Institute of Chemistry Ceylon

COURSE HANDBOOK

3rd Edition 2021

BSc Honours in Chemical Science
Graduateship Programme in Chemistry

Institute of Chemistry Ceylon

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BSc Honours in Chemical Science
Graduateship Programme in Chemistry

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DISCLAIMER

This handbook has been compiled with information received up to March 2021. It is hereby notified that this handbook is only for general information and is not for official purposes. Any information contained herein should be confirmed by reference to the relevant authority or should be confirmed by the relevant authority.

Vision

Contribute towards a society with good values by offering intellectual growth through education in chemical sciences.

Mission

To be a centre of excellence by offering quality education in chemical sciences through teaching, learning, research, innovations and good ethical practices.

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Message from the President

It is with great pleasure that I pen this message to be included in the Handbook of the College of Chemical Sciences, Institute of Chemistry Ceylon. This illustrious Institute has contributed immensely to the chemical industry in the country and the field of academia for the past 40 years. The College of Chemical Sciences, functioning as the educational arm of the Institute of Chemistry Ceylon, has worked towards providing very high standard professional education to students willing to pursue higher studies or employment in the field of science and it is with pleasure that I join hands towards advancing the education provided by this Institute.

College of Chemical Sciences comprises a dynamic and highly stimulating teaching and research environment owing to the skilled academics and staff members that have dedicated their life to offer quality education to the students. An integral part of the exposure provided by the College of Chemical Sciences equip our graduates with the necessary requirements and training to achieve success in the cooperate sector as can clearly be seen today. We hope for our graduates to flourish in the fields that they decide on, be it in the academia or industry and to look beyond their immediate horizons to realize the potential they have within them.

I wish all the student who become part of this family all the success in their endeavor in pursuing studies in the field of Chemistry.

Professor Sagarika Ekanayake
President, Institute of Chemistry Ceylon

Message from the Dean

Welcome! I am pleased to extend my sincere wishes to all the new enrollees. You have made a life-changing decision to become a part of the Institute of Chemistry Ceylon (IChemC). The College of Chemical Sciences, functioning as the educational arm of the Institute, has been nurturing undergraduates for over fifty years now. The Graduateship Programme in Chemistry (GIC) is a qualification that has opened a variety of international and national career prospects for aspiring Chemists. From this year onwards, we introduce the Bachelor of Science Honors (BSc) in Chemical Science. At present, we have many prospective candidates enrolled in this honours programme.

The BSc Honors in Chemical Science is accredited by the Ministry of Higher Education and recognized by the UGC. The GIC is a Professional Degree accredited by the Royal Society of Chemistry, UK. Many of our alumni hold doctorates from prestigious academic bodies placed locally and abroad, and their scientific contributions are highly recognized. Likewise, those who join the industrial and corporate sectors are doing equally well. They have given IChemC its due recognition as an Institute that produces quality graduates in Chemistry.

We have pooled together highly competent internal academics, visiting lecturers from state universities, and qualified professionals from government agencies and research institutes to help you achieve your dreams as of now and beyond.

I wish you the best of luck with your studies and encourage you to complete your degree on a high note within the allocated four-year period.

Professor Sujatha Hewage
Dean, College of Chemical Sciences

Institute of Chemistry Ceylon

The Institute of Chemistry Ceylon is the successor to the Chemical Society of Ceylon (founded in 1941) and was established in the year 1971 for the general advancement of the science and practice of chemistry. It is a not-for profit organization, learned society catering to the Chemical Sciences as well as a professional, qualifying and examination body looking after and responsible for the maintenance and enhancement of the profession of Chemistry in Sri Lanka. It is the oldest such body in any branch of the basic sciences in Sri Lanka. The Golden Jubilee of the Institute was held in 1991 & the Diamond Jubilee in 2001. The 75th Anniversary falls on 25th January 2016.

The Institute of Chemistry Ceylon was incorporated by Act of Parliament No. 15 of 1972 with the following aims and objectives: -

(a) to promote and advance the science of Chemistry and its applications in Sri Lanka;

(b) to advise the Government, and give counsel to public corporations, local bodies and other institutions on all matters connected with the application of Chemistry to the progress and development of the country;

(c) to promote the acquisition, dissemination and interchange of chemical knowledge by:-providing a forum for the presentation of original communications and discussions thereon; establishing and maintaining libraries; publishing matters of interest to the profession of chemistry & any other means;

(d) to promote education in chemistry at all levels;

(e) to promote, encourage and foster original research in Chemistry;

(f) to assess the eligibility of candidates for admission to the various grades of membership;

(g) to conduct or provide for the conduct of the qualifying examinations for all grades of membership of the Institute and to promote, provide or approve programmes of study for such examinations;

(h) to conduct or provide for the conduct of examinations for the award of diplomas, certificates and other distinctions, in such branches of Chemistry as the Institute may from time to time, deem necessary and to prescribe, approve or provide programmes of study for such examinations;

(i) to ensure the maintenance of high standards in the professional activities and the general conduct of its members;

(j) to establish liaison with other scientific and professional organizations;

(k) to establish and enhance the status of the profession of Chemistry in Ceylon;

(l) to take any other measures that may be necessary for the attainment of all or any of the objectives of the Institute.

The Institute was declared as an approved charity by an Order published by the Hon'ble Minister of Finance in the Government Gazette No. 121 of 26.12.80. Donations made by any institution or individual to the Institute of Chemistry Ceylon, are therefore deductible from the assessable income of such institution or individual for income tax purposes.

College of Chemical Sciences

The College of Chemical Sciences (CCS) was established in January 2001 during the Diamond Jubilee celebration of the Institute of Chemistry Ceylon on 25-01-2001. As per By-Law 15 of the Institute of Chemistry Ceylon, the College of Chemical Sciences was established to conduct all the educational and training activities of the Institute. Any recommendations made by the Academic Board of CCS is approved by the Academic Board of the Institute of Chemistry Ceylon, which is governed by the Council of the Institute.

Day to day administration is carried out by a full-time Dean also appointed by the Council. Full time Academic Staff Members constitute the internal academic staff (page 8) while the Teaching Assistants constitute the internal Academic Support Staff. The administrative staff is headed by the Registrar of the College. A Librarian & Assistant Librarians are in charge of the Library. A number of other full time non-academic staff comprise the balance staff. A number of Visiting Academics drawn from Universities, research institutes, and service organizations and well as the private sector also assist in carrying out the day to day teaching activities of the College.

As per By–Law 15.1 of the Institute, the functions of the College are:-

(a) to conduct post-secondary, Graduateship, Diploma and Certificate courses in the Chemical Sciences

(b) to promote education in and application of Chemistry at levels

(d) to initiate research activities in collaboration with Universities, Industry and foreign Institutions

(e) to establish library facilities including database access and technology information

(f) to conduct refresher/in-service/training courses for scientists and teachers

(g) to assist industry in product development, problem solving, quality improvement and product diversification

(h) to encourage staff exchange between the College and the Universities/ Research Institutes in Sri Lanka and overseas.

(i) to publish journals/monographs etc., to disseminate the latest know how in the Chemical Sciences

(j) to take any measures that may be necessary for the attainment of the educational goals of the Institute

Academic Board of the Institute of Chemistry Ceylon

A statutory committee known as the Academic Board of the Institute of Chemistry Ceylon is appointed by the Council annually to promote, conduct and co-ordinate all the education, training, and academic affairs of the College of Chemical Sciences. All the formal educational programmes are the immediate responsibility of this committee which is chaired by the President of the Institute, and includes the Dean as the Vice Chairman, Secretary for Educational Affairs as the Secretary of the Academic Board of IChemC, Senior Assistant Registrar or Assistant Registrar as the Assistant Secretary. Two representatives of the Academic Board of CCS also constitute this committee. The Heads of Departments of CCS and full-time visiting professors, one of the Honorary Secretaries of the Institute, the Chairman of the Admissions & Ethical Practices Committee of the Institute and the Institute's Honorary Treasurer are appointed as ex-officio members of the Academic Board. In addition, the Board consists of eleven elected members, and also comprises of the Registrar of the Institute and the Librarian as representatives of the administrative staff. Additional members can be co-opted as required.

The Academic Board of the Institute of Chemistry Ceylon has the following powers, duties and functions as per by – law 15.4

(a) to recommend to the Council names to fill vacancies that may arise from time to time in the Academic Board of the Institute of Chemistry Ceylon .

(b) to have the right to co-opt additional members (Corporate or non-Corporate) for the purpose of effectively carrying out its powers, functions and duties subject to Council approval being obtained. Such persons co-opted have no voting rights and could be excluded from any meeting or part of a meeting if such an exclusion is deemed fit in the opinion of the Academic Board of the Institute of Chemistry Ceylon.

(c) to conduct the functions of the College as set out in by –law 15.1

(d) to have powers to conduct or provide for the conduct of examinations for the award of diplomas, certificates and other distinctions in such branches of Chemistry as the Institute may from time to time deem necessary and to prescribe, approve or provide courses of study for such examinations.

(e) to inform the Council on all matters concerning courses of study and examinations conducted, sponsored or approved by the Institute, including the appointment, reprimandment, suspension or dismissal of students, examination candidates and other personnel associated with such courses of study and examinations except examiners and lecturers.

(f) to recommend to the Council any reprimandment, suspension or dismissal of examiners and lecturers.

(g) to recommend to the Council for the award of educational qualifications, awards and other distinctions.

(h) to conduct examinations for outside institutions including government departments, when requested on a

payment of fees.

(i) to submit an Annual Report to the Council by such date as determined by the Council.

(j) to form and revise regulations governing courses and examinations of the Institute, and shall inform the Council on all such instances.

(k) to meet within a month of its appointment and thereafter at intervals not exceeding two months. The quorum for such meetings shall be seven.

(l) to have the right to decide on the utilization of the funds in the name of the College in such a manner as to promote the duties and functions of the College of Chemical Sciences, subject to approval of the Council being obtained.

Academic Board of the College of Chemical Sciences

The Academic Board of College of Chemical Sciences is appointed for formulating recommendations with regard to the educational and allied activities of the College. The Board is chaired by the Dean, and includes the Senior Assistant Registrar or Assistant Registrar as the Secretary. The elected members consist of all internal academics of CCS and five members representing visiting lecturers. In addition, two representatives of the Students' Association of CCS also constitute this committee.

The Academic Board of College of Chemical Sciences is chaired by the Dean, and includes the Senior Assistant Registrar or Assistant Registrar as the Secretary. The elected members consist of all internal academics of CCS and five members representing visiting lecturers. In addition, two representatives of the Students' Association of CCS also constitute this committee.

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B.A. (Peradeniya), M.Sc. (Kelaniya)

Non-Academic Staff

Accounts Division

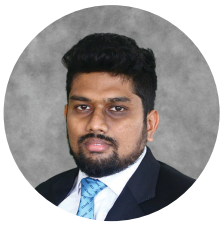
Ms. A C Wijesuriya
Assistant Finance Manager
AAT

Mr. U R J P Bandara
Senior Accounting Officer
HNDA

Mr. E A D Ishantha
Senior Accounting Officer
HNDA

Ms. P H Udyani
Accounts Assistant

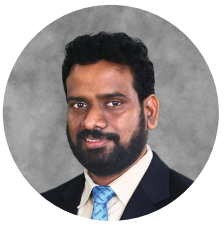
Examinations Division



Mr P M Hettige
Management Assistant
B.Sc. (Peradeniya)

Main Office

Mr. D I S H Jayasingha
Publications Officer



Mr. H L R H Abeyrathna
Education Assistant
DLTC

Mr. U J N Chandana
Office Assistant

Mr. M G S Sankalpa
Attendant

Mr. H H Lionel
Maintenance Assistant

Mr. R A Milton
Hall Attendant

Ms. H M Mallika
Office Assistant

Library

Mr. N M Waidyasuriya
Deputy Librarian
Dip. LIBSE (Kelaniya)

Mr. N Mahindasiri
Assistant Librarian
B.Lab.Edu. (Colombo)

Ms. F A Azmeer
Library Attendant

Ms. H F T H Fonseka
Library Attendant

Laboratory

Mr. W R R Perera
Laboratory Assistant

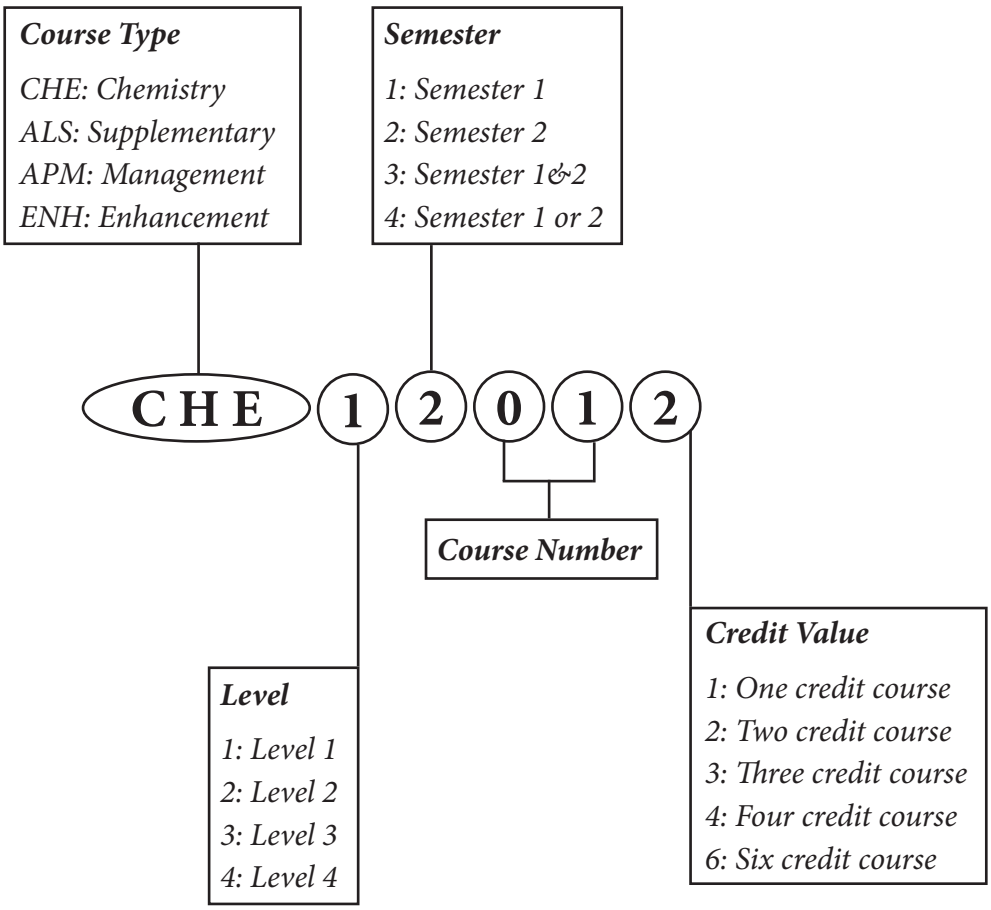
Mr. P U P Perera
Laboratory Assistant

Mr. I W Sunil
Laboratory Assistant

Mr. G S M R Perera
Laboratory Attendant

Mr. D F H de Silva
Laboratory Attendant

BSc (Hons) Course Code Description



BSc (Hons) Course Contents

Level 1

Semester 1

Chemistry	
CHE 11012	Chemical Principles
CHE 11022	Basic Organic Chemistry
CHE 11031	Classical Methods in Chemical Analysis I
CHE 11041	Elementary Chemistry Laboratory
Supplementary	
ALS 11052	Calculus
ALS 11062	Fundamentals of Physics for Chemists
Enhancement	
ENH 11072	Basic Mathematics*
ENH 11082	Biology for Physical Science Students*
ENH 11092	General English
Management	
APM 11102	Principles of Management
APM 11112	Optimization Methods in Management Science

(Note: Students who have faced GCE A/L or London A/L in the physical science stream are required to complete ENH 11082 (Biology for Physical Science Students) and students who have faced GCE A/L or London A/L in the bioscience stream are required to complete ENH 11072 (Basic Mathematics). Where a student has secured A/L passes in Biology as well as Mathematics, the Dean shall, in consultation with the student, make the decision regarding which course to be completed by the student.)

