introduction : E-technology, e-activities, Principle of technology using Internet and web versions, **E-Commerce and E-business:** Definition, Types and models of e-business and e-commerce, E-market place, e-auctions, E-shops and e-purchase, Law in e-commerce, **Electronic marketing:** Marketing, promotion and publicity on Internet-marketing tools, Search Engine marketing, Web design for enterprise presentation, Trends in e-marketing, **Electronic banking and e-payments:** Base definition of electronic banking, Electronic services in banking, Electronic payment systems, **Electronic learning and training:** Base definition of electronic learning and distance education, Technologies, trends, practices of e-learning, E-courses in modern society

Practical: Implementation of e-commerce concepts as a web application.

Teaching and Learning Methods

Classroom lectures, self-learning and discussion, computer practical demonstration and training.

Evaluation Method

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks = $(1 \times Theory + 1 \times Practical)/2$

Recommended Readings

1. Laudon K. C. and Traver C. G., E- Commerce 2015: business, technology, society, 11^{th} Edition., 2015.
2. Developers from DevZone, Building eCommerce Applications, Kindle Edition, 2011
3. Kenneth C. Laudon, Carol Guercio Traver, E-Commerce 2017 (13th Edition) 13^{th} Edition, 2017

Course Title:	Parallel Computing
Course Code	IT3243
Credit Value	3 (30h Theory + 30h Practical + 90h Independent learning)

Objective

To provide knowledge on characteristics of parallel architecture and parallelism of the standard algorithms

Intended Learning Outcomes

- define the control mechanism of parallel computers
- analyze the communication efficiency in a parallel system
- compare the message passing cost in a topology
- convert sequential algorithm into parallel algorithm
- build parallel programming using message passing interface

Contents

Introduction: Scope of Parallel Computing, Applications in Science, Commercial, Computing Scenario, **Trends In processor:** Parallel Architectures, Pipeline, Super scaler, Parallel Computing Platform, Control Structure, Flynn taxonomy, **Parallel algorithm design:** properties of parallel algorithm, Decomposition, Process-Processor mapping, shared address space, memory management, Decomposition techniques, Data and Task parallelism, master slave model, hypercube model **Communication:** communication and routing mechanism and cost, topology, one_to_all , all_to_all, broadcast, scattering, gathering, prefix sum, circular shift, **Parallel Analytical Model:** Efficiency, Speedup, Throughput, Cost, Scalability, Amdahl's Law, **Message Passing:** Parallel concepts of matrix operation, sorting, graph operations

Practical:

Implementation of parallelized algorithms using message passing interface technique.

Teaching and Learning Methods

Classroom lectures, self-learning, discussion and computer practical demonstration and training.

Evaluation Method

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks = $(2 \times Theory + 1 \times Practical)/3$

Recommended Readings

1. Ananth Grama, George Karypis, Vipin Kumar, Anshul Gupta, Introduction to Parallel Computing, 2ndEdition,Addison-Wesley, 2003.
2. Peter Zinterhof, Marián Vajteršic, Roman Trobec, Parallel Computing: Numerics, Applications, and Trends, Springer London, 2009

Course Title:	Multimedia Computing
Course Code	IT3252
Credit Value	2 (30h Theory + 70h Independent learning)

Objective

To provide knowledge on data representation, storage and embedding the multimedia contents in web pages.

Intended Learning Outcomes

- identify a range of concepts, techniques and tools for creating and editing the interactive multimedia applications.
- explain the characteristics of animation used in multimedia programs
- discuss various compression techniques for audio and video file formats
- create a suitable storyboard for audio, video and animation
- implement a multimedia application based on latest multimedia technologies

Contents

Introduction: Multimedia, Multimedia Applications, **Data Compression:** Basic data compression techniques, Graphic compression, Audio compression, Video compression, **Media Composition:** Text and Graphic editors, Sound editors, Video editors **Media Entertainment:** Virtual reality, Interactive audio, Interactive video. file types, their features and usage, Authoring multimedia, multimedia on the Internet, Emerging Trends, Social and Legal issues, **Multimedia System:** Multimedia hardware, Multimedia System architecture, **Digital Media:** Digital libraries, Media formats, Capture, authoring and production tools, Compression, Streaming media.

Teaching and Learning Methods

Classroom Lectures, Laboratory session, self-learning and discussion

Evaluation Method

- In-Course Assessments 30%
- End-Semester Examination 70%

Recommended Readings

1. Evangeline, D. Anitha, S, Computer Graphics and Multimedia Insights, Mathematical Models and Programming Paradigms, 2016
2. Tay Vaughan , Multimedia: Making It Work, Ninth Edition, 9^{th} Edition,2014
3. Mark J. Guzdial and Barbara Ericson, Introduction to Computing and Programming with Java: A Multimedia Approach, 2006

Course Title:	Operations Research
Course Code	IT3262
Credit Value	2 (30h Theory + 70h Independent learning)

Objective

To provide knowledge on techniques used in operations research to solve real-life problems.