Compulsory Credits	: 14
Elective Credits	: 00
Enhancement Credits	: 04

Semester 2

Chemistry	
CHE 12012	Chemistry of Main Group and Transition Elements
CHE 12022	Principles of Physical Chemistry I
CHE 12032	Basic Concepts in Biochemistry I
CHE 12041	Organic Chemistry Laboratory
CHE 12051	Classical Methods in Chemical Analysis II

Supplementary

ALS 12062	Basic Electronics for Chemists
ALS 12072	Basic Statistics I

Enhancement

ENH 12082	Effective Communication

Management

APM 12102	Introduction to Industrial Economics
APM 12112	Accounting Concepts and Costing

Compulsory Credits	: 16
Elective Credits	: 00
Enhancement Credits	: 02

Level 2

Semester 1

Chemistry

CHE 21012	Concepts in Inorganic Chemistry I
CHE 21022	Reactive Intermediates in Organic Reactions and Organic Synthesis
CHE 21032	Principles of Physical Chemistry II
CHE 21041	Basic Analytical Spectrometry
CHE 21051	Analytical and Inorganic Chemistry Laboratory
CHE 21061	Basic Concepts in Biochemistry II

Supplementary

ALS 21072	Basic Statistics II

Management

APM 21102	Principles of Human Resource Management and Leadership
APM 21112	Marketing Management

Compulsory Credits	: 15
Elective Credits	: 00
Enhancement Credits	: 00

Semester 2

Chemistry

CHE 22012	Concepts in Inorganic Chemistry II
CHE 22022	Heterocyclic Chemistry and Spectroscopy
CHE 22032	Principles of Physical Chemistry III
CHE 22041	Physical Chemistry Laboratory

CHE 22051	Separation Methods and Fundamentals of Chromatography
CHE 22061	Natural Products
Enhancement	
ENH 22071	English for Scientific Writing
Management	
APM 22082	Computer Based Tools for Management
APM 22092	Total Quality Management
APM 22102	Operations Management

Compulsory Credits : 15
Elective Credits : 00
Enhancement Credits : 01

Level 3

Semester 1

Chemistry	
CHE 31013	Advanced Inorganic Chemistry I
CHE 31022	Physical Organic Chemistry, Pericyclic Reactions and Natural Products Chemistry
CHE 31032	Quantum Chemistry and Molecular Spectroscopy
CHE 31042	Electroanalytical Chemistry and Optical Spectroscopy
CHE 31051	Advanced Inorganic Chemistry Laboratory
CHE 31062	Environmental Chemistry
CHE 31071	Analytical and Environmental Chemistry Laboratory
CHE 31082	Polymer Science

Compulsory Credits : 15
Elective Credits : 00
Enhancement Credits : 00

Semester 2

Chemistry	
CHE 32012	Advanced Topics in Physical Chemistry I
CHE 32022	Advanced Chromatography
CHE 32032	Research Methodology
CHE 32042	Advanced Organic Chemistry Laboratory
CHE 32052	Advanced Physical Chemistry Laboratory
CHE 32061	Seminar Presentation and Report Writing

Supplementary

ALS 32072	Basic Chemical and Process Engineering

Management

APM 32082	Innovation and New Product Development

Compulsory Credits	: 15
Elective Credits	: 00
Enhancement Credits	: 00

Level 4

Semester 1

Chemistry

CHE 41022	Advanced Inorganic Chemistry II
CHE 41023	Advanced Spectroscopy, Synthesis and Photochemistry
CHE 41032	Advanced Topics in Physical Chemistry II
CHE 41042	Frontiers in Chemistry
CHE 41052	Advanced Biochemistry
	Research Project
	Industrial Placement and Scientific Training

Management

APM 41062	Project Management

Compulsory Credits	: 13
Elective Credits	: 02
Enhancement Credits	: 00

Semester 2

Chemistry

CHE 43016	Research Project (continuation)
CHE 43026	Industrial Placement and Scientific Training (continuation)
CHE 42012	Molecular Modeling and Molecular Simulations
CHE 42022	Selected Topics in Physical Chemistry II

Enhancement

ENH 42032	Comprehensive Chemistry (Theory)
ENH 42042	Comprehensive Chemistry (Practical)

Management

APM 42052	Professional Practices

Compulsory Credits : 12

Elective Credits : 03

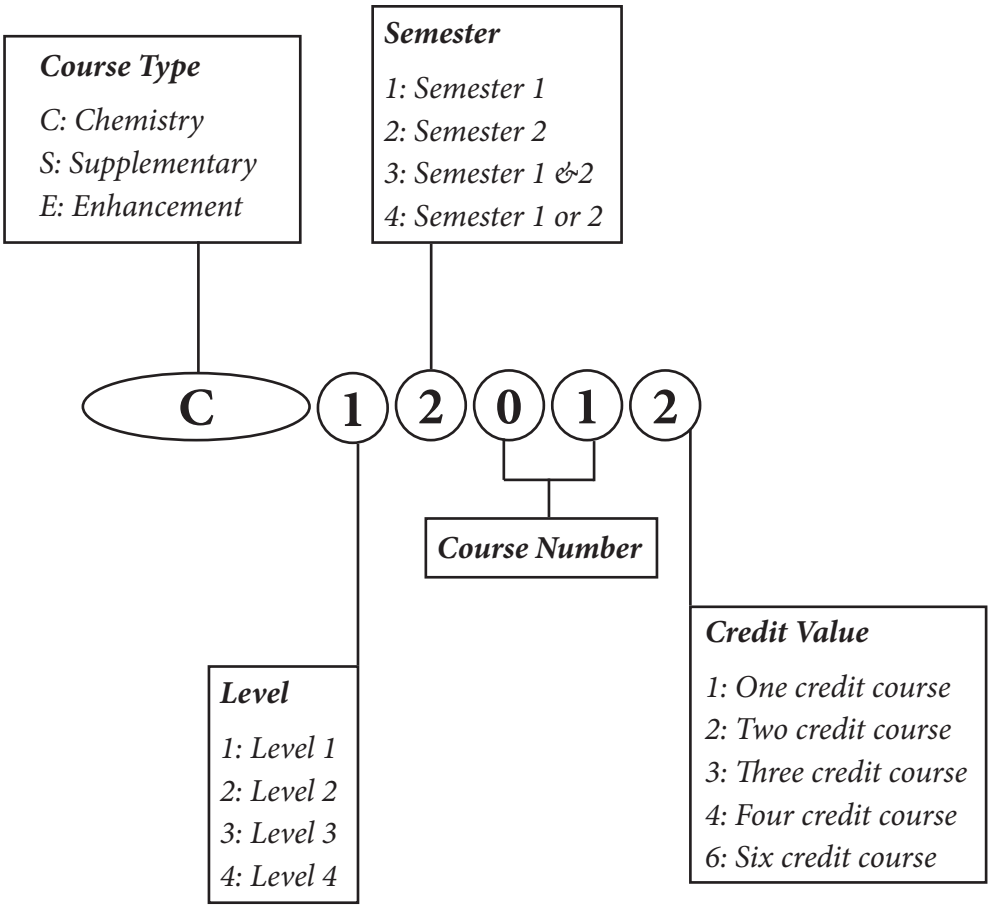
Enhancement Credits : 04

Level 3 & Level 4 - Elective Courses

Elective

CHE 44063	Analytical Industrial Biochemistry
CHE 44073	Electrochemical Technology
CHE 42081	Mineral Resources in Sri Lanka - Chemistry and Applications
CHE 41093	Food Chemistry and Technology
CHE 44102	Agrochemicals
CHE 44113	Chemical Education
CHE 44122	Industrial Chemistry and Technology
CHE 42132	Quality Management
CHE 42142	Further Topics in Environmental and Green Chemistry
CHE 44152	Pharmaceutical Technology
CHE 44163	Pharmaceutical and Medicinal Chemistry

GIC Course Code Description



GIC Course Contents

Level 1

Semester 1

C 11012	Chemical Principles
C 11022	Basic Organic Chemistry
C 11031	Classical Methods in Chemical Analysis I
C 11041	Elementary Chemistry Laboratory
C 11122	Industry, Environment and the Society
Supplementary	
S 11052	Calculus
S 11062	Fundamentals of Physics for Chemists
Enhancement	
E 11072	Basic Mathematics
E 11082	Biology for Physical Science Students
E 11092	General English
E 11132	Basic Concepts

Compulsory Credits	: 12
Elective Credits	: 00
Enhancement Credits	: 06

Semester 2

C 12012	Chemistry of Main Group and Transition Elements
C 12022	Principles of Physical Chemistry I
C 12032	Basic Concepts in Biochemistry I
C 12041	Organic Chemistry Laboratory
C 12051	Classical Methods in Chemical Analysis II
Supplementary	
S 12062	Basic Electronics for Chemists
S 12072	Basic Statistics I
Enhancement	
E 12082	Effective Communication

Compulsory Credits	: 12
Elective Credits	: 00
Enhancement Credits	: 02

Level 2

Semester 1

C 21012	Concepts in Inorganic Chemistry I
C 21022	Reactive Intermediates in Organic Reactions and Organic Synthesis
C 21032	Principles of Physical Chemistry II
C 21041	Basic Analytical Spectrometry
C 21051	Analytical and Inorganic Chemistry Laboratory
C 21061	Basic Concepts in Biochemistry II
C 21121	Science and Industrial Applications
Supplementary	
S 21072	Basic Statistics II

Compulsory Credits	: 12
Elective Credits	: 00
Enhancement Credits	: 00

Semester 2

C 22012	Concepts in Inorganic Chemistry II
C 22022	Heterocyclic Chemistry and Spectroscopy
C 22032	Principles of Physical Chemistry III
C 22041	Physical Chemistry Laboratory
C 22051	Separation Methods and Fundamentals of Chromatography
C 22061	Natural Products
C 22111	Energetics in Chemistry
Supplementary	
S 22123	Introduction to Management, Economics and Finance
Enhancement	
E 22071	English for Scientific Writing

Compulsory Credits	: 13
Elective Credits	: 00
Enhancement Credits	: 01

Level 3

Semester 1

Chemistry

C 31022	Physical Organic Chemistry, Pericyclic Reactions and Natural Products Chemistry
C 31042	Electroanalytical Chemistry and Optical Spectroscopy
C 31051	Advanced Inorganic Chemistry Laboratory
C 31062	Environmental Chemistry
C 31071	Analytical and Environmental Chemistry Laboratory
C 31082	Polymer Science
C 31093	Industrial Exposure

Compulsory Credits : 13
Elective Credits : 05
Enhancement Credits : 00

Semester 2

Chemistry

C 32012	Advanced Topics in Physical Chemistry I
C 32022	Advanced Chromatography
C 32032	Research Methodology
C 32042	Advanced Organic Chemistry Laboratory
C 32052	Advanced Physical Chemistry Laboratory
C 32061	Seminar Presentation and Report Writing
C 32092	Chemical Laboratory: Design, Operation and Management

Supplementary

S 32072	Basic Chemical and Process Engineering

Compulsory Credits : 15
Elective Credits : 03
Enhancement Credits : 00

Level 4

Semester 1

Chemistry

C 41052	Advanced Biochemistry
C 41172	Nanotechnology
C 41093	Food Chemistry and Technology
	Research Project
	Industrial Placement and Scientific Training

Compulsory Credits	: 07
Elective Credits	: 11
Enhancement Credits	: 00

Semester 2

Chemistry

C 43016	Research Project (continuation)
C 43026	Industrial Placement and Scientific Training (continuation)
C 42081	Mineral Resources in Sri Lanka – Chemistry and Applications
C 42132	Quality Management
C 42142	Further Topics in Environmental and Green Chemistry

Enhancement

E 42032	Comprehensive Chemistry (Theory)
E 42042	Comprehensive Chemistry (Practical)

Compulsory Credits	: 11
Elective Credits	: 06
Enhancement Credits	: 04

Level 3 & Level 4 - Elective Courses

Level 3 Electives

C 31013	Advanced Inorganic Chemistry I
C 31032	Quantum Chemistry and Molecular Spectroscopy

Level 4 Electives

C 41022	Advanced Inorganic Chemistry II
C 41023	Advanced Spectroscopy, Synthesis and Photochemistry

C 41032	Advanced Topics in Physical Chemistry II
C 41042	Frontiers in Chemistry
C 44063	Analytical Industrial Biochemistry
C 44073	Electrochemical Technology
C 44113	Chemical Education
C 44122	Industrial Chemistry and Technology
C 44152	Pharmaceutical Technology
C 44163	Pharmaceutical and Medicinal Chemistry

Level 3/4 Electives

C 34012/44012	Petroleum and Petrochemistry
C 34022/44022	Chemical Toxicology
C 34033/44033	Further Management, Economics and Finance
C 34042/44042	Cosmetic Science and Clinical Herbal Product Development
C 34051/44051	Industrial Safety Health and Environmental Technology
C 34063/44063	Molecular Biology and Biotechnology
C 34072/44072	Textile Science and Clothing Technology
C 34081/44081	Applied Microbiology
C 34092/44092	Polymer Chemistry and Technology

Course Summary

BSc (Hons)									
Level	1		2		3		4		Total
Semester	1	2	1	2	1	2	1	2	
Chemistry compulsory	6	8	9	9	15	11	11	10	79
Chemistry elective	0	0	0	0	0	0	2	3	5
Supplementary	4	4	2	0	0	2	0	0	12
Management	4	4	4	6	0	2	2	2	24
Enhancement	4	2	0	1	0	0	0	4	11
Total GPA credits	14	16	15	15	15	15	15	15	120
Total credits per year	30		30		30		30		
Total non GPA credits	4	2	0	1	0	0	0	4	11

GIC									
Level	1		2		3		4		Total
Semester	1	2	1	2	1	2	1	2	
Chemistry compulsory	8	8	10	10	13	13	7	11	80
Chemistry elective	0	0	0	0	5	3	11	6	25
Supplementary	4	4	2	3	0	2	0	0	15
Management	0	0	0	0	0	0	0	0	0
Enhancement	6	2	0	1	0	0	0	4	13
Total GPA credits	12	12	12	13	18	18	18	17	120
Total credits per year	24		25		36		35		
Total non GPA credits	6	2	0	1	0	0	0	4	13

LEVEL 1

C 11012/CHE 11012 - Chemical Principles

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: apply quantum theory of radiation and basic wave mechanics to explain the atomic structure;

ILO2: correlate the theory of quarks and gluon interaction with properties of protons and neutrons;

ILO3: apply Valance Shell Electron Pair Repulsion Theory, Valance Bond Theory and Molecular Orbital Theory to explain bonding/geometry/magnetic properties of molecules;

ILO4: explain energetics of ionic solids;

ILO5: identify the intermolecular forces present between molecules.

Note: ILO means intended learning outcome.

1. Quantum theory and atomic structure (7 h)

1.1. Atomic spectra: Wave nature of light, electromagnetic radiation and atomic spectra.

1.2. The quantum theory of radiation: Photon, photoelectric effect; The Bohr Theory of the hydrogen atom, hydrogen spectrum and origin of the line spectrum; Lyman, Balmer, Paschen, Bracket and Pfund series.

1.3. Wave mechanics: Wave–particle duality of matter, de Broglie equation, Heisenberg uncertainly principle, wave function, quantum numbers and atomic orbitals, electron spin and Pauli exclusion principle, orbital shapes and energies.

1.4. Electron configuration of atoms in the periodic table: Aufbau principle, Hund's rule, screening (shielding) and penetration.

2. Subatomic particles and nuclear properties (7 h)

2.1. Fundamental particles: Types and properties of quarks and leptons, antiparticles of quarks and leptons.

2.2. Composite particles: Structure of baryons and mesons, structure of the proton and neutron according to the quark model.

2.3. Nuclear properties: Types and properties of nuclear forces and force carrier particles.

2.4. Beta decay of a neutron in terms of quarks.

3. Chemical bonding (14 h)

3.1. Basic concepts: Lewis Symbols, types of chemical bonds (iconic, covalent, metallic, octet rule, exceptions to octet rule, electronegativity (Pauli, Muliken, Alfred, Rochow and Slater rules), bond polarity, dipole moment, rules to draw Lewis structure, resonance structures and resonance hybrids, polarization of ions and

Fajan's rules, properties of covalent bonds (energy and length).

3.2. Molecular shapes: VSEPR (Valence Shell Electron Pair Repulsion) theory, effect of lone pairs and bond repulsion on bond angles and molecular distortion.

3.3. Theories of covalent bonding

Valence Bond Theory (VBT): hybridization, mode of orbital overlap and type.

Molecular Orbital Theory : LCAO method, molecular orbital energy level diagrams for homonuclear diatomic molecules (H_2, N_2, O_2, F_2), hetero diatomic molecules (CO, NO, HF) and polyatomic molecules/ions with σ- and π- delocalized bonds (NO_2, O_3, NO_3^-, CO_3^{2-}, CO_2); Combined model for NO_2^-, O_3, NO_3^-, CO_3^{2-}, CO_2; Prediction of bond order and magnetism of molecules/ions based on molecular orbital energy level diagrams.

Energetics of ionic solids: Lattice energy, estimation of lattice energy by electrostatic model: Madelung constant, Born exponent, Born - Lande' equation and Born-Mayers equation, estimation of lattice energy by Born-Haber cycle, calculated versus experimental lattice energy, energetics of the dissolution of an ionic salt.

4. Intermolecular (Nonbonding or van der Walls) forces (2 h)

4.1. Types of intermolecular forces: Ion-dipole, dipole-dipole, ion-induced dipole, dipole-induced dipole, hydrogen bonding, and instantaneous dipole-induced dipole (also called London forces or dispersion forces).

4.2. A combination of intermolecular forces determines the properties of liquids: Surface tension, capillarity and viscosity.

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning.

Recommended Readings

- Catherine E Housecroft and Alan G Sharpe (2012), Pearson, England, Inorganic chemistry, 4th Edition
- Theodore E. Brown, H. Eugene H. LeMay, Bruce E. Bursten and Catherine Murphy (2017), Pearson, England, Chemistry: The Central Science, 14th Edition
- J. D. Lee (2006), Blackwell science, Concise Inorganic Chemistry, 5th Edition
- F. Albert Cotton, Geoffrey Wilkinson, Carlos A. Murillo, Manfred Bochmann (1999), Advanced Inorganic Chemistry, John Willey and Sons, INC., 6th Edition
- Brian W Pfennig (2015), Principles of Inorganic Chemistry, John Wiley & sons

C 11022/ CHE 11022 - Basic Organic Chemistry

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: differentiate between stereo isomers as well as conformational isomers;

ILO2: compose the structure of an organic molecule based on the IUPAC nomenclature and vice versa;

ILO3: correlate reaction mechanisms with bonding aspects of the functional group and propose synthetic pathways for conversion of functional groups of aliphatic and aromatic compounds;

ILO5: identify aromatic, antiaromatic and nonaromatic compounds;

ILO6: predict the rate and orientation of electrophilic substitution of substituted benzene.

Note: ILO means intended learning outcome.

1. Structure, nomenclature and stereochemistry of organic compounds (12 h)

1.1. Basic concepts in organic chemistry, bonding and structural theory, resonance, IUPAC nomenclature of organic compounds.

1.2. Isomerism: Geometrical (E and Z) and optical (R and S) isomerism, conformational isomers of acyclic and cyclic compounds.

2. Chemistry of aliphatic and aromatic compounds (18 h)

2.1. Chemistry of aliphatic compounds: Structure and reactivity of alkanes, alkenes, alkynes, alkyl halides, alcohols, ethers, epoxides, carbonyl compounds, carboxylic acids, carboxylic acid derivatives, amines

2.2. Aromaticity and reactions of aromatics, Huckel rule, anti-aromatics, non-benzenoid aromatics.

2.3. Electrophilic aromatic substitution rate and orientation of electrophilic substitution of substituted benzenes.

2.4. Properties and reactions of phenols and aromatic amines including acidity and basicity of substituted compounds.

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning.

Recommended Readings

- Solomons, T. W. G.; Fryhle, C. B.; Snyder, S. A. (2013). Organic Chemistry, 11th Edition, John Wiley.
- McMurry, J. E. (2011). Organic Chemistry, 8th Edition, Brooks Cole.
- Wade Jr, L. G. (2012). Organic Chemistry, 8th Edition, Pearson.
- Bruice, P. Y. (2013). Organic Chemistry, 7th Edition, Prentice Hall.

C 11031/CHE 11031 - Classical Methods in Chemical Analysis I

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: differentiate basic terminologies used in analytical chemistry and in chemical analysis;

ILO2: sketch redox and neutralization titration curves for single step and multistep titrations involving different thermodynamic properties;

ILO3: apply Henderson–Hasselbalch equation to buffer solutions and calculate the concentrations required to prepare a solution with a given buffer capacity.

Note: ILO means intended learning outcome.

1. Classical chemical analysis (2 h)

Qualitative and quantitative analysis; Accuracy and precision; The analytical process; Sensitivity, selectivity and specificity in analytical chemistry.

2. Neutralization titrations (7 h)

Principles of neutralization titrations: Primary and secondary standards; Acid-base titrations (strong, weak and poly functional acids, hydrolysis of salts), titration curves, theory of indicators; Buffer solutions: Henderson–Hasselbach equation, buffer capacity and buffer value for a buffer system, preparation of buffer solutions.

3. Redox titrations (6 h)

Redox titrations and titration curves, selection of redox indicators, thermodynamic aspects of redox titrations, iodometric titrations.

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning.

Recommended Readings

- Solomons, T. W. G.; Fryhle, C. B.; Snyder, S. A. (2013). Organic Chemistry, 11th Edition, John Wiley.
- McMurry, J. E. (2011). Organic Chemistry, 8th Edition, Brooks Cole.
- Wade Jr, L. G. (2012). Organic Chemistry, 8th Edition, Pearson.
- Bruice, P. Y. (2013). Organic Chemistry, 7th Edition, Prentice Hall.

C 11041/ CHE 11041 - Elementary Chemistry Laboratory

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: illustrate solubilities of 's', 'p' and 'd' block elements;

ILO2: relate the reactions of 's', 'p' and 'd' block elements to perform semi micro qualitative analysis of cations and anions;

ILO3: identify the functional groups present in an organic compound using simple tests;

ILO4: practice correct techniques to prepare solutions and perform titrations;

ILO5: apply the knowledge in neutralization titration in quantitative analysis of samples.

Note: ILO means intended learning outcome.

1. **Chemistry of 's', 'p' and 'd' block elements (12 h)**

   Solubility of 's' and 'p' block elements, solubility of 'd' block elements, semi micro qualitative analysis of anions and cations; Hydrogen spectrum and Rydberg equation.

2. **Identification of functional groups in organic compounds by qualitative analysis (12 h)**

3. **Neutralization titrations (21 h)**

   Calibration of volumetric glassware; strong acid vs strong base titrations with different indicators; titrations of weak acids and polyprotic acids, titration of carbonate/ bicarbonate and carbonate/ hydroxide mixtures with acids.

Methods of Teaching and Learning

A combination of laboratory classes, pre-laboratory and post laboratory assignments, laboratory reports.

Recommended Readings

- Svehla, G. (1996). Vogel's Qualitative Inorganic Analysis, 7th Edition, Prentice Hall.
- Skoog, D. A.; West, D. M.; Holler, F. J.; Crouch, S. R. (2013). Fundamentals of Analytical Chemistry, 9th Edition, Cengage Learning.
- Vogel A.I.; Tatchell A.R.; Furnis B.S.; Hannaford A.J.; Smith P.W.G. (1996). Vogel's Textbook of Practical Organic Chemistry, 5th Edition, Prentice Hall.
- Moting, J.R.; Mofrrill, T.C.; Hammond, C.N.; Neckers, D.C. (1999). Experimental Organic Chemistry, Freeman.

S 11052/ALS 11052 - Calculus

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: explain principles of calculus;

ILO2: solve problems using differentiation techniques;

ILO3: solve problems applying integration;

ILO4: solve problems applying differential equations.

Note: ILO means intended learning outcome.

1. Introduction to the calculus (2 h)

Limits, definition, limits involving infinity and limits not involving infinity.

2. Differentiation (8 h)

2.1. Introduction, first principles, notations; Differentiation of sums, products, quotients, functions of functions and composite functions; Differentiation of logarithmic, exponential and trigonometric functions.

2.2. Partial differentiation and total differentiations.

2.3. Turning points, maxima, minima and point of inflexion.

3. Integration (8 h)

Basic integrations, integration by parts, integration by partial fractions, definite integrations, applications of integrations.

4. Differential equations (8 h)

4.1. Differential equations, introduction, solving differential equations, exact differential equations and Eulers' theorem.

4.2. Homogeneous functions

5. Use of calculus in solving problems in chemistry (4 h)

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning.

Recommended Readings

- Smith, R.T.; Minton, R.B. (2004). Calculus: Concepts & Connections, 1st Edition, McGraw-Hill
- Himonas, A.; Howard, A. (2002). Calculus: Ideas & Applications, Abridged Edition, John-Wiley
- Connelly, J. A.; Fratangelo, R. A. (1979). Elementary Technical Mathematics with Calculus, Macmillan

S 11062/ALS 11062 - Fundamentals of Physics for Chemists

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: demonstrate fundamental concepts of geometric optics and physical optics;

ILO2: describe fundamental concepts and laws in wave motion;

ILO3: demonstrate basic principles of oscillators;

ILO4: solve problems on fundamental concepts related to current electricity;

ILO5: analyze circuits using network theorems.

Note: ILO means intended learning outcome.

1. Optics (10 h)

Ray matrix method in geometrical optics: Reflection, refraction, transmission, lenses, surfaces, optical systems, linear polarization, Malus's Law, circular & elliptical polarization, polarizers, matrix formulation of polarized light and elements; Optical activity, coherence; Divisions of wave front and amplitude: Young's double slit experiment, Lloyd's mirror, Fresnel's biprism, Fresnel's double mirror, fringes of equal inclination and fringes of equal thickness; Fraunhofer diffraction; Rectangular and circular apertures, resolving power, single slit, double slit and diffraction grating, X-ray diffraction; Ion production, ion detection, manuring of ions in mass spectrometers, ion mirrors, ion selection, ion gates, MS-MS.

2. Waves and vibrations (12 h)

Periodic motions: Sinusoidal vibrations, simple harmonic motion, superposition of two vibrations with 1-d and 2-d; free vibrations, damped harmonic oscillator, forced vibrations, power absorbed by a driven oscillator, resonance; Wave equation, wave speeds in specific media, phase and group velocities, impedance and energy flux; Reflection and transmission; Impedance matching between two media; Fourier analysis of pulses; Coupled oscillators; Two coupled pendulums, superposition of normal modes, sound; Velocity of sound waves, Perception of sound, intensity and pressure level, Doppler effect, acoustics of buildings.

3. Circuit theory (8 h)

Voltage and current sources; Different types of alternating voltages and currents; Root mean square (rms) values, circuit elements; Active and passive elements, resistor networks; Thevenin's and Norton's theorems, conditions for maximum power and voltage transfer, loading effect, direct current circuits; Transient response of RC and RL circuits, LC oscillations, integrating and differentiating circuits.

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning.

Recommended Readings

- Grant R. Fowles, Introduction to Modern Optics, Dover, 1975
- Eugene Hecht, Optics, 4th edition, 2001
- Hugh, Young; Roger Freeman (2013), Sears & Zemansky's University Physics with Modern Physics (13th edition). Pearson Education.
- James J. Brophy, Basic Electronics for Scientists,1983

C 11122 - Industry, Environment and the Society

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: identify the importance of the environment and the society in industrial development;

ILO2: describe the expansion of industrial activities since the industrial evolution;

ILO3: identify advantages and undesirable factors of industrial development;

ILO4: brief on local industrial setting;

ILO5: identify challenges faced in modern industrial activities.

Note: ILO means Intended Learning Outcome

1. Industrial revolution (4 h)

Pre-mechanized industrial production; History and characteristics of the industrial revolution; Influence on human life; Technological development in industries, such as textiles, iron production, glass and mining; Social and environmental effects; Oppositions on industrial revolution; Effect on agriculture.

2. Industrial development (10 h)

Globalization of industries and its effects; Impact of industrial development – then and now; Effect on the society – industrial changes on social aspects, need of consumer protection; economical considerations; Energy/power sources – fossil fuels, hydropower, nuclear power, solar power, wind power, tidal power, etc.; Expansion of agricultural industry, its impact on man and the environment; Health problems due to industrial pollution; Advantages of automation; Industrial policies.

3. Environmental effects (8 h)

Effect on the environment – global warming, ozone layer depletion, deforestation, water shortage, etc.; Compromise between industrial development and pollution control; introduction to waste management and treatment; Value addition to industrial byproducts; Home-owned and small-scale industries.

4. Overview of local industries (4 h)

Introduction to different types of industries, such as polymers and plastics, apparel & textiles, tiles & ceramics, herbal products, pharmaceuticals & cosmetics, food & beverages, soaps & detergents, and paints.

5. Modern industrial society (4 h)

Modernization of industries due to advances in nanotechnology and computer technology; Advantages and disadvantages; Social aspects; Sustainability of the industrial society

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning.

Recommended Readings

- P. Robbins, J. Hintz and S.A. Moore, Environment and Society: A Critical Introduction, 2nd Edition, Wiley-Blackwell, 2014.
- Environment and Society, Ed C. Schlottmann, D. Jamieson, C. Jerolmack, A. Rademacher and M. Damon, NYU Press, 2017.
- Introduction to Environmental Management, 1st Edition, Ed M.K. Theodore and L. Theodore, CRC Press, 2010.
- T.J. Kaczynski, Industrial Society and Its Future, Pub House Books, 2018.

E 11072/ENH 11072 - Basic Mathematics

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: make use of the basic mathematical concepts required in chemistry;

ILO2: solve problems in chemistry using the basic knowledge of algebra and trigonometry;

ILO3: apply coordinate geometry to solve problems in chemistry;

ILO4: solve matrices and determinants.

Note: ILO means intended learning outcome.

1. Basic mathematics (14 h)

1.1. Numbers: Real numbers, integers, prime numbers, rational and irrational numbers, complex numbers.

1.2. Basic algebra: Expressions and terms, products, factors and quotients, simplification, expansion.

1.3. Types of equations, simple (first degree), quadratic (second degree), simultaneous, formulae (e.g. $A = \pi r^2$), variables/constants; Solving of equations.

1.4. Laws of indices, partial fractions, permutations and combinations.

1.5. Factorials, infinity, binomial theorem, polynomials.

1.6. Variables, functions with one and more than one variables, linear and nonlinear functions, exponential functions.

1.7. Logarithms, laws and properties of logarithms, natural logarithm and logarithmic functions, relationship between logarithms and exponential terms.

2. Basic trigonometry (4 h)

Pythagoras theorem, definition from coordinates, signs of trigonometric functions, important trigonometric formulae, deriving of trigonometric formulae.

3. Coordinate geometry and vectors (8 h)

Equations of straight line and circle, relationships between Cartesian and polar coordinates, tangents to a curve; Introduction to vectors, cross product, dot product; Argand diagrams.

4. Matrices and determinants (4 h)

Definition of a matrix, addition and multiplication of matrices, transpose, inverse, diagonal and unit matrix; Rules of determinants, minors and cofactors.

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning.

Recommended Readings

- Skoog, D. A.; West, D. M.; Holler, F. J.; Crouch, S. R.(2013), Fundamentals of Analytical Chemistry. Cengage Learning
- Hanifa, M. R. M. (2009). Mathematics for Chemistry and Biology Students (PSE3117), Open University of Sri Lanka publication.

E 11082/ENH 11082 - Biology for Physical Science Students

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: explain the structure of cells in living organisms;
ILO2: identify basic features of cells in plants, animals and microorganisms;
ILO3: describe the structure and functions of cellular organisms;
ILO4: explain the biological processes occurring in an animal and plant cell;
ILO5: explain the principles involved inheritance and fundamentals of molecular human genetics and evolution.
ILO6: describe the ecological interactions and its impact on human activity.

Note: ILO means intended learning outcome.

1. The cell (2 h)

1.1. Structure of the cell.
1.2. Comparison of prokaryotic and eukaryotic cells, plant and animal cells.
1.3. Structure and function of cellular organelles: Nucleus, cell membrane, cytoplasm, endoplasmic reticulum, ribosome, lysosome, mitochondria, cell wall, vacuole, chloroplast.
1.4. Microscopic view of different cell types.

2. Cell division (2 h)

2.1. Karyotypes: Haploid and diploid cells.
2.2. Cell cycle.
2.3. Mitosis and meiosis.
2.4. Microscopic view of different stages of cell division.

3. Classification of living organisms (6 h)

3.1. Classification of living organisms according to Margulis and Schwartz.
3.2. Introduction to kingdoms Prokaryotae, Protoctista, Fungi, Plantae and Animalia.
3.3. Classification of bacteria.
3.4. Basic characteristics of viruses.
3.5. Saprotrophs, parasites and symbiosis.

4. Biological processes (6 h)

4.1. Human biological processes: Circulation, immunity, nervous system, endocrine system, respiration, digestion, mobility, excretion and osmoregulation, reproduction.
4.2. Plant biological processes: Transport-xylem and phloem, gaseous exchange,

excretion, asexual and sexual reproduction, microscopic view of cross section of a plant leaf, stem and root.

5. Molecular basis of inheritance (5 h)

5.1. DNA and RNA.

5.2. Protein synthesis.

6. Genetics (4 h)

6.1. Mendel's laws.

6.2. Chromosomal basis of inheritance.

6.3. Mutations.

6.4. Genetics that deviate from Mendel's laws: Incomplete dominance, co-dominance, polyallelism, gene interaction, polygenic inheritance, gene linkage.

6.5. Human genetic disorders.

7. Evolution (2 h)

7.1. Mechanisms of evolution, role of natural selection, Darwinism.

7.2. Hardy-Weinberg equilibrium.

7.3. Importance of biodiversity.

8. Ecology and environment (3 h)

8.1. Population, community, ecosystem, landscape, biosphere.

8.2. Terrestrial and aquatic ecosystems, population dynamics.

8.3. Trophic categories, food chains.

8.4. Environmentalism and ethics.

8.5. Destruction of environment: Pollution, overpopulation.

8.6. Conservation of environment: Resource management, sustainability.

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning.

Recommended Readings

- M. C. Mix, P. Farber, K. I. King, Biology: The Network of Life, , 2nd Edition, Harper Collins College Publishers
- G. Odian, I. Blei, Schaum's Outlines: General, Organic & Biological Chemistry, Tata McGraw Hill 3rd Edition.
- Bettelheim, Brown, Introduction to General, Organic and Biochemistry, 7th Edition.

E 11092/ENH 11092 - General English

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: attain an intermediate proficiency in the four language skills: listening, speaking, reading and writing;

ILO2: be able to use these four skills to describe and explain situations, conditions and actions as well as to ask accurate questions which can elicit proper responses;

ILO3: be competent in the use of complex grammar structures and advanced vocabulary in language situations;

ILO4: be able to make speeches and presentations;

ILO5: be able to use English in subjects related to Science and Management.

Note: ILO means Intended learning outcome

1. **Listening (Theory: 1 h; Practical: 3 h)**

   Listening activities: Advanced listening comprehension passages, information gap activities, time-sensitive activities and note-taking skills.

2. **Grammar I (Theory: 1 h; Practical: 3 h)**

   Revising parts of speech and tenses, conditional clauses, pronouns and phrases, how to use modal and related verbs for advice, obligations and permission and auxiliary verbs.

3. **Speaking I (Theory: 1 h; Practical: 3 h)**

   Describing events, objects and people, carrying out informal and formal conversations; Using proverbs and popular phrases in conversation.

4. **Grammar II (Theory: 1 h; Practical: 3 h)**

   The perfect tense, the future tense, combining sentences, participles, the infinitive and the gerund, order of adjectives, comparisons and contrasts.

5. **Reading (Theory: 1 h; Practical: 3 h)**

   Reading and comprehension activities to understand and extract the essential information from a variety of texts (ranging from simple to advance). The comprehension passages will be based on different areas and fields including science and management subjects.

   Reading strategies such as contextual clues, previewing, skimming, scanning, predicting, use of general knowledge and students' prior knowledge as well as intensive reading.

6. **Grammar III (Theory: 2 h; Practical: 3 h)**

   Modals of probability, analyzing complex and compound sentences, comparative sentences, reported speech, passive voice, phrasal and prepositional verbs, transformation

of sentences.

7. **Speaking II (Theory: 2 h; Practical: 3 h)**

   Advanced situational dialogues and conversation activities, speaking on given topics and developing skills of debating (necessary skills in expressing agreement and disagreement).

8. **Academic Writing (Theory: 2 h; Practical: 3 h)**

   Writing lab reports on scientific experiments: writing the experiment, observations and reporting conclusions.

9. **Writing I (Theory: 2 h; Practical: 3 h)**

   Classification of essays (reflective, narrative, descriptive, expository and creative) and advanced essay writing (with an emphasis on subjects within the fields of science and management).

10. **Writing II (Theory: 2 h; Practical: 3 h)**

    Précis-writing, autobiographies and appreciating literature (poetry, short story, novel, non-fiction and drama).

Methods of teaching and learning

The eclectic approach will be used in teaching English to promote skills of conceptualization as well as a learner-centred approach in the teaching-learning process. The lecturer will incorporate the suitable methods and strategies such as task-based language learning to guarantee the best possible learning experience. The lecturer will particularly focus on individual, pair and group work, incorporate teaching approaches such as known-to-unknown and learning to learn and will consider the different learning styles of the students (multiple intelligences) in the teaching-learning process.

Recommended readings

- Evans, T.D. & Bates, M. (1976). Nucleus: General Science: English for Science and Technology. New York: Prentice Hall Press.
- Hewings, M. (2002). Advanced English Grammar. Cambridge: Cambridge University Press.
- Maciver, A. (1986). The New First Aid in English. Glasgow: Robert Gibson & Sons, Ltd.
- Meldrum, J. (2013). Speak Now: Communicate with Confidence. Oxford: Oxford University Press.
- Richards, J.C. New Interchange: English for International Communication. New Delhi: Cambridge University Press India Pvt. Ltd.
- Soars. L & Soars. J. (2009). American Headway: The World's Most Trusted English Course. Oxford: Oxford University Press.
- Soars. L & Soars. J. (2003). New Headway: Advanced Workbook with Key. Oxford: Oxford

University Press.

- Lesikar, R.V. Flatley, M.E., Rentz, K., & Pande. N. (2015). Business Communication: Making Connections in a Digital World (13th Ed). New Delhi: McGraw- Hill Education (India) Pvt. Ltd.
- Parvathi, N. (2018). Grammar for Communication. Boralesgamuwa: Olanco Press.
- Samaranayake, W.H. (2007). Practical English. Colombo: Samaranayake Publishers.

E 11132 - Basic Concepts

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: interconvert quantities from one unit system to another;

ILO2: perform calculations on composition variables;

ILO3: be confident in stoichiometric calculations;

ILO4: solve basic chemistry problems involving algebraic symbols;

ILO5: name organic and inorganic compounds according to IUPAC nomenclature.

Note: ILO means intended learning outcome.

1. Units and Dimensions (8 h)

International system of units; Definition of basic, derived and subsidiary SI units; Inter-relationship of SI units with CGS units; Evaluation of values of typical quantities such as gas constant, Boltzmann constant, standard pressure using SI and CGS units; Dimensions of simple physical quantities; Composition variables: concentration (molarity); molality, mole fraction, mass fraction, percentage composition, ppm, ppb & ppt units, inter-conversion of composition variables.