Intended Learning Outcomes

- identify operational research models from the verbal description of the real system
- formulate a real-world problem as a linear programming model
- build transportation and assignment models
- design new models to improve decision –making
- analyse sensitivity of the direction and magnitude in an optimal solution
- determine critical path analysis for real-life project scheduling

Contents

Linear programming: Linear Programming Formulations, Linear Programs, Optimal Solutions, unboundedness, Geometry of Linear Programming, **The Simplex Method:** Transforming the Linear Programs to Standard Form, Simplex Method, Artificial Variable techniques in Simplex Method, Linear Programming Duality, Sensitivity and Post Optimality Analysis **Transportation Models:** Balanced and unbalanced transportation problems, degeneracy, Transportation Algorithms, Transhipment Problems **Assignment Models:** Hungarian Method of Assignment Problems, **Project Scheduling:** Programme Evaluation Review Technique (PERT) and Critical Path Method (CPM), Network analysis and applications, tools for optimization

Teaching and Learning Methods

Classroom lectures, self-learning and discussion.

Evaluation Method

- In-Course Assessments 30%
- End-Semester Examination 70%

Recommended Readings

1. Hamdy A. Taha, Operations Research: An Introduction , 9^{th} Edition, 2010
2. C. B. Gupta ,Optimization Techniques in Operation Research, 2012
3. Martin Kunc and Jonathan Malpass, Behavioral Operational Research: Theory, Methodology and Practice, 2018
4. R. Panneerselvam , Operations Research, Second Edition, 2009

Course Title:	Management and Entrepreneurial Skills
Course Code	ACU3212
Credit Value	2 (30h Theory + 70h Independent learning)

Objective

To provide knowledge on basic understanding of principles of management and entrepreneurial skills and developing the ability to apply them in IT industries.

Intended Learning Outcomes

- define the basic management theories
- explain the evolution of management in various eras
- discuss the managerial roles, levels, functions of management
- apply the managerial skills in IT organizations
- develop the entrepreneurial skills in future

Contents

Introduction Definition of management, Types of managers, Level of managers, Managerial skills and Rolls, Evolution theories of management, **Functions of management:** Planning, Organizing, Directing and Controlling, Definition of Entrepreneurship, Challenges faced by the entrepreneurs in Sri Lanka, Types of Entrepreneurs, Small scale Entrepreneurs, Women entrepreneurs

Teaching and Learning Methods

Classroom lectures, self-learning and discussion.

Evaluation Method

- In-Course Assessments 30%
- End-Semester Examination 70%

Recommended Readings

1. Daft, R.L, New Era of Management, 10^{th} Edition, 2012
2. Griffin, R.W, Management: Principles and Applications, 10^{th} Edition, 2013
3. Armstrong,M., Armstrong's Handbook of Human Resource Management Pracice,12th Edition, 2012

Course Title:	Research Methodology and Scientific Writing
Course Code	ACU3222
Credit Value	2 (30h Theory + 70h Independent learning)

Objective

To provide knowledge on the procedures to conduct an efficient research

Intended Learning Outcomes

- identify the overall process of designing a scientific research.
- formulate a research question
- create a research proposal.
- define scientific reasoning and problem solving.
- analyze the relevant literatures critically
- identify the types of methods best suited for the question
- summarize the research findings and publishing

Contents

Introduction: Introduction to research, Building blocks of science in research, Various steps in scientific research, **Concepts and techniques:** Concept of applied and basic research, Quantitative and Qualitative research techniques, Hypothesis development, Review of advantages and disadvantages of various data collection methods and their utility, Stability measures, Statistical techniques, Application of Statistical software package in research, **Scientific Writing:** Purpose of the written report, Structure and components of research report, Mechanism of writing a research report, Tables, Figures and Caption, Citations and References, Patents.

Teaching and Learning Methods

Classroom lectures, self-learning and discussion.

Evaluation Method

- In-Course Assessments 30%
- End-Semester Examination 70%

Recommended Readings

1. C. R. Kothari, Research Methodology Methods and Techniques, New Age International Publishers, New Delhi, 2004.
2. Donald H.Mc Burney, Research Methods, Thomson Asia Pvt. Ltd. Singapore, 2002.
3. Zobel,J ,Writing for Computer Science, 3^{rd} Edition, 2014
4. Peter Pruzan, Research Methodology: The Aims, Practices and Ethics of Science, 2016

LEVEL 4

Course Title	Computer Organization and Architecture
Course Code	IT4113
Credit Value	3 (30h Theory + 30h Practical + 90h Independent learning)

Objective

To provide knowledge on the improvements in computer performance and processing architecture.

Intended Learning Outcomes

- illustrate the integrated function of computer hardware components.
- define the involvement of the processor and memory during the instruction execution.
- explain the storage organization to improve the data transfer rate.
- evaluate the methods implemented to improve the instructions execution rate.
- analyze the organization of major components in modern processors.
- demonstrate programming ability using low-level language.