2. Problem Solving (12 h)

Philosophy of problem solving: Identification of defining equation towards the goal in problem solving, solving problems targeting the goal; Ability to transform equations to alternative forms containing alternate symbols; Stoichiometric calculations; Calculations involving algebraic symbols; Graphical analysis.

3. IUPAC Nomenclature of Typical Organic and Inorganic Compounds (10 h)

The introductory work already done for the A/L will be reviewed and extended to cover the nomenclature of more complex compounds that would arise in the B.Sc./Graduateship Programme

Methods of Teaching and Learning

Lectures, in-class discussions, real world case studies and self-study

Recommended readings

- N.G. Connelly et al., Nomenclature of Inorganic Chemistry - IUPAC Recommendations 2005, The Royal Society of Chemistry, 2005.
- R. Panico, W. H. Powell and J.C. Richer, A Guide to IUPAC Nomenclature of Organic Compounds (recommendations 1993), Blackwell Science, 1993, Corrections published in Pure Appl. Chem., Vol. 71, No. 7, pp.1327-1330, 1999.
- Graham Doggett, Martin Cockett, Maths for Chemists: RSC (Tutorial Chemistry Texts),

2012.

- Raymond A. Barnett, Michael R. Ziegler, Karl E. Byleen, College Algebra with Trigonometry, 7th Edition.
- William L. Hart, Bert K. Waits, College Algebra, 6th Edition.

APM 11102 - Principles of Management

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

LO1: demonstrate understanding of different historical perspectives in management and organization studies;

LO2: demonstrate understanding of the characteristics of contemporary organizations and the different approaches to organizational structure and design;

LO3: demonstrate understanding of the fundamentals of individual, team and group behavior;

LO4: analyze the process of organizational learning, adapting, and change.

Note: ILO means intended learning outcome.

1. **Unit I (4 h)**

   Understanding organizations, evolution of management thought.

2. **Unit II (14 h)**

   Organizational structure and design, organization and environment, managerial process: planning, strategic decision making and controlling.

3. **Unit III (12 h)**

   Drivers of individual behaviour, motives of group and team behavior (understanding the different generations in the workplace, in particular the GenY or Millennials (born after 1979) and Gen Z.), organizational culture, learning and the processes of organizational change.

Methods of Teaching and Learning

Lectures, in-class discussions, real world case studies and self-study

Recommended Readings

- Robbins, S P, DeCenzo, D A and Coulter, M (2015), Fundamentals of Management-Essential Concepts and Applications, Prentice Hall, New Jersey.
- Certo, S (2014), Modern Management, Prentice Hall, Delhi.
- Robbins, SP, and Judge, TA (2010), Organizational Behaviour, Prentice Hall, New Jersey
- Material provided in the CAL.

APM 11112 - Optimization Methods in Management Science

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: identify and analyze business problems and formulate business decision problems as mathematical models and lay out as spreadsheet models;

ILO2: apply appropriate quantitative techniques and perform sensitivity analysis in managerial decision-making;

ILO3: identify and use software to solve complicated problems;

ILO4: communicate the analysis and results of business decision problems.

Note: ILO means intended learning outcome.

1. **Unit I (12 h)**

   Introduction to operations research, linear programming (LP), problem formulation, algebraic representation, solving LP problems, applications of LP.

2. **Unit II (9 h)**

   Data envelopment analysis for performance measurements.

3. **Unit III (6 h)**

   Assignment problem, network modules.

4. **Unit IV (9 h)**

   Project scheduling with known/uncertain activity times, time and cost trade-offs.

5. **Unit V (6 h)**

   Decision analysis.

6. **Unit VI (3 h)**

   Correlation and linear regression.

Methods of Teaching and Learning

Lectures and computer Assisted Learning

Recommended Readings

- Anderson, D R, Williams, T A and Sweeney, S J (2011),An Introduction to Management Science: Quantitative Approaches to Decision Making, 13th Edition, South Western College Pub.
- Fedrick, S. Hiller, G. Lieberman, B. Nag (2014), Introduction to operations research, McGraw-Hill Professional, 9th Edition, McGraw Hill Education (India) Pvt. Ltd.
- Kenneth R. Baker (2015) Optimization Modeling with Spread sheets, 3rd Edition, Thomson learning academic Resource center.

C 12012/CHE 12012 - Chemistry of Main Group and Transition Elements

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: discuss chemistry of main group elements;

ILO2: explain 3-centre 2-elctron bonding;

ILO3: compare chemistry of the first element of a main group with the rest of the elements in the same group;

ILO4: discuss colour and magnetic properties of transition elements;

ILO5: compare chemistry of lanthanides with actinides;

ILO6: describe reasons for lanthanide contraction.

Note: ILO means intended learning outcome.

1. Chemistry of main group elements (13 h)

1.1. Trends in the variation of physical and chemical properties of the main group elements down their respective groups.

1.2. Anomalous properties of the first member of a group and diagonal relationships, occurrence and uses, 3-center 2-electron bonding in diborane.

1.3. Inert pair effect, allotropes of carbon, sulphur and phosphorus.

1.4. Trends in the chemistry of compounds of main group elements explained on the basis of their thermodynamic and structural properties.

1.5. Compounds of rare gases.

2. Chemistry of transition elements (10 h)

d-block metals vs. transition elements, electronic configurations, occurrence and extraction, colour and magnetic properties, variable oxidation states, uses, chemistry of compounds of chromium, manganese, cobalt and copper, introduction to coordination chemistry.

3. Chemistry of lanthanides (4f) and actinides (5f) (7 h)

3.1. Chemistry of lanthanides: Occurrence, electronic configurations, oxidation states, lanthanide contraction, colour and magnetic properties, separation of lanthanide elements and their industrial uses.

3.2. Chemistry of actinides: Occurrence, electronic configurations, oxidation states, actinide contraction, colour and magnetic properties, separation of actinide elements.

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning.

Recommended Readings

- Cartherine E Housecroft and Alan G Sharpe (2012), Pearson, England, Inorganic Chemistry, 4th Edition.
- Theodore E. Brown, H. Eugene H. LeMay, Bruce E. Bursten and Catherine Murphy (2017), Pearson, England, Chemistry: The Central Science, 14th Edition.
- J. D. Lee (2006), Blackwellscience, Concise Inorganic Chemistry, 5th Edition.
- F. Albert Cotton, Geoffrey Wilkinson, Carlos A. Murillo, Manfred Bochmann (1999), Advanced Inorganic Chemistry, John Willey and Sons, INC., 6th Edition.

C 12022/ CHE 12022 - Principles of Physical Chemistry I

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: apply current units for physical quantities;

ILO2: describe properties of ideal and real gasses using gas laws;

ILO3: analyze chemical reactions using energetics;

ILO4: establish the rate law of a chemical reaction;

ILO5: use principles of chemical kinetics to different systems.

Note: ILO means intended learning outcome.

1. Units and dimensions (3 h)

Unit conversion, significant figures, mass balance and charge balance.

2. Gaseous state (3 h)

Gaseous state of matter, properties of gas, perfect gas, real gas, review of the ideal gas equation of state, deviation of gases from ideal behavior, van der Waals equation of state and other equations of state, kinetic molecular theory of gas, liquefaction of gases, reduced equation of state and law of corresponding states.

3. Introduction to thermodynamics (12 h)

Zeroth law of thermodynamics; First law of thermodynamics: Concepts of work, heat and energy, different types of work, isochoric, isobaric, isothermal and adiabatic processes; Thermal capacity, enthalpy, variation of internal energy and enthalpy with temperature; Thermochemistry: Hess' Law, standard state, determination of enthalpy, Kirchoff's equation; Univariant systems; Isoenthalpic processes and Joule-Thomson effect; Second law of thermodynamics and entropy functions, calculation of entropy changes, entropy as a criterion for spontaneity and equilibrium; Introduction to the concept of free energy, Gibbs and Helmholtz functions.

4. Introduction to kinetics (12 h)

Review of basic concepts; Zeroth order, first order and second order reactions; Elementary reactions and complex reactions; Experimental determination of rate, rate constant and order of a reaction, factors affecting the rate of a reaction, Arrhenius equation, determination of activation energy of a reaction; Introduction to complex reactions: Parallel and consecutive reactions, first order reversible reactions, first order consecutive reactions; Mechanism of a reaction, rate determining step, influence of electromagnetic radiation; Quantitative description of the rate determining step; Steady state approximation and its applications; Enzyme catalyzed reactions; Kinetics of atomic and free radical reactions; Introduction to chain reactions.

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning.

Recommended Readings

- Atkins, P.; de Paula, J. (2014). Physical Chemistry, 9th Edition, W H Freeman.

C 12032/ CHE 12032 - Basic Concepts in Biochemistry I

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: explain the structures and function of basic biomolecules;
ILO2: describe the action of biological buffers;
ILO3: explain the structure and functions of biological membranes;
ILO4: describe cellular transport mechanisms;
ILO5: explain the general characteristics of enzymes including kinetics;
ILO6: explain the functions and mechanisms of selected hormones.

Note: ILO means intended learning outcome.

1. Introduction to biomolecules (10 h)

1.1. Carbohydrates

Monosaccharides: Glucose, fructose, galactose, isomerism, optical rotation; Disaccharides: Sucrose, maltose, glycosidic bonds; Polysaccharides: Starch, glycogen, cellulose, chitin; Simple tests for carbohydrates, biological importance of carbohydrates, glycoproteins, glycosaminoglycans and their biological importance.

1.2. Lipids

Fatty acids: Saturated & unsaturated fatty acids, nomenclature of fatty acids, numbering of carbon atoms of fatty acids and positioning of double bonds, the omega carbon, essential fatty acids, triacylglycerols & phospholipids, properties and biological importance, amphipathic properties of phospholipids.

1.3. Amino acids & proteins.

2. Structure and function of nucleic acids (6 h)

2.1. Nucleosides & nucleotides.

2.2. Introduction to DNA replication.

2.3. Transcription and translation: Prokaryotes and eukaryote.

3. pH, buffers and biological buffers (2 h)

3.1. Physiological pH and its importance; extracellular and intercellular buffers, pK in biological systems.

3.2. Biological buffers and their action: HCO_3^-/CO_3^{2-}, $HPO_4^{2-}/H_2PO_4^-$, hemoglobin, proteins: importance of histidine.

4. Structure, functions of biological membranes & transport across membranes (4 h)

4.1. General structure: Structure and function of a biological membrane, major components.

4.2. Significance of degree of unsaturation of lipids.

4.3. Contribution of cholesterol to the characteristics of the membrane.

4.4. Role of proteins: Membrane proteins, glycated membrane proteins.

4.5. Methods of transport: Simple diffusion, mediated transport: Types, principles and properties.

4.6. Voltage and ligand gated channels.

4.7. Important transport systems: GLUT transporters, ion channels, sodium – potassium pump, glucose – sodium co-transporter.

4.8. Hypotonic, Isotonic & hypertonic solutions and their effect on cells, ionophores, oral rehydration therapy.

5. Enzymes (4 h)

5.1. Introduction & classification.

5.2. General characteristics of enzymes: Physical properties, active site, specificity; Mechanism of action, mechanism of enzyme catalysis, Lock and Key hypothesis, substrate hypothesis, enzyme activity.

5.3. Enzyme kinetics: Single substrate, Michaelis-Menten equation, inhibition, regulation.

5.4. Inhibition of enzymes: Competitive, non-competitive and suicide inhibition.

5.5. Isoenzymes.

5.6. Important diagnostic enzymes.

6. Hormones and their mechanism of action (4 h)

6.1. Introduction to the endocrine system.

6.2. Classification of hormones.

6.3. Endocrine glands and their location.

6.4. Biological functions of hormones (basics).

6.5. Hormone receptors.

6.6. Basic biochemical mechanisms of hormone signal transduction.

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning.

Recommended Readings

- Geoffrey, M. C. (2000). The Cell, A Molecular Approach. 2nd Edition, Boston University, Sunderland (MA): Sinauer Associates.
- Berg, J. M.; Tymoczko, J. L.; Stryer, L. (2002). Biochemistry.5th Edition, W H Freeman.
- Ferrier, D. R. (2013). Biochemistry (Lippincott Illustrated Reviews Series). 6th Edition, North American Edition.
- Rodwell, V.; Bender, D.; Botham, K. M.; Kennelly, P. J.; Weil, P. A. (2015). Harpers Illustrated Biochemistry, 30th Edition, McGraw – Hill Education.

C 12041/CHE 12041 - Organic Chemistry Laboratory

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to;

ILO1: identify an organic compound using melting point and mixed melting points;
ILO2: purify an organic compound using recrystallization;
ILO3: plan a method and carry out the separation of components of a mixture of organic compounds;
ILO4: identify an unknown compound by derivatization;
ILO5: synthesize an organic compound;
ILO6: analyze the progress of a reaction using thin layer chromatography.

Note: ILO means intended learning outcome.

1. **Purification and identification of organic compounds (12 h)**

   Re-crystallizations including mixed solvents, identification of compounds by determining boiling points, melting points and mixed melting point.

2. **Separation of mixtures containing organic compounds (acid-neutral; base –neutral, phenol-neutral, acid-phenol, three component mixtures) and identification of the components. (9 h)**

3. **Preparation of derivatives and characterization of organic compounds. (6 h)**

4. **Synthesis of simple organic compounds (one pot synthesis). (6 h)**

5. **Multistep synthesis of an organic compound. (9 h)**

6. **Thin layer chromatography as a tool (3 h)**

   6.1. Determination of purity of an organic compound;

   6.2. Monitoring of the progress of a reaction.

Methods of Teaching and Learning

A combination of laboratory classes, combination of pre-laboratory and post laboratory assignments, laboratory reports

Recommended Readings

- Vogel A.I.; Tatchell A.R.; Furnis B.S.; Hannaford A.J.; Smith P.W.G. (1996). Vogel's Textbook of Practical Organic Chemistry, 5th Edition, Prentice Hall.
- Moting, J.R.; Mofrrill, T.C.; Hammond, C.N.; Neckers, D.C. (1999). Experimental Organic Chemistry, Freeman.
- Williamson, K.L. (1994). Macroscale and Microscale Organic Experiments, 2nd Edition, Heath and Company.

C 12051/CHE 12051 - Classical Methods in Chemical Analysis II

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: calculate conditional formation constants and apply complexometric titrations in analysis;

ILO2: apply conditional solubility products in calculations related to gravimetric analysis.

Note: ILO means intended learning outcome.

1. **Complexometric titrations (5 h)**

   Equivalence point pM and theoretical titration curves, conditional formation constants, effect of pH on conditional formation constant; Indicators for complexometric titrations.

2. **Precipitation methods of analysis (10 h)**

   Solubility products in qualitative analysis: Conditional solubility product, ionization fraction (α) and activity coefficient (γ), stability of ligand-metal complexes; Solubility product applications in cation analysis; Gravimetric methods of analysis: Basic principles, particle size of a precipitate, nucleation, Von Weimarn's theory, common ion effect, properties of a good precipitate, applications of gravimetry; Contamination of a precipitate, precipitation from homogeneous solution (PFHS), post-precipitation, minimizing of post-precipitations.

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning.

Recommended Readings

- Skoog, D. A.; West, D. M.; Holler, F. J.; Crouch, S. R., Fundamentals of Analytical Chemistry. Cengage Learning: 2013.
- Day; Underwood, Quantitative Analysis. Prentice Hall PTR: 1991.
- Harris, D. C.; Lucy, C. A., Quantitative Chemical Analysis. WH Freeman: 2018.

S 12062/ALS 12062 - Basic Electronics for Chemists

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: describe basics of analog and digital electronics;

ILO2: discuss the functions and characteristics of semiconductor materials, diodes, transistors, JFTs and operational amplifiers;

ILO3: solve problems related to number systems and Boolean algebra;

ILO4: design combinational and sequential logic circuits/device.

Note: ILO means intended learning outcome.

1. Analog electronics (18 h)

Introduction to p and n type semiconductors, p-n junction diode and its action under forward-bias and reverse-bias conditions, diode as a circuit element, diode models, rectifier circuits,

Zener diodes, voltage regulation and low voltage DC power supply, limiting and clamping circuits, special diode types (LED, photo-diode, etc.).

Seven segments and other display devices and their applications, bipolar transistors, operation of an n-p-n transistor in the active mode, transistor biasing and transistor as an amplifier, designing of a common emitter amplifier, voltage gain, transistor as a switch, introduction to field effect transistors, JFETs and MOSFETs, operational amplifiers, inverting and non-inverting amplifiers, summing amplifiers, op-amp based electronic ammeters and voltmeters, semiconductor device applications in chemical industry.

2. Digital electronics (12 h)

Basic logic gates, Introduction to logic families, logic operators and Boolean laws, designing of combinational logic circuits, minimization of logic expressions using algebraic and Karnaughmap methods, construction of a half adder and full adder circuits, flip-flop as a memory element, SR, JK, D and T flip-flops, sequential logic circuits, registers, counters.

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning

Recommended Readings

- Paul Horowitz & Winfield Hill, The Art of Electronics, 3rd Edition, 2015.
- Adel S. Sedra & K C Smith, Microelectronic Circuits: (Oxford Series in Electrical & Computer Engineering), 6th Edition, 2009.
- J. J. Brophy, Basic Electronics for Scientist, 1990.
- Ronalds J. Tocci & Neil Widmer, Digital Systems Principles and Applications, 11th Edition, 2010.

S 12072/ALS 12072 - Basic Statistics I

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: explain the basic concepts of terms used in statistical analysis;
ILO2: analyze a given set of data statistically;
ILO3: apply concept of probability and hypothesis testing for a given set of data;
ILO4: compute different measures of central tendency and variation of a given set of data;
ILO5: compare measures by statistical set and determine the relationship between variables;
ILO6: make decisions using statistical data analysis;
ILO7: calculate linear regression coefficients for data sets;
ILO8: make use of spreadsheet application in data processing in chemistry experiments;
ILO9: utilize spreadsheets for plotting graphs and fitting equations.

Note: ILO means intended learning outcome.

1. Descriptive statistics (3 h)

Importance of statistic for chemists, definitions of variables and variates, scales measurement, standard scales of measurement, their properties and their applications, types of errors, including concepts of accuracy, precision and bias, operations used in data reduction and simplifications, representation of data in graphical forms, data processing and the concepts of visualization of distributions, measures of center and measures of variation, concepts of modality, skewness, and kurtosis in frequency distributions, measurement of central tendency, measures of variation.

2. Sampling (2 h)

Introduction into the concepts of population and sample as well as representative samples, bias in samples, sampling error and the distinction between population and sample parameters; Comparisons of relative variability via coefficient of variation and measurement of variation between sample means via the standard error of the mean (SEM); Introduction to sampling methods, styles of sampling and randomization.

3. Distributions (1 h)

Introduction to distributions including different types of distributions and the normal distribution.

4. Probability and hypothesis testing (3 h)

Introduction to the concepts of probability, sample space and the calculation of probabilities of discrete and continuous variables; Use of *z*-scores, *z*-tables, the importance of the 95% confidence interval and the use of *t*-distributions; Introduction to the concepts of hypothesis, hypothesis testing, statistical significance (null and alternative hypothesis),

uncertainty and errors in hypothesis testing, use of the *P* value and the concept of the power of a test.

5. **Comparison of means (2 h)**

   Introduction to mean comparisons techniques, such as *z*-tests and *t*-tests for one sample and two samples, paired *t*-test, *Q*-test and Grubbs test.

6. **Relationship between variables (2 h)**

   Concept of relationships between variables, agreements and associations between variables, linear relationships, correlation, the use of simple linear regression, distinguishing between association and cause and effect.

7. **Categorical data analysis (2 h)**

   Comparing proportions, comparing observed and expected counts of categorical variables, chi-square test and odds ratio.

8. **Linear regression (3 h)**

   Linear regression, correlation coefficient, fitting of straight line, parabola, exponential, polynomial, least square method.

9. **Spreadsheet applications (12 h)**

   Plotting graphs and formatting, calculation of curve fitting equations, r^2/r, standard deviations and standard errors of a calibration plot using appropriate packages, use of functions in spreadsheets to handle and present scientific data.

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning.

Recommended Readings

- Skoog, D. A.; West, D. M.; Holler, F. J.; Crouch, S. R.(2013), Fundamentals of Analytical Chemistry. Cengage Learning.
- Harris, D. C. (2007) Quantitative Chemical Analysis, W.H. Freeman and Company.
- Barrante, James R. "Applied Mathematics for Physical Chemistry" 03rd Edition, 1974, Presntice-Hall, Inc.

E 12082/ENH 12082 - Effective Communication

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: describe basics of effective communication;

ILO2: demonstrate effective oral communication skills in a variety of speaking situations such as small groups, public address and professional settings;

ILO3: apply principles of effective listening skills;

ILO4: evaluate a variety of communication messages;

ILO5: prepare and organize the speech;

ILO6: demonstrate critical thinking skills in a variety of communication situations.

Note: ILO means Intended learning outcome.

1. **How does communication work (Theory:1 h; Practical: 1 h)**

   Influence or persuade?, identifying and adjusting your communication style, five communication styles, six Cs of effective communication, four-step cycle of communication, dynamics of communication.

2. **Face-to-face communication (Theory: 2 h; Practical: 2 h)**

   First impressions, appearance, being positive, using the right words, three components of communication, body language and non-verbal messages.

3. **Telephone communication (Theory: 2 h; Practical: 2 h)**

   Overcoming the challenges of telephone communication, improving telephone communication, factors of voice, advantages and disadvantages of telephone communication.

4. **Written communication (Theory: 2 h; Practical: 2 h)**

   Quick tips for types of messages, the power of words, right first time, keep it concise, address your target, keep it simple, your three stage structure.

5. **Questioning and listening skills (Theory: 2 h; Practical: 2 h)**

   Active listening, verbal signs of active listening, non-verbal signs of active listening, five levels of listening, how does asking questions would help you, open and closed questions.

6. **How to be an effective communicator (Theory: 2 h; Practical: 2 h)**

   Your level of understanding, dismantling your assumptions, prejudices, your preconceptions: stereotyping, your history & experiences, asking for feedback, how to find out what others think about you, is your self-image correct? wheel of communication.

7. **Overcoming communication problems (Theory: 2 h; Practical: 2 h)**

   Four tips for delivering difficult messages, dealing with conflict, dealing with opposition, barriers to communication, why communication goes wrong.

8. **Getting better outcomes (Theory: 2 h; Practical: 2 h)**

   Best practices for communicating effectively, Timing: Effect of location, Intimidation.

Methods of teaching and learning

Lectures, tutorials, audio-visuals, class room activities; Group discussions, Seminars

Recommended readings

- Helio Fred Garcia (2012). The Power of Communication: Skills to Build Trust, Inspire Loyalty, and Lead Effectively.
- Anthony Gutierez (2014). Effective Communication in the Workplace: Learn How to Communicate Effectively and Avoid Common Barriers to Effective Communication.

APM 12102 - Introduction to Industrial Economics

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: explain difference between microeconomics and macroeconomics;

ILO2: explain scarcity, choice, opportunity cost, demand, supply, production, cost and revenue;

ILO3: evaluate alternative capital investments;

ILO4: explain current economic challenges related to investment projects and expansion of business operations;

ILO5: explain how to deal with inflation, taxes, depreciation and uncertainty;

ILO6: assess risks and uncertainty associated with industrial economic decisions.

Note: ILO means intended learning outcome.

1. **Introduction to economics (3 h)**

   Microeconomics, macroeconomics.

2. **Introduction to economics (3 h)**

   Demand, supply, production, cost and revenue.

3. **Capital investment alternatives (6 h)**

   Present worth (PW), annual cash flow analysis, rate of return analysis, future worth analysis, benefit-cost ratio analysis, payback period, sensitivity and breakeven analyses.

4. **Introduction to Industrial economics (9 h)**

   The role and purpose of industrial and engineering economic analysis, costs and cost estimating, interest and equivalence.

5. **Income, depreciation and cash flow (6 h)**

   Basic aspects of depreciation, causes of depreciation, depreciation for tax purposes, depreciation and asset disposal, taxation and capital cost allowance.

6. **Impact of taxes on decisions, impact of inflation in economic decisions (3 h)**

Methods of Teaching and Learning

Lectures, case discussions, presentations

Recommended Readings

- Williams, J, Haka, S, Bettner, M andCarcello, J (2009), Financial Accounting, 14th Edition, McGraw- Hill/Irwin.
- Hilton, R W (2011), Managerial Accounting: Creating Value in a Dynamic Business Environment, 9th Edition, McGraw-Hill/Irwin.

APM 12112 - Accounting Concepts and Costing

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: explain the principles of financial and managerial accounting;

ILO2: record economic transactions and develop the key financial statements for the enterprise;

ILO3: reconcile a bank statement;

ILO4: identify and estimate the cost components for a product or service.

Note: ILO means intended learning outcome.

1. **Unit I (6 h)**

   Concepts of financial accounting.

2. **Unit II (10 h)**

   Practice of book keeping including books of prime entry, ledgers and trial balance; Preparation of trading profit & loss and balance sheet; Cash flow statement.

3. **Unit III (4 h)**

   Bank reconciliation.

4. **Unit IV (10 h)**

   Use of accounting information for managerial decision-making in planning and control including cost classification; Estimation and analysis; Job-order, variable and activity-based costing.

Methods of Teaching and Learning

Lectures, case discussions, presentations

Recommended Readings

- Williams, J, Haka, S, Bettner, M and Carcello, J (2009), Financial Accounting, 14th Edition, McGraw- Hill/Irwin.
- Hilton, R W (2011), Managerial Accounting: Creating Value in a Dynamic Business Environment, 9th Edition, McGraw-Hill/Irwin.

LEVEL 2

C 21012/CHE 21012 - Concepts in Inorganic Chemistry I

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: correlate nuclear stability with radioactivity;

ILO2: describe detection methods for radioactivity;

ILO3: explain structures and magnetic properties of solids;

ILO4: apply band theory to metals, semiconductors and insulators;

ILO5: apply X-ray diffraction methods in the study of solids.

Note: ILO means intended learning outcome.

1. Nuclear chemistry (12 h)

1.1. Odd-even rule, n/p ratio and magic numbers, introduction to Shell Model and Liquid Drop Model.

1.2. Properties of α, β and γ, types of radioactive decay, radioactivity of actinides with special reference to thorium and uranium, radioactive decay law - derivation of equations, activity, radioactive decay series - 4n, 4n+1, 4n+2 and 4n+3, artificial radioactivity.

1.3. Charged particle accelerators, nuclear cross section, nuclear fusion, fission and chain reactions, calculation of energy released; Energy balance of fission process, nuclear reactors, radioisotopes as tracers and radiation sources for diagnostic and therapeutic purposes, radiopharmaceuticals: Tcm99, I131, P32, Inm113.

1.4. Isotope dilution analysis, neutron activation analysis, radioelement dating methods, effects and measurements of radiation-interaction with matter, dose, rem, RBE, measurement of radiation, GM tube, scintillation counter.

2. Inorganic solids (18 h)

2.1. Types of crystalline solids: Ionic, covalent, molecular and metallic crystals.

2.2. Close packing and non-close packing: Cubic and hexagonal close packing, interstitial holes, unit cell.

2.3. Structures of the lattices of ionic compounds: Structures of ionic compounds of the types AX and AX_2, layer structures.

2.4. Defects in solid state lattices and their influence on materials properties: Stoichiometric and non-stoichiometric defects.

2.5. Bonding in metals and semiconductors: Band theory of metals and insulators, Fermi level, band theory of semiconductors, superconductivity.

2.6. Synthesis and preparation of materials: Particles, ceramics, layers and coatings, chemical and physical processes, diffusion in solids.

2.7. Alloys and intermetallic compounds: Substitutional alloys, interstitial alloys,

intermetallic compounds.

2.8. Magnetic properties of solids: diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism.

2.9. Unit cell parameters, crystal systems, Miller indices, application of X-ray powder diffraction and X-ray crystallography in the study of solids.

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions, self-study and computer assisted learning.

Recommended Readings

- Catherine E Housecroft and Alan G Sharpe (2012), Pearson, England, Inorganic chemistry, 4th Edition.
- Theodore E. Brown, H. Eugene H. LeMay, Bruce E. Bursten and Catherine Murphy (2017), Pearson, England, Chemistry: The Central Science, 14th Edition.
- J. D. Lee (2006), Blackwell science, Concise Inorganic Chemistry, 5th Edition.
- F. Albert Cotton, Geoffrey Wilkinson, Carlos A. Murillo, Manfred Bochmann (1999), Advanced Inorganic Chemistry, John Willey and Sons, INC., 6th Edition.
- Brian W Pfennig (2015), Principles of Inorganic Chemistry, John Wiley & sons.

C 21022/CHE 21022 - Reactive Intermediates in Organic Reactions and Organic Synthesis

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:
ILO1: propose pathways to synthesize simple organic molecules;
ILO2: device routes for the transformation of functional groups;
ILO3: strategize pathways for multi-step synthesis;
ILO4: illustrate rearrangement reactions using mechanisms;
ILO5: illustrate the feasibility of a reaction using energy profiles.
Note: ILO means intended learning outcome.

1. **Reactive intermediates and their reactions (12 h)**

   Carbocations, carbanions, free radicals and carbenes as intermediates; Nucleophilic aromatic substitution reactions by addition-elimination mechanism and elimination-addition mechanism.

2. **Synthetic methods (8 h)**

   C-C, C-N bond forming reactions (organometallic and transition metal complex catalyzed reactions) in organic synthesis.

3. **Enolate chemistry (6 h)**

   Kinetically controlled and thermodynamically controlled enolates; Reactions of enolate ion (aldol condensation, iodoform reaction, Michael addition); Claisen and Dieckmann Condensation, Robinson annulation.

4. **Rearrangement reactions (4 h)**

   Favorskii, Curtius, Beckmann, Baeyer–Villiger oxidation, pinacol-pinacolone, benzil-benzilic acid rearrangement, Claisen rearrangement.

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning.

Recommended Readings

- Ege, S. N. (2003). Organic Chemistry, Structure and Reactivity, 5th Edition, Houghton Mifflin Harcourt.
- Carey, F. A.; Sundberg, R. J. (2008). Advanced Organic Chemistry, 5th Edition, Springer.
- Silverstein, R. M.; Webster, F. X.; Kiemle, D.J. (2005). Spectrometric Identification of Organic Compound, 7th Edition, Wiley.
- Williams, D. H.; Fleming, I. (2011). Spectroscopic Methods in Organic Chemistry, 6th Edition, Tata Mc. Graw Hill.
- Finar, I. L. (2004). Organic Chemistry, Volume 2, 5th Edition, Pearson.

C 21032/CHE 21032 - Principles of Physical Chemistry II

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: describe the fundamentals of quantum mechanics and its postulates;

ILO2: describe rotational and vibrational spectra of diatomic molecules;

ILO3: explain adsorption isotherms in different systems.

Note: ILO means intended learning outcome.

1. Introduction to quantum mechanics (12 h)

The quantization of radiation: Planck's concept of quantization, black-body radiation, photo- electric effect; Wave properties of matter: de Broglie's hypothesis, wave particle duality, electron diffraction and electron microscope, Heisenberg uncertainty principle; Postulates of quantum mechanics, Schrödinger (time-independent) equation, quantum mechanical operators, eigen functions; Application of Schrodinger equation to simple systems: Particle in one-dimensional box (Hamiltonian operator, boundary conditions, quantization of energy and quantum number, probabilistic interpretation of the wave function); Extrapolation of the particle in 1-D model to 2-D and 3-D boxes; Introduction to quantum mechanical tunneling; Postulates of quantum mechanics.

2. Fundamentals of molecular spectroscopy (10 h)

Fundamentals of spectroscopy, electrical and optical properties of molecules, introductory electronic spectroscopy; Microwave spectroscopy: Pure rotational spectra of diatomic molecules, applications of rotational spectra of diatomic molecules, classification of molecules according to their moment of inertia, positions of peaks in the microwave absorption spectrum of a diatomic molecule, centrifugal distortion; Vibrational spectroscopy: Pure vibrational spectrum of a diatomic molecule, harmonic oscillator approximation and its limitations, anharmonicity, Morse potential, selection rules.

3. Surface and colloid chemistry (8 h)

Introduction to surface phenomena: Absorption and adsorption, surface tension, surface free energy, angle of contact, effects of solutes and temperature on surface tension, surface pressure; Kelvin equation and its applications: Vapour pressure above curved surfaces, super cooling and super heating; Determination of specific surface areas of adsorbents: Langmuir trough method, monomolecular films, equation of state for an ideal surface film, molecular areas; Use of Gibbs and Langmuir adsorption isotherms, comparative description of physisorption and chemisorption; Sticking probability and condensation coefficient; Colloidal systems: Classification, physical properties, macromolecules and micelles, lyophilic and lyophobic colloids, stability of colloids, foams and emulsions; Electrophoresis and isoelectric point.

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning.

Recommended Readings:

- Mcquarrie, D.A. (2007). Quantum Chemistry, 2nd Edition, University Science Books.
- Levine, I. N. (2008). Quantum Chemistry, 6th Edition, Prentice Hall.
- Duncan Shaw (2013). Introduction to Colloid and Surface Chemistry, 4th Edition, Elsevier.
- Bandarage, G; Physical Chemistry Part III, Introduction to molecular spectroscopy, OUSL.
- Bandarage, G; Understanding the basics of molecular spectroscopy, OUSL.

C 21041/CHE 21041 - Basic Analytical Spectrometry

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: apply Beer's law in quantitative analysis;

ILO2: illustrate the optical configuration of a typical atomic absorption and emission spectrometer;

ILO3: describe background correction methods in atomic absorption spectrometry;

ILO4: explain basic types and principles of atomic X-ray spectroscopy.

Note: ILO means intended learning outcome.

1. Beer's law and quantification techniques (4 h)

Transmittance and absorption; Beer's law, types of electronic transitions, external and standard addition calibration curves, and related calculations; Sensitivity, limit of detection, practical quantization limit, linear range and liner dynamic range.

2. Atomic absorption and emission spectrometry (7 h)

Basic principles related to atomic emission; Absorption and fluorescence: Spectrometric techniques; Instrumentations for atomic spectrometry: Atom generation devices: Flames, electric arcs/sparks, furnaces and plasmas; Radiation sources: Line and continuum sources in AAS; Introduction to wavelength selection devices: Monochromators, polychromators and their figures of merit; Radiation detection in atomic spectrometry; Band broadening: Doppler broadening and collisional broadening, spectral line widths; Emission spectral profile and absorption coefficient profile; Interferences in atomic absorption spectrometry: Spectral interferences and background absorption, chemical interferences and methods for minimization of chemical interferences.

3. X-ray spectroscopy (4 h)

Properties of X-radiation: Generation of X-rays, types of X-ray sources, nature of interaction of X-rays with matter; Photoelectric effect, coherent and non-coherent effects; X-ray absorption spectroscopy; X ray fluorescence spectroscopy; Introduction to energy dispersive and wavelength dispersive X-ray fluorescence spectrometry, instrumentations and applications.

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning.

Recommended Readings:

- Harris, D. C. (2010). Quantitative Chemical Analysis, 8th Edition, W. H. Freeman.
- Christian, G. D.; Dasgupta, P.; Schug, K., Analytical Chemistry (2013), 7th Edition. Wiley

Global Education

- Skoog, D. A.; Holler, F. J.; Crouch, S. R. (2007). Principles of Instrumental Analysis, 6th Edition, Thomson Brooks/Cole.
- Skoog, D. A.; West, D. M.; Holler, F. J.; Crouch, S. R.(2013), Fundamentals of Analytical Chemistry. Cengage Learning.

C 21051/CHE 21051 - Analytical and Inorganic Chemistry Laboratory

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: prepare buffer solutions of different pH with different buffer capacities;

ILO2: determine analyte concentrations by redox and complexometric titrations;

ILO3: practice techniques in gravimetry, such as ignition techniques and homogeneous precipitations;

ILO4: perform quantitative analysis for an analyte of interest in a given sample by colorimetry.

Note: ILO means intended learning outcome.

1. **Buffer preparation (6 h)**

   Preparation of buffers for a given pH and a given buffer capacity.

2. **Redox titrations (12 h)**

   Titrations with potassium permanganate and potassium dichromate, iodometric titrations.

3. **Complexometric titrations (15 h)**

   Differentiation of magnesium and calcium ions in a mixture, elimination of interferences in EDTA titrations.

4. **Gravimetry (6 h)**

   Homogeneous precipitations, weight measurement techniques, gravimetry using sintered glass crucibles, gravimetry using sample ignition techniques.

5. **Colorimetry (6 h)**

   Direct and indirect colorimetry, external calibration curves and standard addition curves in analysis.

Methods of Teaching and Learning

A combination of laboratory classes, pre-laboratory and post laboratory assignments, laboratory reports.