Contents

Introduction: Computer Evolution, Structures and Functions, Execution time, Designing for Performance **Computer Functions:** Components of functions, Computer interconnection structure, Bus interconnection, PCI, **Pipeline:** Concepts of Pipelining execution, Hazards, Organization of Pentium processor. **Instruction Set Architecture:** types of Operands and Operations, Instructions and Its types, Instruction Formats, Addressing Modes, Micro operation, microinstruction sequencing, **Cache Memory:** Cache memory Overview, Cache Memory elements, Cache memory organization, **External Memory:** Magnetic Disk, (RAID), Optical Memory, **Input/Output:** I/O modules, Programmed I/O, Input driven I/O direct Memory Access

Practical: Implementation of Instruction set architecture using assembly language programming.

Teaching and Learning Methods

Classroom lectures, self-learning and discussion, computer practical demonstration and training.

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks = $(2 \times Theory + 1 \times Practical)/3$

Recommended Readings

1. John L. Hennessy, Computer Architecture: A Quantitative Approach, 6^{th} Edition, 2017.
2. William Stallings, Computer Organization and Architecture, 8^{th} Edition, 2012.
3. Barry B. Brey, Intel microprocessors, 8^{th}Edition, 2008.
4. Turbo assembler user guide, Version 5,1995
5. Tom Swan, Mastering turbo assembler, 2^{nd} Edition,1995

Course Title	Agent Based Computing
Course Code	IT4123
Credit Value	3 (30h Theory + 30h Practical + 90h Independent learning)

Objective

To provide the knowledge on technologies used to design the agent-based system.

Intended Learning Outcomes

- develop fundamental concepts of agent technology.
- demonstrate various agent architectures with proper multi-agent framework.
- build sharable knowledge among software agents.
- construct software agents using Agent Development Environments.
- make use of agents to monitor various virtual enterprises.
- modify the current software systems architecture as an agent-based system.

Contents

Introduction: Concepts of agents, types of Agents, Competence, Trust Agent Characteristics BDI concepts, **Intelligent agents:** Software agents, Environment, Degree of automation, Action and Reaction, Sensor and Effectors, Agent learning and knowledge acquisition, Specified Intelligent agents, Applications, **Mobile Agents:** Mobility, Payload, Protocols, Characteristics, **Multi-agent systems:** Classifying multi-agent interactions - cooperative versus non-cooperative, zero-sum and other interactions, KQML/KIF, the FIPA framework., Agent-Based Modelling and Simulations, applications, Case Studies, **Communication:** Agent communication, KQML, Agent toolkits.

Practical: Implementation of agent concepts and develop an agent based system.

Teaching and Learning Methods

Classroom lectures, self-learning and discussion, computer practical demonstration and training.

Evaluation Method

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks = $(2 \times Theory + 1 \times Practical)/3$

Recommended Readings

1. Michael Luck, Peter McBurney and Chris Preist, Agent Technology: Enabling Next Generation Computing, Springer, 2003
2. Michael Wooldridge, An Introduction to Multi-Agent Systems, 2^{nd} Edition,2002.
3. Haiping Xu, Practical Applications of Agent-Based Technology, 2012.

Course Title	Bioinformatics and Computational Biology
Course Code	IT4133
Credit Value	3 (30h Theory + 30h Practical + 90h Independent learning)

Objective

To provide knowledge on computational algorithms and techniques for biological applications

Intended Learning Outcomes

- explain the basics of molecular biology.
- define the structure and functions of DNA.
- analyse the types of biological data models
- apply different approaches and algorithms for biological problems.
- make use of machine learning techniques in bioinformatics problems
- demonstrate the problems in bioinformatics.

Contents

Introduction: Cell Biology, Mendelian Genetics, Molecular Biology, Nucleotides and Amino Acids, Protein. **Bioinformatics databases:** Bioinformatics Data and types, Structure, Sequence, Genomic Databases, **Algorithms:** Partial Digest, LCS, Global, local, pairwise and multiple Sequences Alignment, Scoring matrices, Motif finding, Phylogeny, UPGMA algorithms and Characteristic matrix, **Proteins and Proteomics:** Protein Synthesis, Protein Secondary structure, Prediction algorithms, 3D Structures, , Protein Reverse Engineering, **Genomic Analysis:** genetics, gene, Gene Expression, Microarray and Genetic Analysis, Probabilistic modeling of array data, Next Generation Sequencing, Short read alignment with burrows-wheeler transform, Clustering and classification, **Technology Overview:** Data mining, Pattern recognition and discovery, **Modeling and Simulation:** Molecular Modelling, Protein Homology Modelling, Docking, Drug discovery, **Applications of Bioinformatics:** Genetic Engineering, Recombined DNA, Forensic Applications, transgenic organisms and Plants

Practical: Implementation of concepts and algorithms covered in theory using a high-level programming language and tools.

Teaching and Learning Methods

Classroom lectures, self-learning and discussion, field visits, computer practical demonstration and training.

Evaluation Method

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks = $(2 \times Theory + 1 \times Practical)/3$

Recommended Readings

1. Neil C. Jones and Pavel A. Pevzner, An Introduction to Bioinformatics Algorithms, The MIT Press Cambridge, England, 2004.
2. Jin Xiong, Essential Bioinformatics, 2006
3. Jeremy Ramsden, Bioinformatics: An Introduction (Computational Biology),3^{rd} Edition, 2016

Course Title	Compiler Design
Course Code	IT4142
Credit Value	2 (30h Theory + 70h Independent learning)

Objective

To provide knowledge on the essential aspects of compilers and related tools.

Intended Learning Outcomes

- identify the compilation process of high-level languages.
- define syntax of different types of grammars and languages
- apply different methods used in compiler construction
- utilize tools for lexical, syntax and semantic analysis
- elaborate types of storage allocation and intermediate codes

Contents

Introduction to Compilers: Compilation process, Phases of Compilation, Programming language basics, Regular Grammar and regular expression for common programming language features, pass and phases of translation, interpretation, bootstrapping, data structures in the compilation, compiler-construction tools. **Lexical Analysis:** Defining syntax, Type of grammars, Chomsky's Normal Forms, Role of Lexical Analyzer, LEX lexical analyzer generator, Lexical Errors, Expressing Tokens by Regular Expressions, Converting Regular Expression to NFA and DFA, Minimization of DFA, Finite automaton, Distinguishable states. **Syntax Analysis:** Context-free grammars, Derivations, Parse trees, Ambiguity, **Top-down parsing:** Backtracking, LL (1) grammars, recursive descent parsing, Predictive parsing, Preprocessing steps required for predictive parsing, Grammar Transformation, LL (1) parsing Table, **Bottom-up Parsing:** Shift-reduce conflicts, Reduce-Reduce conflicts, Shift-Reduce parsing, Simple LR, LR and LALR parsing, Error recovery in parsing, handling ambiguous grammar, YACC – automatic parser generator. **Semantic Analysis:** Intermediate forms of source Programs, Type checker, Symbol tables and Type Tables, an organization for block structured languages, hashing, tree structures representation of scope information. **Storage Allocation:** Block structures and non-block structure storage allocation, static and dynamic storage allocation, Runtime stack and heap storage allocation, storage allocation for arrays, strings and records. **Code Generation:** Consideration for Optimization, Scope of Optimization, local optimization, loop optimization, frequency reduction, folding, DAG representation, global optimization, redundant subexpression elimination, Induction variable elements, Live variable analysis, Object code forms, machine dependent code optimization, register allocation and assignment generic code generation algorithms, DAG for register allocation.

Teaching and Learning Methods

Classroom lectures, self-learning and discussion.

Evaluation Method

- In-Course Assessments 30%
- End-Semester Examination 70%

Recommended Readings

1. Robin Hunter, The Essence of Compilers, 2004.
2. Alfred V. Aho, Monica S. Lam, Ravi Sethi, and Jeffrey D. Ullman, Compilers: Principles, Techniques, and Tools, 2^{nd} Edition, Pearson, 2012.

Course Title	Advanced Computer Networks
Course Code	IT4153
Credit Value	3 (30h Theory + 30h Practical + 90h Independent learning)

Objective

To provide knowledge on the advanced functionalities, techniques and protocols used in the computer networks.

Intended Learning Outcomes

- demonstrate the concepts of internetworking
- define the principles and functionality of internetwork OS
- identify the need for services integrated with the switches.
- demonstrate the relevant issues and techniques of network management solutions.
- implement the routing protocol with the network testing.
- develop simulation-based implementation on VLAN techniques.

Contents

Advanced Concepts: Connection oriented networks, Internetworking, Traffic engineering, High Speed LAN, FDDI, **Routing:** Network Layer, Routing algorithms, Routing Protocols, Operating Cisco IOS, configuring a router, Managing the Cisco Router File System, Routing Protocols, TCP/IP Suite Error and Control Messages, Network testing, Overview of Transport Layer Ports **Learning about Other Devices:** Discovering and Connecting to neighbors, Getting Information about remote devices, **Switching:** Data Link Layer, Switching Concepts, Switch operation and configuration, Spanning Tree Protocol, VLANs configuration and troubleshooting, Wireless communication, Network management system, **Emerging Trends:** Introducing Optical networks, Radio frequencies and Cognitive Radio.

Practical: Implementation of Routing and Switching techniques using network infrastructure.

Teaching and Learning Methods

Classroom lectures, self-learning and discussion, field visit, computer practical demonstration and training.