Recommended Readings

- Svehla, G.; Suehla, G.; Vogel, A. I. (1996). Vogel's Qualitative Inorganic Analysis, 7th Edition, Longman.
- Crouch, S.; West, D.; Holler, F.; Skoog, D. A. (2012) Fundamentals of Analytical Chemistry, 9th Edition, Wadsworth.

C 21061/CHE 21061 - Basic Concepts in Biochemistry II

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: explain the mechanism of DNA damage and repair;

ILO2: explain energy generation and metabolism;

ILO3: integrate selected biochemical pathways;

ILO4: explain methods in biomolecule separation;

ILO5: determine the suitable separation techniques for biomolecule separation.

Note: ILO means intended learning outcome.

1. Introduction to DNA damage, repair mechanisms and mutations (2 h)

1.1. DNA damage: Agents that cause damage to DNA and types of damage.

1.2. Repair mechanisms: Natural mechanisms available for the repair of damaged DNA.

1.3. DNA mutations: Basics of DNA mutations and their effects, mutations that cause cancer.

2. Metabolism and energy generation (4 h)

2.1. Metabolic pathways harvesting energy stored in molecules: Aerobic glycolysis and its role in energy harvesting; ATP production at substrate level.

2.2. Anaerobic glycolysis and its significance.

2.3. TCA and its role in energy harvesting.

2.4. Fatty acid oxidation and its role in harvesting energy stored in fatty acids.

3. Electron transport and oxidative phosphorylation (4 h)

3.1. Electron transport chain (ETC): Introduction, location, points of entry of reducing equivalents into ETC.

3.2. Malate and glycerophosphate shuttles: Shuttles that transport reducing equivalents from cytoplasm into mitochondria.

3.3. ATP production in ETC, comparison of substrate level ATP production and oxidative phosphorylation.

3.4. Mitchell's chemiosmotic hypothesis.

3.5. Inhibitors and uncouplers.

4. Separation techniques in Biochemistry (5 h)

4.1. Methods of disintegration of tissues/cells.

4.2. Separation of sub-cellular organelles.

4.3. Solvents and precipitation of salt.

4.4. Paper and thin layer chromatography.

4.5. Column chromatography: Molecular sieving, affinity, ion exchange, examples of practical applications.

4.6. Electrophoresis: Introduction, practical applications, ultracentrifugation.

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning.

Recommended Readings:

- Nelson, D. L., & Cox, M. M. (2017). Lehninger Principles of Biochemistry (7th Ed.). W.H. Freeman.
- Harvey, Richard A., Ph. D. Lippincott's Illustrated Reviews: Biochemistry. Philadelphia: Wolters Kluwer Health, 2011.

C 21121 - Science and Industrial Applications

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: explain the importance of scientific fundamentals in industrial applications;

ILO2: explain how basic research is extended toward industrial applications;

ILO3: demonstrate knowledge on entrepreneurship;

ILO4: take the challenge in industrial environment.

Note: ILO means intended learning outcome.

Importance of fundamental of science in industrial applications, scientific inventions, importance of basic research, extension of basic research toward applications, entrepreneurship, importance of leadership skills, management skills and group activities in industry, preparation for industrial environment.

Methods of Teaching and Learning

A combination of laboratory classes, pre-laboratory and post laboratory assignments, laboratory reports.

Recommended Readings

- P. Robbins, J. Hintz and S.A. Moore, Environment and Society: A Critical Introduction, 2nd Edition, Wiley-Blackwell, 2014.
- Environment and Society, Ed C. Schlottmann, D. Jamieson, C. Jerolmack, A. Rademacher and M. Damon, NYU Press, 2017.
- Introduction to Environmental Management, 1st Edition, Ed M.K. Theodore and L. Theodore, CRC Press, 2010.
- T.J. Kaczynski, Industrial Society and Its Future, Pub House Books, 2018.
- The Industrial Information Technology Handbook, 1st Edition, Ed. R. Zurawski, CRC Press, 2004.

S 21072/ALS 21072 - Basic Statistics II

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: interpret basic descriptive statistics;
ILO2: identify the independent and dependent variables in an experimental description;
ILO3: distinguish among the kinds of experimental validity;
ILO4: define the partition of the total sum of squares and degrees of freedom for the ANOVA tests presented;
ILO5: describe inferential statistical tests;
ILO6: define possible probability values, manually compute simple and conditional probabilities, apply the product and addition rules, do a test for independence, and compute a probability using Bayes theorem;
ILO7: describe the relationship between ANOVA and regression;
ILO8: execute statistical analysis with professional software.

Note: ILO means intended learning outcome.

1. **Variability and sampling distribution (Theory: 3 h; Practical: 2 h)**

   Introduction to statistics, sources of variability, hypothesis testing, sampling distribution.

2. **One-way ANOVA (Theory: 7 h; Practical: 12 h)**

   One-way ANOVA with 2 groups, linear model and assumptions, effect size, power and sample size multiple groups, orthogonal contrasts, planned comparisons, pairwise multiple comparisons.

3. **Two-way ANOVA (Theory: 2 h; Practical: 9 h)**

   Simple, main and interaction effects; Mixed-factor ANOVA.

4. **Applications (Theory: 3 h; Practical: 5 h)**

   Applications of statistical software.

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning.

Recommended Readings:

- Mann, Prem S. (1995). Introductory Statistics (2nd ed.). Wiley. ISBN 0-471-31009-3.
- Basic Statistics, An introduction with R, TenkoRaykov and George A Marcoulides, 2012, Rowman & Littlefield Publishers.
- Basic Statistics, BL Agarwal, New Age International, 2006.
- Basic statistics: Understanding conventional methods and modern insights, Oxford University press 2009.

APM 21102 -
Principles of Human Resource Management and Leadership

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: demonstrate understanding of the theoretical aspects of HRM functions;

ILO2: analyse the application of HRM techniques of staffing, recruitment, selection, training and development, performance appraisal and reward systems in less complex scenarios;

ILO3: identify different leadership styles and their application.

Note: ILO means intended learning outcome.

1. **Unit I (9 h)**

   Introduction to HRM, recruitment and selection, performance management and motivation, training and development, influence of groups and environment on personality.

2. **Unit II (12 h)**

   Recruitment and selection, performance management and motivation, training and development, influence of groups and environment on personality.

3. **Unit III (9 h)**

   Introduction to leadership, leadership styles, evaluation of global leaders and their styles of leadership, universal communication model, purpose and modes on organizational communication.

Methods of Teaching and Learning

Lectures, discussion of cases and self-study

Recommended Readings

- Dessler, Human Resources Management, 12th Ed. (2012), Prentice Hall.
- Armstrong M — A Handbook of Human Resource Practice, 12th Ed (2012).
- Lesikar, Pettit, and Flatley, (2001). "Basic Business Communication", Irwin McGraw-Hill.
- Kaagan Stephen S., (1999). "Leadership Games", Response Books.

APM 21112- Marketing Management

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: explain the increasingly significant role of marketing in modern organizational management;

ILO2: identify the variables at work of various marketing situations;

ILO3: prepare a comprehensive marketing plan for a business organization.

Note: ILO means intended learning outcome.

1. **Unit I (6 h)**

   Evol marketing as an organizational function, evolution of marketing conceptsution of marketing philosophies and concepts.

2. **Unit II (18 h)**

   Marketing goals and strategies, consumer behavior, marketing mix and targeting, strategies for products, pricing, channeling and promoting products, brand strategies and brand management.

3. **Unit III (6 h)**

   Preparation of a marketing plan.

Methods of Teaching and Learning

Interactive classroom sessions, case analysis, projects

Recommended Readings

- Kotler, P (2015), Marketing Management, 15th Edition, Prentice Hall.
- Boyd and Walker (2015), Marketing Management.
- Wells W D, Moriarty S and Burnett J (2011), 9th Edition, Advertising & IMC; Principles and Practice, Prentice Hall.

C 22012/CHE 22012 - Concepts in Inorganic Chemistry II

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: identify isomerism in coordination complexes;

ILO2: calculate overall formation constant;

ILO3: apply Valance Bond Theory and Crystal Field Theory to make predictions on coordination complexes;

ILO4: calculate oxidation state of the metal and total electron count at the metal in organometallic compounds;

ILO5: explain bonding in metal-π-bonding ligands in organometallic compounds;

ILO6: apply symmetry elements and symmetry operations for simple molecules.

Note: ILO means intended learning outcome

1. Coordination chemistry (18 h)

1.1. Definitions: Central metal atom/ion, ligands, donor atom, coordination sphere, coordination number and polydentate ligands.

1.2. Hard/soft acids and bases, hard/soft acid base theory (HSAB Theory).

1.3. Isomerism and nomenclature of coordination complexes: Types of isomerism, IUPAC nomenclature.

1.4. Stability of complexes in aqueous solution: Stepwise and overall formation constants, thermodynamic and kinetic stability, chelate effect, macrocyclic effect.

1.5. Bonding in coordination complexes.

1.6. Valence Bond Theory (VBT): Hybridization schemes, application of VBT.

1.7. Crystal Field Theory: Octahedral and tetrahedral crystal fields, splitting of d-orbitals by octahedral, tetrahedral and square planar fields, determination of crystal field splitting energy and crystal field stabilization energy, factors affecting magnitude of (Δ), pairing energy, high spin and low spin complexes, spectrochemical series, evidence for crystal field stabilization energy - variation of lattice energy and ionic radii of divalent metal halides of first transition element series, colour and magnetism in coordination complexes, tetragonal distortion, Jahn-Teller effect.

1.8. Molecular orbital theory: Molecular orbital theory for octahedral complexes having metal–ligand σ-bonding only, octahedral complexes of π-donor and π-acceptor ligands.

2. Introductory organotransition metal chemistry (6 h)

2.1. Introduction: Introduction to organotransition metal chemistry, classification of ligands according to the number of electrons donated, oxidation state formalism, hapticity of a ligand (η^n).

2.2. Total valence electron count and geometry

Total valence electron count in organometallic compounds, the 18-electron rule, coordinative unsaturation, geometry of organotransition metal complexes.

2.3. Metal-ligand bonding: ligands CO, PR3, alkenes, hydrogen.

3. Elements of symmetry in molecules (6 h)

Elements of symmetry and symmetry operations: Basic types of symmetry elements and their operations on molecules, point groups, determination of point groups of simple molecules.

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning.

Recommended Readings

- J. D. Lee, Concise Inorganic Chemistry, 5th Edition.
- Shriver and Atkins (2010), Inorganic Chemistry, 5th Edition.
- Robert H. Crabtree, The Organometallic Chemistry of the Transition Metals, 5th Edition
- Cartherine E Housecroft and Alan G Sharpe (2012), Pearson, England, Inorganic chemistry, 4th Edition.

C 22022/CHE 22022 - Heterocyclic Chemistry and Spectroscopy

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: relate the nature of bonding to structural features, properties and, reactivity of the heterocyclic compounds;

ILO2: elucidate the structure of a simple organic molecule using spectrometry.

Note: ILO means intended learning outcome

1. Polynuclear aromatic hydrocarbons (4 hrs)

Properties, Synthesis and Reactions of naphthalene, anthracene and phenanthrene

2. Heterocyclic Chemistry (8 hrs)

Chemistry of one hetero atom (O, S and N) five membered heterocyclic compounds
Chemistry of six membered heterocyclic compounds
Benzo derivatives of five membered heterocyclic compounds
Benzo derivatives of six membered heterocyclic compounds
Some simple biologically important molecules
Examples of two hetero atom compounds which are biologically important

3. Structure elucidation (18 h)

Electromagentic radiation; Applications of ultraviolet and visible spectroscopy, chromophores, auxochrome and solvent effect, Woodwards rules; Infrared spectroscopy: molecular vibrations and absorption characteristic of functional groups; Nuclear magnetic resonance (NMR) spectroscopy: Magnetic properties of nuclei and nuclear excitation; ^{1}H NMR spectroscopy: chemical shifts, spin spin coupling, coupling constants; ^{13}C NMR spectroscopy: Chemical shifts; off resonance spectra; Mass spectrometry: Molecular ion, fragmentation patterns.

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning.

Recommended Readings

- Ege, S. N. (2003). Organic Chemistry, Structure and Reactivity, 5th Edition, Houghton Mifflin Harcourt.
- Carey, F. A.; Sundberg, R. J. (2008). Advanced Organic Chemistry, 5th Edition, Springer.
- Gupta, R. R.; Kumar, M.; Gupta, V. (1998) Heterocyclic Chemistry, 1st Edition, Springer.
- Acheson, R.M. (1977). An Introduction to the Chemistry of Heterocyclic Compound,

John Wiley & Sons.

- W. Voelter, and D. G. Daves, Biologically active principles of natural products. Georg Thieme Verlag.
- 1984. Mann, J.; Davidson, R. S.; Hobbs, J.B.; Banthorpe, D.V.; Harbone, J.B. (1996). Natural Products: Their Chemistry and Biological Significance, Longman.

C 22032/CHE 22032 - Principles of Physical Chemistry III

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: determine the electromotive force (emf) of a galvanic cell;

ILO2: evaluate performance of cells using principles of electrochemistry and thermodynamics;

ILO3: determine conductivity of electrolytes;

ILO4: apply phase rule for industrial processes.

Note: ILO means intended learning outcome.

1. **Introduction to electrochemistry (20 h)**

   Electrode potential, standard electrode potential and reversible electrode potential; Galvanic cells and electrochemical cells, liquid junction potential and salt bridge cell; Electromotive force (emf) and experimental measurement of cell emf; Applications of emf measurements, types of chemically reversible electrodes (metal, metal ion, metal amalgam, etc.); Thermodynamics of Galvanic cells, construction of Galvanic cells, role of a salt bridge in a cell; The Nernst equation, equilibrium constant of a cell reaction; Applications of emf measurements; Electrochemistry of corrosion, introduction to the measurement of corrosion rates, passivation, corrosion inhibition; Calculation of activity coefficients, Debye-Huckel limiting and extended laws for activity coefficient; Applications of emf measurements; Batteries and fuel cells; Electrolyte solutions, electrical molar conductivity, conductivity cell, relationship between conductivity and composition of solution, Faraday's law, silver coulometry, ion mobilities, transport numbers, Kohlraush law of independent ionic migration, limiting molar conductivity, Onsagar limiting law, determination of limiting molar conductivity of weak and strong electrolytes; Introduction to electrotechnology, metal finishing, electroplating, anodizing, electrolysis, electrocatalysis.

2. **Phase equilibria (10 h)**

   Introduction, phase rule, phase transition, first and second order transition; Two component liquid systems: Ideal and non-ideal solutions, zeotropy and azeotropy, distillation of liquid mixtures; Two-component solid-liquid systems: Eutectic mixtures, compound formation, congruent and incongruent melting points; Two component solid solutions; Experimental methods for constructing phase diagrams; Thermal analysis; Henry's Law; Applications of phase equilibria in industry and technology: steam distillation, fractional distillation, metallurgy.

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning.

Recommended Readings

- Atkins, P.; de Paula, J. (2014). Physical Chemistry, 9th Edition, W H Freeman.

C 22041/CHE 22041 - Physical Chemistry Laboratory

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: conduct error analysis using error propagation;

ILO2: determine rate laws for 1st and 2nd order reactions;

ILO3: calculate thermodynamic properties;

ILO4: construct electrochemical cells;

ILO5: prepare buffer solutions to control the different chemical reactions;

ILO6: use colorimetric methods to study progress of chemical reactions.

Note: ILO means intended learning outcome.

1. Introductory sessions

Types of experimental errors, error analysis, reporting results using standard error analysis, propagation of errors, graphical analysis to obtain information precisely.

2. Practical sessions (45 h)

Three-hour practical sessions covering areas such as,

2.1. Chemical kinetics

2.2. Thermodynamics

2.3. Phase equilibria

2.4. Electrochemistry (Potentiometry)

2.5. Acid base equilibria (Buffer solutions)

2.6. Spectrometry (Colorimetry)

Methods of Teaching and Learning

12-14 practical sessions, group works, presentations and two laboratory assessments

Recommended Readings

- Shoemaker, D. P., Garland, C. W., & Nibler, J. W. (1996). Experiments in physical chemistry. New York: McGraw-Hill.

C 22051/CHE 22051 - Separation Methods and Fundamentals of Chromatography

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: explain the principles of discontinuous liquid-liquid extraction;

ILO2: explain the fundamentals of ion exchange;

ILO3: define basic terminologies and interpret theoretical aspects of elution chromatography;

ILO4: evaluate zone broadening in chromatography using plate and rate theories.

Note: ILO means intended learning outcome.

1. Solvent extraction and ion-exchange (7 h)

Liquid-liquid extraction (LLE): Basic principles, LLE involving acid-base equilibria, ion speciation, LLE of a metal-ligand complex; Continuous liquid-liquid extraction; Ion exchange (IE): Chemistry of ion exchange resins and selectivity, static and dynamic operation and capacity; Applications; Clay minerals as ion exchangers.

2. Principles in elution chromatography (8 h)

Introduction to chromatography: Frontal, displacement and elution chromatography; Components of elution chromatography: The stationary phase, the mobile phase and the analyte; Planner and column chromatography; Adsorption, partition, ion exchange and permeation chromatography; Reversed phase and normal phase chromatography; Basic terminologies in chromatography: Retention time, capacity factor, selectivity factor, volumetric flow rate; Zone broadening: Gaussian shape of chromatographic peaks, the plate theory, quantitative description of column efficiency, the rate theory, van Deemter equation for plate height; Column efficiency and resolution; Thermodynamics of elution chromatography: Enthalpy driven and entropy driven chromatograms.

Methods of Teaching and Learning

12-14 practical sessions, group works, presentations and two laboratory assessments

Recommended Readings

- Shoemaker, D. P., Garland, C. W., & Nibler, J. W. (1996). Experiments in physical chemistry. New York: McGraw-Hill.

C 22061/ CHE 22061 - Natural Products

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO 1: provide an overview of the field of natural product chemistry;

ILO 2: identify different types of natural products, their occurrence, structure, biosynthesis and properties;

ILO 3: carry out independent investigations of plant materials and natural products;

ILO 4: predict biosynthetic pathways for a given secondary metabolite.

Note: ILO means intended learning outcome.

1. **Introduction to primary and secondary metabolites**
2. **Chemistry of selected alkaloids (ephedrine, hygrine, arecoline, nicotine atropine, ecogonine, quinine, papervarine, yohimbine series, morphine, codeine series).**
3. **Chemistry of selected steroids (cholesterol, β-sitosterol, testosterone, estrone).**
4. **Chemistry of selected terpenoids (monoterpenoids - myrcene, citral, ionone, terpineol, carvone, limonene, menthol and menthone, thujane, carane, pinane and bornane group, camphor, bornyl alcohols; Sesquiterpenoids - bisabolene, nerolidol, zingiberene, geraniol, farnesol, cadalene; Triterpenoids- basic skeletons).**

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning.