Evaluation Method

Theory: In-Course Assessments 30% and End Semester Examination 70%
Practical: In-Course Assessments 40% and End Semester Examination 60%
Final Marks = $(2 \times Theory + 1 \times Practical)/3$

Recommended Readings

1. James F. Kurose and Keith W. Ross, Computer Networking: A Top-Down Approach, Addison-Wesley, 6^{th} edition, 2013.
2. Larry L. Peterson and Bruce S. Davie, Computer Networks: A Systems Approach, Morgan Kaufmann, 5thedition, 2011.
3. William Stallings, Data and Computer Communications, Prentice Hall, 10^{th} edition, 2014.

Course Title	Research Project
Course Code	IT4216
Credit Value	6 (600 notional hours for research project development)

Objective

To provide an experience to critically analyse existing research and propose a suitable methodology to overcome the drawbacks and.

Intended Learning Outcomes

- analyse critically existing literature
- identify a research problem
- determine a suitable methodology for the identified research problem
- evaluate solution derived using the selected methodology
- create scientific reports
- build a presentation in a logical manner
- disseminate the findings in public domain

Contents

The student should do an individual research project for six credits under the guidance and supervision of a senior lecturer. The supervisor should be selected by the student by discussing the research proposal and submit it to the head of the department for the approval after the proposal presentation. During the first semester of the Level 4 students are required to do the following

- Select the research topic with the guidance of the supervisor
- Present the proposal for approval
- Monthly meeting with supervisor and monthly progress report
- The research will be carried out throughout the level four and it is evaluated at the end of the Level 4

At the end of the research, the student should submit a report for the evaluation and should do the viva voce presentation.

Evaluation Methods:

- Final report 50%
- Project presentation and Implementation 25%
- Viva-voce 25%

Recommended Readings

1. Zobel, J., writing for computer science, Springer, 2007.
2. Booth, W.C, Colomb, G.G and Williams, J.M., The Craft of Research. University of Chicago Press, 2003,
3. Nandi, Learning Research, 2005

Note: Any special circumstances are decided by the department and implemented with the approval of the Faculty Board of Faculty of Applied Science.

Course Title	Industrial Training
Course Code	IT4226
Credit Value	6 (600 notional hours for industrial training)

Objective

To provide hands-on experience in an IT related industry

Intended Learning Outcomes

- solve problems by themselves
- take part in a team to complete a task
- decide the career goals
- build their own professional collaboration
- adapt to the industrial setting with experience

Contents

- The student should get a placement opportunity in an industry where IT is the main field and follow minimum six months training.
- The student who placed in an industry should be assigned an IT related task under the guidance of an industrial supervisor.
- The students will be assigned a supervisor from the department of physical science
- The student should participate in the usual daily activity of the industry.
- The weekly diary should be maintained and signed by the supervisor assigned.
- A set of lecturers from the department visits to the industry to monitor the students' performance during the training period at least one time.
- The student needs to submit a final report and do a presentation at the end of this training.

Evaluation Methods:

- Weekly diary and evaluation from the supervisor 30%
- Final report 40%
- Oral presentation 30%

Recommended Readings

1. Industrial Training Guidelines and Diary, Department of Physical Science, Vavuniya Campus, 2018

Note: Any special circumstances are decided by the department and implemented with the approval of the Faculty Board of Faculty of Applied Science.

Course Title	Augmented and Virtual Reality
Course Code	EL4112
Credit Value	2 (30h Theory + 70h Independent learning)

Objective

To provide the knowledge on the representation of real-world scenario into a virtual environment

Intended Learning Outcomes

- define the elements, architecture and peripheral components of the virtual and augmented reality systems
- apply virtual reality to enhance computer-based application
- evaluate the Virtual and Augmented reality models
- develop VR or AR based system for real-world application
- analyse characteristics of health hazards in AR and VR systems

Contents

Introduction: Introduction to VR and AR, History of VR and AR, Vision, Visuals, Audio, Basic features of VR systems. VR Input and output Hardware, Architecture of VR systems, Immersive Displays, **Techniques:** Tracking, Locomotion, Redirection, Haptics and Pseudo Haptics, creating narratives for VR, Haptic, feedback for free-hand interaction, Mixed Reality in conferencing applications, Use of haptics in VR Motion Tracking, **Visualization and Presentation:** Autostereoscopic Displays, 3D Interaction technologies, VR for scientific visualization, **Augmented Reality:** Hand gesture in VR, Haptics in AR/VR, Interactive clothing simulation for virtual try-on, Mobile augmented reality, **Analysis of Techniques:** Evaluation and Comparison of Locomotion Techniques in VR, **Application:** Advances in 3D Body Scanning, Application of VR and AR in Medicine **Health Issues:** Social Psychology, Pain reduction, Education, Museum, Motion sickness, Cybersickness, Galvanic vestibular stimulation to reduce cybersickness, Virtual Reality exposure therapy. **Tools:** Unity, unreal, Google tango.

Teaching and Learning Methods

Classroom lectures, Laboratory session, self-learning and discussion.