Recommended Readings

- W. Voelter, and D. G. Daves, (1984). Biologically active principles of natural products. Georg Thieme Verlag.
- Mann, J.; Davidson, R. S.; Hobbs, J.B.; Banthorpe, D.V.; Harbone, J.B. (1996). Natural Products: Their Chemistry and Biological Significance, Longman.

C 22111 - Energetics in Chemistry

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO 1: define Helmholtz free energy, Gibbs free energy and write Maxwell relationships;

ILO 2: explain the importance of Clapyron equation and Clausius-Clapyron equation and perform relevant calculations;

ILO 3: define partial molar properties;

ILO 4: apply thermodynamics principles for chemical reactions.

Note: ILO means intended learning outcome.

1. Further Applications of Energetics in Chemistry (15 h)

1.1. Review of basic concepts of thermodynamics including the physical basis of enthalpy.

1.2. Free energy functions: Need for a free energy function, Helmholtz free energy (*A*) and Gibbs free energy (*G*), maximum and network function, *A* and *G* as criteria for equilibrium and spontaneity, spontaneous endothermic processes, significance of free energy function in relation to energy functions, the four fundamental thermodynamic equations, temperature, volume and pressure coefficients of *A* and *G*, Maxwell relationships, thermodynamic equation of state, variation of isochoric and isobaric thermal capacities with pressure and volume, Gibbs-Helmholtz equation, standard free energies.

1.3. One component systems and univariant phase transformations, Clapeyron equation; Clausius-Clapeyron equation.

1.4. Colligative properties.

1.5. Introduction to partial molar properties, in particular chemical potential.

1.6. Chemical changes, derivation of equation for free energy change in general chemical reaction in terms of activity/fugacity, relationship between standard free energy change and equilibrium constant, influence of temperature on equilibrium constant.

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning.

Recommended readings

- P. Atkins, J. de Paula and J. Keeler, Atkins' Physical Chemistry, 11th Edition, Oxford University Press, 2017.
- Physical Chemistry, A molecular Approach, Donald A McQuarrie, John D Simon University Science Books; 1st Edition (July 1, 1997).

S 22123 - Introduction to Management, Economic and Finance

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO 1: explain the basic concepts and principles of management, its evolution as a discipline, elements of the managerial environment and essentials of the planning function;

ILO 2: explain the concepts and principles of organizational structure, design and aspects of operations management;

ILO 3: explain the basic concepts and principles of economics, features of economic systems and differences between Economist's and Accountant's profit;

ILO 4: discuss basic concepts of cost, classification of costs and behavior;

ILO 6: compute and interpret indicators associated with break-even analysis and project evaluation.

Note: ILO means intended learning outcome.

1. Basic principles of management (19 h)

1.1. Introduction to management: Definition of management in terms of effective and efficient utilization of resources to meet organizational goals, levels of managers (top managers, middle managers and action front bottom managers), skills of managers (technical skills, inter-personal skills and conceptualization skills) and how they relate to the level of manager, Ten roles of managers (Henry Mintzberg)

1.2. Evolution of management philosophy and theory: Frederick Taylor's scientific management – time and task study in finding the one best method, systematic selection and training of individuals, extra pay as an incentive, ctandardization, etc., Henry Fayol's, universal management process (14 principles of management and a brief explanation of each principle), Lton Mayo's Hawthorne studies leading to what is known as the, "Hawthorne effect"; Douglas McGregor's theory X and theory Y, contingency theory and systems theory of management.

1.3. Managerial environment: Task environment (key elements), macro-environment (key elements), internal environment (organization culture and its key elements).

1.4. Functions of planning: Planning process, including an introduction to SWOT analysis, types of planning (strategic, intermediate and operational), seduling (Gantt charts), organizing function, organizational structures (bureaucratic, matrix, teams, etc., advantages and disadvantages of the characteristics of different structures), leading function, controlling function, types of control (feedback control, feed forward control and concurrent control), operations management control loops (voice of process and voice, of customer) management.

2. Operations management (12 h)

2.1. Transformation of inputs to useful outputs, productivity, two-key operational

performance objectives (quality, cost, speed, reliability and flexibility), total quality management (key characteristics and how it helps to reduce the cost of quality), just-in-time production and supplies.

2.2. Changing the work place: Continuous improvement, fundamental improvement, innovation and creativity, 5S + 3R concept and how it enhances efficiency, quality circles.

2.3. New product development: New product development process, categories of new products, factors which influence development of new products, value engineering, strategic approach to new product development to gain a competitive advantage.

2.4. Communication methods and skills: Model of effective communication (encoding, transmitting by selecting a medium, decoding, feedback, etc.), noise, body language, barriers to effective communication.

3. Fundamentals of economics (6 h)

Economy and economics; Scarcity, choice and opportunity cost; Basic economic problems; Factors of production; Law of diminishing returns: Marginal, average and total product; Economic systems: Traditional, command, market and mixed; Concept of profit.

4. Aspects of finance (8 h)

4.1. Concept of cost: Cost, cost object and cost centre; Cost classification by purpose: Direct vs. indirect; Cost classification by behavior: Variable, fixed, Semi-variable; Step-up; Sunk cost; Controllable vs. uncontrollable costs.

4.2. Break-even analysis: Cost-volume-profit (CVP) model; Contribution margin; Break-even point; Margin of safety; Break-even chart, Profit/ volume graph and applications; Assumptions and limitations.

4.3. Project evaluation: Types of projects; Steps of project evaluation; Financial appraisal: Cash flows; Payback method; Present value of money; Cost of capital; Net present value (NPV) method; Internal rate of return (IRR) method; Introduction to societal cost benefit analysis.

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning.

Recommended readings

- Robert Kreitner, Management, 6th Edition, Houghton Mifflin Co, USA.
- Dale H. Besterfield, et al, Total Quality Management, 2nd Edition, Pearson Education (Sing) Pte Ltd.
- Mevan Pieris, Reading material on lectures.
- K. B. M. Fonseka, Study Text on Economic and Finance.
- A. Lipsey & A. Chrystal (2011), Economics, 12th Edition., Oxford University Press.
- C. Drury, (2010), Costing, 8th Edition.

E 22071/ENH 22071 - English for Scientific Writing

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: attain at least an upper-intermediate proficiency in the four language skills: listening, speaking, reading and writing;
ILO2: be competent in the use of compound and complex sentence structures;
ILO3: use of advanced vocabulary in writing tasks individually;
ILO4: be able to make speeches (prepared and impromptu) and presentations;
ILO5: be competent language users related to their professional environments;
ILO6: be able to use English in subjects related to Science and Management;
ILO7: be able to effectively write, understand, conceptualize and analyse information through charts, tables, diagrams and graphs;
ILO8: transfer information into another format or mode.

Note: ILO means intended learning outcome.

1. **Effective presentations (Theory: 2 h; Practical: 5 h)**

   Introduction to the course, presentation skills and introducing the standard format for a presentation.

2. **Academic writing I (Theory: 2 h; Practical: 5 h)**

   Preparing, analyzing and describing charts, tables, graphs, processes and diagrams; Developing skills in referencing (adhere to the accepted method).

3. **Academic writing II (Theory: 2 h; Practical: 5 h)**

   Writing a literature review on a given topic and preparing a paper which is to be presented; Use of proper citations and quotations according to the accepted referencing method.

4. **Academic writing III (Theory: 1 h; Practical: 5 h)**

   Data interpretation and research ethics.

Methods of teaching and learning

The eclectic approach will be used in teaching English to promote skills of conceptualization as well as a learner-centered approach in the teaching-learning process. The lecturer will incorporate the suitable methods and strategies such as task-based language learning to guarantee the best possible learning experience. The lecturer will particularly focus on individual, pair and group work, incorporate teaching approaches such as known-to-unknown and learning to learn and will consider the different learning styles of the students (multiple intelligences) in the teaching-learning process.

Recommended readings

- Evans, T.D. & Bates, M. (1976). Nucleus: General Science: English for Science and Technology.
- New York: Prentice Hall Press.
- Hewings, M. (2002). Advanced English Grammar. Cambridge: Cambridge University Press.
- Maciver, A. (1986). The New First Aid in English. Glasgow: Robert Gibson & Sons, Ltd.
- Meldrum, J. (2013). Speak Now: Communicate with Confidence. Oxford: Oxford University Press.
- Richards, J.C. New Interchange: English for International Communication. New Delhi: Cambridge University Press India Pvt. Ltd.
- Soars. L & Soars. J. (2009). American Headway: The World's Most Trusted English Course. Oxford: Oxford University Press.
- Soars. L & Soars. J. (2003). New Headway: Advanced Workbook with Key. Oxford: Oxford University Press.

APM 22082 - Computer Based Tools for Management

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: apply Visual Basics and spreadsheet modeling in business;

ILO2: utilize Excel as a decision-making support tool;

ILO3: emphasize the use of Excel to document and demonstrate models.

Note: ILO means intended learning outcome.

1. **Unit I (15 h)**

   Introduce spreadsheet modelling using Visual Basic for Application (VBA) to model and solve operations research, operations management, statistics, supply chain management, economics, human resource management, and finance real world complex problems.

2. **Unit II (15 h)**

   Managerial decision modelling, decision making under uncertainty, VBA for simulation and decision making: Goal seek, data tables/scenario manager, solver, precision tree, risk and uncertainty via @Risk, RISK optimizer for Excel.

Methods of Teaching and Learning

Lectures, in-class discussion of cases, self-study and mini-projects, computer assisted learning

Recommended Readings

- Winston, W and Christian, A S (2009), Practical Management Science, Revised, 3rd Edition.
- Winston, WL (2007), Microsoft® Office Excel® 2007: Data Analysis and Business Modelling, Microsoft Press.
- Christian A S (2007), VBA for Modelers: Developing Decision Support Systems with Microsoft® Excel, Thomson, Brooks/Cole.
- Stephen, G P and Kenneth, R B (2010), Management Science The Art of Modeling with Spreadsheets 3rd Edition.

APM 22092 - Total Quality Management

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: identify the difference between quality control and quality assurance;

ILO2: implement quality controlling quality assurance parameters;

ILO3: explain the term "Standards Formulation Process";

ILO4: discuss different quality management systems;

ILO5: carry out a quality audit;

ILO6: apply statistical process control in production and service systems.

Note: ILO means intended learning outcome.

1. Standardization and concepts on total quality management (10 h)

1.1. Basic introduction to quality management: Quality, quality control, quality assurance, total quality management, complaint mushroom, quality chain, process definition, deming cycle.

1.2. Standardization concept.

1.3. Levels of standardization.

1.4. Conformity assessment.

1.5. Accreditation.

1.6. Quality management principles.

1.7. Quality costs.

1.8. Standards formulation process.

1.9. 5S concept.

2. Quality management systems (10 h)

2.1. Product certification scheme.

2.2. ISO 9001:2015 Standard requirements.

2.3. ISO 14000 Standard requirements.

2.4. ISO 22000 Standard requirements.

2.5. ISO 17025 Laboratory management system requirements.

2.6. Quality auditing: Definition of audits; Types of audits; Classification of audits; Performing the audits; Audit reporting.

3. Statistical Process Control in Production and Service Systems (10 h)

3.1. Basic introduction to Seven Quality Management tools (pareto analysis, flow chart, check sheet, histogram, scatter diagram, control chart, cause-and-effect diagram).

3.2. Sampling.

3.3. Detail discussion about histogram.

3.4. Detail discussion about control charts.

3.5. Variable/attribute control charts.

3.6. Process capability indices, Cp and Cpk.

Methods of Teaching and Learning

Lectures, tutorials, group work, seminars, computer assisted learning

Recommended Readings

- Evans J.R (2007), "Total quality", 4th edition, Thomson-South-Western.
- Freigerbaun A.V. "Total quality", Mc graw-Hill, New York.
- Evans J.R and Lidsay, (2005), "The Management of the control of quality", 6th Edition, Cincinnati south-western Publication.
- ISO/IEC 17025:2005-general requirements for the competence of testing and calibration laboratories http://ww.iso.org.
- Koneiczka Pnaiesnik, J. Quality Assurance and Quality control in the analytical Chemical Laboratory: A practical approach; CRC Press, 2009.

APM 22102 – Operations Management

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: define the role of operations in an organization;

ILO2: demonstrate basic competencies in planning and controlling of manufacturing and service operations.

Note: ILO means intended learning outcome.

1. **Unit I (15 h)**

   Introduction to operations management, background and development of production management systems, product design and process selection, strategic capacity planning, plant location, facility layout, aggregate planning, operations scheduling, materials planning and control, quality management, recent trends in operations management.

2. **Unit II (15 h)**

   Product design and process selection, strategic capacity planning, plant location, facility layout, aggregate planning, operations scheduling, materials planning and control, quality management.

Methods of Teaching and Learning

Lectures, case analysis and industry visits and product design and development case analysis

Recommended Readings

- Stevenson W, (2014), Operations Management, 12th Edition, McGraw Hill.
- Chase, J and Aquilano (2006), Operations Management for competitive advantage, 11th Edition, McGraw Hill–Irwin.

LEVEL 3

C 31013/CHE 31013 - Advanced Inorganic Chemistry I

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: elucidate the structure of inorganic compounds using spectroscopic methods;
ILO2: explain metal-ligand bonding for various ligands;
ILO3: identify type of organometallic reaction involved in a given reaction;
ILO4: design suitable catalysts for selected industrial synthesis processes;
ILO5: discuss structural chemistry of boron hydrides;
ILO6: apply molecular orbital theory for coordination complexes;
ILO7: predict/interpret electronic spectra of coordination complexes.

Note: ILO means intended learning outcome.

1. Physical methods in inorganic chemistry (15 h)

Applications of ultraviolet (UV), visible and infrared (IR) spectroscopic techniques in inorganic chemistry; Nuclear magnetic resonance (NMR) spectroscopy in inorganic, organometallic and bioinorganic chemistry; Theory and applications of electron-spin resonance (ESR) spectroscopy; Nuclear quadruple resonance (NQR) and Mössbauer spectroscopy.

2. Advanced organotransition metal chemistry (14 h)

2.1. Metal-ligand bonding: ligands; dinitrogen (N2), isocyanide (RNC), nitric oxide (NO), thiocarbonyls (CS), carbenes, carbynes, alkynes, (η^1 and η^3) allyl, η^4-cyclobutadienyl, η^3-cyclopentadienyl anion, η^6-benzene, η^6-cycloheptatriene, η^7-cycloheptaphenylcation.

2.2. Reactivity patterns of organometal compounds: Oxidative addition, reductive elimination, elimination (α, β, γ, E), insertion, association, dissociation, substitution, oxidative coupling).

2.3. Homogeneous catalysis: Free energy change profiles for catalyzed and non-catalyzed reaction, industrial application, alkene isomerization, alkene hydrogenation, alkene hydroformylation, alkene hydrocyanation, alkene hydrosilation, Monsanto acetic acid synthesis, alkene oligomerization, water-gas shift reaction, olefin metathesis, Heck reaction, Wacker process.

2.4. Heterogeneous catalysis: Industrial application; Alkene polymerization (Ziegler-Natta Catalysis), Fischer-Troposch synthesis.

3. Basic molecular polyhedra (7 h)

Boron hydrides: Neutral boron hydrides, hydro borate anions, carboranes, metallaboranes and, metallacarboranes, Lipscomb's styx theory, polyhedral skeletal electron pair theory, Wade-Mingos rules, IUPAC nomenclature.

4. Advanced coordination chemistry: Molecular orbital theory and electronic spectra of coordination complexes (9 h)

Electronic spectra of coordination complexes: Spectral features, Russel-Saunders coupling, Selection rules, term symbols, microstates, relative energies of term, Racah parameters, Orgel diagrams, electronic spectra of octahedral and tetrahedral complexes, Tanabe-Sugano diagrams, number and intensities of bands in electronic spectra from Orgel and Tanabe-Sugano diagrams, nephelauxetic effect, characteristics of charge transfer spectra.

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning.

Recommended Readings

- Perera K. S. D., Inorganic NMR spectroscopy, College of Chemical Sciences, IChemC, Monograph No. 25.
- Miessler, Garry L. and Tarr, Donald A. "Inorganic Chemistry" 4th Edition, 2010, Prentice Hall.
- Cartherine E Housecroft and Alan G Sharpe (2012), Pearson, England, Inorganic chemistry, 4th Edition.
- Shriver and Atkins (2010), Inorganic Chemistry, 5th Edition.

C 31022/CHE 31022 - Physical Organic Chemistry, Pericyclic Reactions and Natural Products Chemistry

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: correlate free energy changes with structural changes for a given reaction;

ILO2: predict the effect of solvents and isotopes on reactivity of organic reactions;

ILO3: determine the mechanism and products formed in concerted reactions;

ILO4: predict biosynthetic pathways for a given secondary metabolite.

Note: ILO means intended learning outcome.

1. Physical organic chemistry (10 h)

Linear free energy relationships: Quantitative treatments of the effects of structures on reactivity, use of Hammett equation, substituent constant σ, σ+, σ-, reaction constant ρ and its significance and applications, free energy diagrams, failures and modifications of Hammett equation; Yukawa-Tsuno equation and its applications, use of σ+, σ- values, Taft equation, steric effects in organic reactions; solvent and kinetic effects on reactivity: Protic, aprotic and dipolar aprotic solvents on reactivity, significance and application of m and y constants, kinetic isotopic effect, two phase reactions in organic chemistry.

2. Pericyclic reactions (10 h)

Cycloaddition, electrocyclic and sigmatropic reactions, aromaticity, anti-aromaticity, molecular orbitals of conjugated polyenes and allyl systems, correlation diagrams, concept of HOMO and LUMO - Fuki frontier orbital approach; Selection rules and stereochemistry of electrocyclic reactions, cycloadditions and sigmatropic shifts, applications of frontier molecular orbital approach, correlation diagram approach, Hückel-Mobius approach; Sommelet-Hauser, Cope and Claisen rearrangements.

3. Natural products chemistry (10 h)

Introduction to primary and secondary metabolites; Major classes of natural products; Basic techniques used in isolation of secondary metabolites; Monoterpenes, sesquiterpenes and triterpenes; Nomenclature and classification of steroids; Biologically important steroids; Properties and classification of alkaloids, chemistry and pharmaceutical properties of important alkaloids; Biosynthetic routes of natural products.

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning.