Evaluation Method

- In-Course Assessments 30% (Practical Examinations)
- End-Semester Examination 70%

Recommended Readings

1. S.K. Ong, A.Y.C. Nee, Virtual and Augmented Reality Applications in Manufacturing, Springer London, 2011
2. Dengzhe Ma, Michael Grafe,Virtual Reality & Augmented Reality in Industry, Springer Science & Business Media, 2012
3. Minhua Ma, Lakhmi C. Jain, Paul Anderson, Virtual, Augmented Reality and Serious Games for Healthcare 1,Springer Berlin Heidelberg, 2014

Course Title	Data Science
Course Code	EL4122
Credit Value	2 (30h Theory + 70h Independent learning)

Objective

To provide knowledge on the Big data analytics techniques on a variety of applications using data mining methods

Intended Learning Outcomes

- demonstrate the use of data mining and its applications
- compare different data mining techniques and algorithms
- explain the Big Data fundamentals, including the evolution of Big Data, the characteristics of Big Data and the challenges introduced
- apply appropriate analytic techniques and tools to analyze big data
- deploy a structured lifecycle approach to data analytics problems

Contents

Data Mining: Introduction, Data Mining Goal, techniques, Process, Application, Data Warehouse and DBMS, Multidimensional Data, OLAP Operations, Data Preprocessing steps, Discretization and Filtering, Knowledge Representation Techniques, Visualization, Attribute generalization and relevance, class comparison, Data mining software application, Data Mining Tools. **Big Data:** The fundamentals of Big Data, Understanding Big Data, Business Motivation and Drivers for Big Data Adoption, State of the Practice in Analytics, Key Roles for Big Data Ecosystem, Data Analytics lifecycle, Discovery, Basic Data Analytic Methods Using R.

Teaching and Learning Methods

Classroom lectures, Laboratory session, self-learning and discussion.

Evaluation Method

- In-Course Assessments 30% (Practical Examinations)
- End-Semester Examination 70%

Recommended Readings

1. Jiawei Han, Micheline Kamber, and Jian Pei. Data Mining: Concepts and Techniques (3rd ed.). Morgan Kaufmann, 2012. eText
2. Witten, I.H., Frank, E., Hall, M.A., Data Mining, Third Edition: Practical Machine Learning Tools and Techniques, Morgan Kaufmann, 2011.
3. EMC Education Services ,Data Science & Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, 2015
4. Thomas Erl, WajidKhattak, Paul Buhler, Big Data Fundamentals Concepts, Drivers & Techniques, 2016

Course Title	GIS and Remote Sensing
Course Code	EL4132
Credit Value	2 (30h Theory + 70h Independent learning)

Objective

To provide knowledge on the theoretical background of Geographical Information System and remote sensing with its application

Intended Learning Outcomes

- define the principles and the technical characteristics of remote sensing to make use of remotely sensed data for the application of geographic information systems
- apply image enhancement techniques on remotely sensed imagery
- select both primary and secondary spatial data for the use of GIS
- identify geometrical features in raster and vector format of digital data

Contents

Introduction: Remote Sensing and Its Techniques, EMR, EMR Interaction, Atmosphere Scattering, Spectral Response Pattern, Vegetation, Absorption, emission and transmission, Geological Remote Sensing, thematic classification of multispectral data. Geo-referencing, **Data Acquisition Platforms:** Satellite remote sensing principles, IRS series, LANDSAT series, SPOT series, High resolution satellites, character and applications, CARTOSAT series, IKONOS Series, QUICKBIRD series, Weather/Meteorological satellites, INSAT series, NOAA, GOES, NIMBUS Applications, Marine observation satellites OCEANSAT, **Data Acquisition Sensors:** Active, Passive, Optical Remote sensing, visible, infrared, thermal, sensors and characters, **Data Analysis:** Data Preprocessing, Visual Interpretation, Ground truth, **Introduction to GIS:** Introduction to GIS, GIS Data models and Sources, Map Scale, Projection, Importing, Preparing, Organizing Dataset, Coordinate System, Cartography, Map Projection Design, Layout, Data management

Teaching and Learning Methods

Classroom lectures, Laboratory session, self-learning and discussion.

Evaluation Method

- In-Course Assessments 30% (Practical Examinations)
- End-Semester Examination 70%

Recommended Readings

1. James B. Cambell, Randolph H. Wynne, Introduction to Remote Sensing, 5^{th} Edition,2011
2. John R. Jensen, Introductory Digital Image Processing, 3^{rd} Edition,2004
3. Thomas Lillesand, Ralph W. Kiefer, Jonathan Chipman (Author), Remote Sensing and Image Interpretation 7^{th} Edition,2015

Course Title	Graph Theory
Course Code	EL4142
Credit Value	2 (30h Theory + 70h Independent learning)

Objective

to provide knowledge on formulation of problems in terms of graphs and solving them using graph algorithms.

Intended Learning Outcomes

- define various mathematical graph representation
- represent real-life situations with mathematical graphs
- find patterns that arise in various graph problems
- construct the standard algorithms of graph theory
- solve real world problems using graph theory algorithms

Contents

Graphs Introduction: Graphs and simple graphs, Graphs isomorphism, The incidence and adjacency matrices, Vertex degrees, Paths and connection, Cycles and the shortest path problem. **Trees:** Trees, spanning trees, cut edges and bonds, cut vertices, Cayley's formula and Kruskal's algorithm, **Connectivity:** Connectivity, Blocks and construction of reliable communication networks. **Euler Tours and Hamilton Cycles:** Euler tours, Hamilton cycles, The Chinese postman problem and the traveling salesman problem. **Planar Graphs:** Planar graphs, Dual graphs and Euler's formula. **Networks:** Flows, Cuts, The Max-Flow Min-Cut theorem and applications. **Graph Colouring:** Vertex colouring, Edge colouring, The Chromatic Polynomial

Teaching and Learning Methods

Classroom lectures, self-learning and discussion.

Evaluation Method

- In-Course Assessments 30%
- End-Semester Examination 70%

Recommended Readings

1. Gary Chartrand, Ping Zhang ,A First Course in Graph Theory, 2012
2. Fred Buckley, Marty Lewinter, Introductory Graph Theory with Applications , 2013
3. NarsinghDeo,Graph Theory with Applications to Engineering and Computer Science, 2016

Course Title	Machine Learning
Course Code	EL4152
Credit Value	2 (30h Theory + 70h Independent learning)

Objective

To provide knowledge on various machine intelligence techniques for automated learning and testing.

Intended Learning Outcomes

- distinguish supervised, unsupervised and semi-supervised learning methods
- identify suitable classifier for a given classification task
- apply clustering techniques to label the groups
- illustrate the basic operations of neural networks and deep learning
- make use of machine learning techniques in NLP
- explain the basic concepts of fuzzy logic

Contents

Introduction to learning and inference: Supervised, Unsupervised, Semi-supervised and reinforcement learning, Bayesian inference, naive Bayes method, Decision Trees, **Classification:** Bayesian decision theory and Bayes optimal classification, Generative and discriminative models, Likelihood functions and priors, Bayes theorem as applied to supervised learning, The maximum likelihood and maximum a posteriori hypothesis, Linear classifiers, classifier accuracy. Introduction to Neural networks, Support vector machines (SVMs), Ensembles, Nearest-neighbor algorithms, **Unsupervised learning:** The K-means algorithm, clustering as a maximum likelihood problem, EM algorithm and its application to clustering, Self-Organizing Maps, Semi-supervised learning. Learning graphical models, Performance evaluation, Learning theory, The problem of over-fitting, the curse of dimensionality, Reinforcement learning, Exploration vs. exploitation trade-off, Markov decision processes, Markov and Hidden Markov models, Pattern Recognition. **Other Topics in Machine Learning:** Introduction to fuzzy logic, Introduction to Deep Learning, introduction to Natural Language Processing

Teaching and Learning Methods

Classroom lectures, self-learning and discussion.

Evaluation Method

- In-Course Assessments 30% (Practical Examinations)
- End-Semester Examination 70%

Recommended Readings

1. Bishop, C.M., Pattern recognition and machine learning, Springer, 2011.
2. Barber, Bayesian Reasoning and Machine Learning, 2012.

Course Title	Numerical Computing
Course Code	EL4162
Credit Value	2 (30h Theory + 70h Independent learning)

Objective

To provide knowledge on computational approaches for numerical problems

Intended Learning Outcomes

- formulate simple numerical problems with the knowledge of computing
- define various algorithm of the numerical solution
- analyse a suitable method to solve the linear equation
- identify the errors of a numerical solution
- build the solutions of numerical problems using the appropriate numerical methods.

Contents

Error Analysis: Round off errors, Loss of significance, **Roots of Polynomials:** the bisection method, fixed point iteration, convergence of iterative methods, Aitken's process, order of convergence, Newton-Raphson method. **Interpolation:** Computing with polynomials, Newton interpolation polynomial and Lagrange polynomial, Errors in Interpolation, **Numerical Differentiation:** Finite Divided Difference Table, Forward and Backward divided difference methods, **Numerical Integration:** Trapezoidal Rule and Simpson's Rules, Errors Numerical Integration, **The numerical solution of system of linear equation Direct method:** Gaussian Elimination, pivoting strategies, operational count, Matrix factorization, stability and conditioning, Vector and matrix norms, **Iterative method:** Jacobi, Gauss-Seidel methods, Successive over-relaxation method, Convergence of Iteration methods.

Teaching and Learning Methods

Classroom lectures, self-learning & discussion.

Evaluation Method

- In-Course Assessments 30% (Practical Examinations)
- End-Semester Examination 70%

Recommended Readings

1. E. Ward Cheney and David R. Kincaid, Numerical Mathematics and Computing, 2012
2. K. Atkinson and W. Han, Elementary numerical analysis,3^{rd} Edition,2003
3. R.L. and Faires, D.F, Burden, Numerical Analysis,10^{th} Edition, 2015
4. S. Kanaganathan, Fundamentals of Numerical Computing,2009

Course Title	Optical Networks
Course Code	EL4172
Credit Value	2 (30h Theory + 70h Independent learning)

Objective

To provide knowledge on switch architectures, algorithms, and emerging trends in optical switching networks techniques.

Intended Learning Outcomes

- identify various components in optical fiber communication
- define the control management of optical network topologies
- illustrate several optical switch architectures used in optical communication.
- distinguish various network survivability mechanisms
- explain the emerging trends in optical networks

Contents

Optical Fiber Communication Concepts: Optical Switching Components, WDM for Optical Transmission, Routing and Wavelength Assignment, Wavelength-Convertible Networks, Optical Switching Mechanisms, Quality of Service. **Switch Architectures:** Terabit Transport Networks, Layered Architecture, Design of Optical Layer, Heuristics Design. **Survivability:** Protection and Restoration Techniques, Optical Layer with Fault-tolerance Capability. **Emerging Trends:** Light Trails, Traffic Grooming, Elastic Optical Networks, Li-Fi and Optical Wireless Communication, Data Center Networks.

Teaching and Learning Methods

Classroom lectures, self-learning and discussion.

Evaluation Method

- In-Course Assessments 30%
- End-Semester Examination 70%

Recommended Readings

1. Rajiv Ramaswami, Kumar N Sivarajan and Galen H. Sasaki, "Optical Networks - A practical perspective", Morgan Kaufmann Publishers, 3^{rd} Edition, 2010.
2. Govind P. Agrawal, "Fiber-Optic Communication Systems", Wiley Publication, 4^{th} Edition, 2010.
3. Milorad Cvijetic and Ivan Djordjevic, "Advanced Optical Communication Systems and Networks", Artech House, 1^{st} Edition, 2013.

Course Title	Smart Systems
Course Code	EL4182
Credit Value	2 (30h Theory + 70h Independent learning)

Objective

To provide knowledge on designing automated systems using smart and IoT technologies

Intended Learning Outcomes

- demonstrate sensors and its application
- identify the use of signal processing in smart systems
- illustrate the communication between smarter systems
- Apply the sensors and networks to automate a selected phenomenon
- make use of devices, gateways and data management in the Internet of Things.
- utilize several simulation tools

Contents

Introduction: Introduction to Smart system, Integration of Devices, Introduction to Signal Processing, Micro System, **Sensors and Devices:** Microactuators, Microsensors, Antenna, Remote Controls, **Methods and Techniques:** Wireless Sensor Networks, Automation Techniques, Smart Medical System, Smart Home System, **New technologies:** Introduction to Internet of Things, RFID and I/O Control, NFC, Multi-Agent System, Simulations.

Teaching and Learning Methods

Classroom lectures, Laboratory sessions, self-learning & discussion.

Evaluation Method

- In-Course Assessments 30% (Practical Examinations)
- End-Semester Examination 70%

Recommended Readings

1. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Machine-to- Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014
2. Mahmoud A. Al-Qutayri, Smart Home Systems, InTech, 2010
3. Gerard Meijer, Kofi Makinwa, Mchiel Pertijs, Smart Sensor Systems: Emerging Technologies and Applications, 1^{st} Edition, 2014

Course Title	Software Defined Networking
Course Code	EL4192
Credit Value	2 (30h Theory + 70h Independent learning)

Objective

To provide knowledge on main concepts, architectures and Internet architectural framework of Software Defined Networking (SDN).

Intended Learning Outcomes

- compare various planes used in SDN.
- demonstrate the concepts and applications of OpenFlow protocol.
- identify the specific architectures used in SDN.
- make use of SDN techniques in large data centers and Internet exchange.
- illustrate traffic engineering concepts in SDN scenarios.

Contents

Plane Separation: Control Plane and Data Plane, IETF Forces, Active Networking. Concepts, Advantages and Disadvantages, **OpenFlow Protocol:** Concepts, Applications, Manipulation Techniques. **Network Virtualization Framework:** SDN Controllers. Switching and Firewall Implementation using SDN Concepts. Software-based and Hardware-based, Programmable Network Hardware. **Data Centers:** Internet Exchange Points, Backbone Networks, Home Networks, Traffic Engineering.

Teaching and Learning Methods

Classroom lectures, self-learning & discussion.

Evaluation Method

- In-Course Assessments 30%
- End-Semester Examination 70%

Recommended Readings

1. Thomas D. Nadeau and Ken Gray, "SDN: Software Defined Networks, An Authoritative Review of Network Programmability Technologies", O'Reilly Media, 2013.
2. Siamak Azodolmolky, "Software Defined Networking with OpenFlow", Packt publishing, 2013.
3. Paul Goransson, Chuck Black, and Timothy Culver, "Software Defined Networks: A Comprehensive Approach", Morgan Kaufmann, 2^{nd} Edition, 2016.

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Assistant Registrar/Administration	024 222 3316
Assistant Registrar/Faculty of Applied Science	024 222 8401
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