Recommended Readings

- Isaacs, N. (1996). Physical Organic Chemistry, 2nd Edition, Prentice Hall.
- Costa, M.D.P. De (2010). Pericyclic reactions. Theory and Applications, Revised Edition, Institute of Chemistry Ceylon, Monograph 22.
- W. Voelter, and D. G. Daves, (1984). Biologically active principles of natural products. Georg Thieme Verlag.
- Mann, J.; Davidson, R. S.; Hobbs, J.B.; Banthorpe, D.V.; Harbone, J.B. (1996). Natural Products: Their Chemistry and Biological Significance, Longman.

C 31032/CHE 31032 - Quantum Chemistry and Molecular Spectroscopy

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: apply Schrödinger equation for simple systems, such as 1-D box, harmonic oscillator, rigid rotor, H atom;

ILO2: demonstrate the skills in approximation methods to solve problems in quantum mechanics;

ILO3: apply molecular orbital and bonding information to calculate energies of He-like atoms;

ILO4: demonstrate the applicability of microwave, infrared, and Raman spectroscopy into various molecular systems;

ILO5: construct character tables of molecular point groups and identify IR and Raman active modes.

Note: ILO means intended learning outcome.

1. Quantum chemistry (15 h)

Harmonic oscillator (quantum mechanical treatment), rigid rotor model, angular momentum in quantum mechanics; energy levels and stationary states of a hydrogen atom; Application of the Schrodinger Equation for the hydrogen atom, probabilistic aspects and orbital shapes, effect of a magnetic field on energy levels; Approximate methods, perturbation theory and variation methods; Introduction to quantum chemical calculations on atoms and molecules; Definition of atomic units and status of quantum chemical calculations on helium atom; Application of the above method for multi – electronic systems

2. Molecular spectroscopy (15 h)

Vibration-rotation spectroscopy of diatomic and poly atomic molecules, Born Oppenheimer approximation, selection rules, origin of P, Q and R branches; Vibrations in polyatomic molecules: Vibrational degrees of freedom, fundamentals, hot bands, overtones in IR spectra; Applications of IR spectroscopy in structure determination of molecules.

Selection rules and effect of nuclear spins on linear molecules with centre of symmetry; Raman spectroscopy: Classical and quantum theory of Raman effect, polarization effects, vibration using IR and Raman data, rotational and vibrational Raman spectroscopy.

Electronic spectroscopy of diatomic molecules, vibrational coarse structure, rotational fine structure, Frank Condon Principle, dissociation energy and dissociation products.

Introduction to Lasers, principles of LASER operations: The nature of stimulated emission,

resonators and pumping processes, coherent radiation, standing waves and nodes, the kinetics of laser emission, rate equations, threshold conditions, pulsed vs. continuous emissions, transitions, lifetimes and line widths, three-level and four-level lasers.

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning.

Recommended Readings

- Atkins, P.W.; Paula, J. D. (2009). Atkins Physical Chemistry, 9th Edition, Oxford University Press.
- Struve, W. S. (1989). Fundamentals of Molecular Spectroscopy, John Wiley & Sons, Inc.
- Pavia, D.L.; Lampman, G.M.; Kriz, G.S.; Vyvyan, J.R. (2007). Introduction to Spectroscopy, 4th Edition, Cengage Learning Products.
- Ball, D.W. (2009). The Basics of Spectroscopy, PHI Learning Pvt Ltd.
- Levine, I. N. (2008). Quantum Chemistry, 6th Edition, Prentice Hall.
- McQuarrie, D. A. (2007). Quantum Chemistry, 2nd Edition, University Science Books.
- Engle, T. (2012). Quantum Chemistry and Spectroscopy, 3rd Edition, Pearson.

C 31042/CHE 31042 - Electroanalytical Chemistry and Optical Spectroscopy

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: apply electroanalytical techniques for quantitative and qualitative analysis;

ILO2: comprehend the factors that must be controlled to obtain reliable and reproducible electroanalytical data;

ILO3: identify basic components in optical spectrometry;

ILO4: illustrate optical configurations in molecular absorption spectrometry;

ILO5: explain the concept of Fourier transform and FTIR instrumentation;

ILO6: employ signal to noise ratio in instrumental analysis.

Note: ILO means intended learning outcome.

1. Electroanalytical chemistry (12 h)

1.1 Electrodes and potentiometry; Reference electrodes: Calomel electrode, Silver/ silver chloride electrode, liquid junction potentials, double junction reference electrodes; Indicator electrodes: Metallic indicator electrodes; Metal electrodes of the first kind, second kind and redox electrodes; Membrane electrodes: Ion selective electrodes; Response and selectivity of ion selective electrodes; Ion selective electrodes of different types; Glass electrodes, solid state electrodes, liquid-liquid electrodes, precipitate electrodes, compound electrodes; Ion selective field effect transistors; Gas sensing probes; Direct potentiometric measurements; Potentiometric titrations.

1.2 Electrogravimetry and coulometric methods of analysis: Current-voltage relationship during electrolysis, Ohmic potential drop, concentration polarization, kinetic polarization, over potential, problems associated with two-electrode cells, three-electrode cells and control potential electrolysis.

1.3 Coulometry: Controlled working electrode potential Coulometry, Coulometric titrations, mediators.

1.4 Classical polarography and miscellaneous methods; Chemical analysis using polarography and its limitations; Modified polarographic techniques: Tast Polarography, normal and differential pulse polarography, square wave polarography.

1.5 Voltammetry: Anodic and cathodic stripping voltammetry, potentiometric stripping analysis; Potential sweep methods: Linear sweep and cyclic voltammetry at solid electrodes; Reversible, irreversible and quasi reversible voltammograms; Randles – Sevcik equation; Mechanistic studies using voltammetry; Amperometry: Amperometric titrations and biamperometry; Voltammetry under convection control; Introduction to convective systems; Hydrodynamic voltammetry;

Rotating disk electrode voltammetry; Levich equation; Rotating ring disk electrode voltammetry; Chemical analysis and mechanistic studies using rotating disk electrode voltammetry.

2. **Optical spectroscopy: Instrumentation (6 h)**

   Optical configuration of spectrometers, radiation sources: Thermal and photon emitters, properties of an ideal radiation source; Wavelength selection devices, absorption filters, interference filters, prism and grating monochromators, order sorting, resolution of a monochromator; Spectral bandwidth and effective spectral bandwidth; Transducers: Thermal and photon detectors, photo multiplier tubes, photoconductive cells, photodiode detectors, photodiode array detectors, charge transfer devices.

3. **Molecular absorption and luminescence spectrometry (UV-Vis) (4 h)**

   UV-Vis instrumentation: Single beam, double beam in space, double beam in time UV-Vis spectrometers; Radiation sources in UV-Vis spectrometry, photometric and spectrophotometric titrations; Stray light; Deviation of Beer's law; Instrumentation of luminescence spectroscopy; Absorption vs fluorescence; Collection of a fluorescence spectrum; Fluorimeters and spectrofluorometers; Basics of phosphorimetry.

4. **Vibrational spectroscopy: instrumentation (4 h)**

   IR sources, Transducers and detectors. Fourier-transform interferometry and Michelson interferometer; Sample handling in IR spectrometry; Direct IR and reflectance IR spectrometry; Attenuated total reflectance (ATR) and diffuse reflectance.

5. **Signal and noise in instrumental analysis (4 h)**

   Signal-to-noise ratio; Sources of noise in instrumental analysis; Instrumental noise: Thermal, shot and flicker noise; Environmental noise; Signal-to-noise enhancement: Grounding and shielding, modulation, synchronous demodulation; Averaging methods.

Methods of Teaching and Learning

A combination of lectures, tutorials and computer assisted learning

Recommended Readings

- Harris, D. C. (2010). Quantitative Chemical Analysis, 8th Edition, W. H. Freeman.
- Skoog, D. A.; Holler, F. J.; Crouch, S. R. (2007). Principles of Instrumental Analysis, 6th Edition, Thomson Brooks/Cole.
- Mendham, J. M. (2006). Vogels Textbook of Quantitative Chemical Analysis. 6th Edition, Pearson Education.
- Christian, G. D.; Dasgupta, P.; Schug, K., (2013). Analytical Chemistry, 7th Edition: Wiley Global Education.
- Robinson, J. W.; Frame, E. M. S.; Frame, G. M., (2004). Undergraduate Instrumental Analysis. 6 ed.; Taylor & Francis.
- Currell, G., (2008) Analytical Instrumentation: Performance Characteristics and Quality. Wiley.

C31051/CHE 31051 - Advanced Inorganic Chemistry Laboratory

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: acid-digestion and solvent extraction in inorganic analysis;

ILO2: precipitation/solvent extraction, cations/anions by ion exchange and paper chromatography for inorganic analysis;

ILO3: analyze natural samples qualitatively and quantitatively;

ILO4: apply techniques used in inorganic synthesis;

ILO5: analyze coordination complexes;

ILO6: apply chromatographic methods in inorganic chemistry.

Note: ILO means intended learning outcome.

Qualitative and quantitative analysis of mineral and clay samples; Precipitation/solvent extraction; Cations/anions by ion exchange chromatography for inorganic separations; Paper chromatography for identification of cations; Synthesis and analysis of coordination complexes.

Methods of Teaching and Learning

Pre-lab and post-lab assignments, Individual and group laboratory experiments, handling of UV-visible spectrophotometer, self-studying, record one of the synthesis carried out according to a given research paper

Recommended Readings

- Vogel's textbook of Quantitative Chemical analysis (2000), Prentice Hall.
- Harris, D.C. (2006) Quantitative Chemical Analysis, Freeman.
- Inorganic Experiments Edited by J. Derek Woolins, (2000) 3rd revised Edition, Wiley-VCH
- Sally A. Henrie (2015), Green Chemistry Laboratory Manual for General Chemistry, CRC press.
- Geoferey Pass, Haydn Sutcliffe Practical Inorganic Chemistry, Preparations, Reactions and instrumental methods, 2nd Edition, Springer Science + Business media, B.V.

C 31062/CHE 31062 - Environmental Chemistry

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: predict possible chemical processes occurring in the environment;

ILO2: assess quality of water, air and soil;

ILO3: explain chemistry involved in water purification techniques;

ILO4: analyze results by data processing of basic software packages.

Note: ILO means intended learning outcome.

1. **Aquatic chemistry (12 h)**

   Introduction to different aquatic systems, water quality parameters: pH, turbidity, BOD, COD and DO; metal speciation, pH-pE diagrams, water quality assessment methods, chemistry involved in water purification techniques for drinking, pollution and pollutants in aquatic systems, Effect of climate change on water sector and water conservation techniques.

2. **Atmospheric chemistry (10 h)**

   Introduction to atmosphere, acid rain, industrial and photochemical smog, indoor air pollution and noise pollution, air quality parameters, total suspended particle test, quantitative analysis of air pollution of CO_2, CO, SO_2, O_3, temperature and pressure profiles, chemistry of stratosphere and troposphere, Chapman mechanism, polar ozone depletion, one-box model, air pollutants, air quality assessment methods, sources and transformations of tropospheric and stratospheric aerosols and particulate matter.

3. **Soil chemistry (8 h)**

   Introduction to lithosphere, soil quality parameters, natural and anthropogenic soil pollution, soil quality assessment methods, solid waste and soil pollution.

Methods of Teaching and Learning

A combination of lectures, tutorials, field visit and computer assisted learning

Recommended Readings

- Girard J.E., Girrard J (2014), Principles of Environmental Chemistry, Jones &Barlet Learning.
- Manhan S.E., Environmental Chemistry, 3rd Edition (2012), Institute of Chemistry Publication.
- Sotheeswaran S, (2012) Environmental Organic Chemistry, 3rd Edition, Institute of Chemistry Publications; Monograph No.11.

C 31071/CHE 31071 - Analytical and Environmental Chemistry Laboratory

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: perform digestion and determination of atomic absorption analysis;

ILO2: determine of multiple compounds in a mixture using UV-Visible and FT-IR spectrometry;

ILO3: determine analyte concentrations using gas chromatography;

ILO4: carryout sampling, preservation and storage in a correct way;

ILO5: assess quality of water, air and soil;

ILO6: analyze results by data processing of basic software packages.

Note: ILO means intended learning outcome.

1. Analytical chemistry laboratory (20 h)

1.1. Determination of composition (NPK value) of fertilizer samples.

1.2. Colorimetric and visible spectroscopy: Determination of metal ions and adulterants in food.

1.3. FTIR: Determination of product tampering.

1.4. Atomic absorption spectroscopy: Determination of metal ions in industrial samples and vitamin tablets.

1.5. Gas chromatography: Deducing Henrys law constant and volatile organics.

1.6. Extracting oil from lemon peel using super critical carbon dioxide.

1.7. Voltammetry and electrochemical determinations.

2. Environmental chemistry laboratory (20 h)

Techniques for collection of environmental samples; Sample preparation and sample storage; Study of quality of fresh water, sea water, soil, industrial effluents and quality of air; Use of basic software packages for data processing and reporting of analytical results.

Methods of Teaching and Learning

A combination of laboratory classes, pre-laboratory and post laboratory assignments, field work, laboratory reports.

Recommended Readings

- Harris, D. C. (2010). Quantitative Chemical Analysis, 8th Edition, Macmillan.
- Mendham, J. (2006). Vogels Textbook of Quantitative Chemical Analysis, 6th Edition, Pearson Education, India.
- Cortés-Figueroa, J. E. (2003). Journal of Chemical Education.

- Lee, S. H.; Mukherjee, S.; Brewer, B.; Ryan, R.; Yu, H.; Gangoda, M. (2012). Journal of Chemical Education.
- Mendham, J. (2006). Vogels Textbook of Quantitative Chemical Analysis, 6th Edition, Pearson Education, India.
- A Laboratory Manual for Environmental Chemistry (2008), R. Gopalan , Amirtha Anand & R. Wilgred Sugumar.
- Laboratory Experiments in Environmental Chemistry (1999), D. Neal Boehnke, R. Del Delumyea.

C 31082/CHE 31082 - Polymer Science

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: compare different polymerization reactions;

ILO2: express the size of polymer molecules in terms of its molecular weight;

ILO3: identify the differences in behaviour and molecular structure of thermoplastic and thermosetting polymers;

ILO4: describe the crystallinity and associated defects in polymers;

ILO5: identify environmental hazards of polymer materials.

Note: ILO means Learning Outcome

1. **Polymer vs. simple molecules (3 h)**

   History of the development of polymers, hydrocarbon molecules, polymer molecules, chemistry of polymer molecules, classification of polymers, natural polymers vs. synthetic polymers, plastics vs. elastomers.

2. **Polymerization reactions and mechanisms (4 h)**

   Introduction to addition polymerization, condensation polymerization, ionic polymerization, coordination polymerization, copolymerization.

3. **Molar mass of polymers (5 h)**

   Molecular weight of polymers vs. simple molecules, number average molecular weight, weight average molecular weight, viscosity average molecular weight, polydispersity index, distribution of molecular weight of a typical polymer, practical importance of polymer molar mass.

4. **Microstructure of polymers (3 h)**

   Molecular shape of polymers, molecular structure of polymers, different types of polymer configurations, geometrical isomerism in polymers, different types of copolymers.

5. **Thermal behavior of polymers (3 h)**

   Thermoplastic and thermosetting polymers, thermal behaviour of polymers: glass transition temperature, crystallization temperature, melting temperature.

6. **Crystallinity of polymers (4 h)**

   Morphology of amorphous polymers and semi-crystalline polymers, polymer crystallinity, defects in polymer crystals.

7. **Thermodynamics of polymer mixing (6 h)**

   Polymer solutions and polymer blends, phase behavior of binary polymer solutions and

blends.

8. Environmental concerns of polymers (2 h)

Environmental problems caused by rubber and plastic wastes, potential procedures for solving those problems; refusing, reusing, recycling.

Methods of Teaching and Learning

Teacher centered teaching methods with multimedia assisted explanations, In-class group discussions, tutorials, Reading assignments

Recommended Readings

- Callister, W. and Rethwisch, D. Materials science and engineering. 9th Edition. ISBN : 978-1-118- 32457-8.
- Odian, G. (2004). Principles of polymerization. Hoboken, N.J.: Wiley-Interscience. ISBN: 978-0-471- 27400-1.
- Young, R. and Lovell, P. (2011). Introduction to polymers. Boca Raton: CRC Press. ISBN-13: 978- 0849339295.

C 31093 - Industrial Exposure

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: explain details of the Sri Lankan industrial setting;

ILO2: disseminate knowledge on local industrial activities;

ILO3: describe application of automated analytical sensors in industry;

ILO4: identify important quality control parameters associated with local industries;

ILO5: experimentally determine selected quality control parameters of industrial products.

Note: ILO means intended learning outcome.

1. **Industrial visits (32 field visit h)**

   Guided visits to selected industries in Sri Lanka, lectures by industrialists representing polymers and plastics, apparel & textiles, tiles and ceramics, herbal products, cosmetics, food and beverages; Waste management and treatment procedures used in industries; Value addition strategies.

2. **Dissemination of knowledge (50 notional h)**

   Report writing on selected industrial processes; Presentations on selected industrial processes.

3. **Industrial analytical sensors (10 h)**

   Design, development and applications of chemical sensors and biosensors with relevant examples from forensic science, medicine, automobile industry, security and defense, corrosion monitoring and space shuttle applications; Analytical determination in industrial processes and automation in industry.

4. **Laboratory experiments (30 h)**

   Quality control of various industrial products representing local industries, such as paint, food & beverages, textiles, cosmetics, soaps & detergents, polymers, pharmaceuticals, herbal products, ceramics, minerals, plastics, cement & concrete.

Methods of Teaching and Learning

Teacher centered teaching methods with multimedia assisted explanations, In-class group discussions, tutorials, Reading assignments

Recommended Readings

- L.S. Aft, Fundamentals of Industrial Quality Control, 3rd Edition, CRC Press, 1998.
- H. Baltes, Sensors: A Comprehensive Survey, Update 9, J. Wiley & Sons, 2001.
- J.S. Wilson, Sensor Technology Handbook, Newnes Publishers, 2005.

- K. Iniewski , Smart Sensors for Industrial Applications , 1st Edition, 2013.
- R.L. Droste and R.L. Gehr, Theory and Practice of Water and Wastewater Treatment, 2nd Edition, J Wiley & Sons, 2018.

C 32012/CHE 32012 - Advanced Topics in Physical Chemistry I

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: interpret electrochemical systems using fundamental theories;

ILO2: demonstrate the formation of electric double layer;

ILO3: discuss applicability of theoretical models on surface reactions;

ILO4: correlate free energy in thermodynamic systems.

Note: ILO means intended learning outcome.

1. Advanced electrochemistry (14 h)

The non-structural treatment of ion solvent interactions, Born model, thermodynamics of ion-solvent interactions, ion solvation and solvation number; Debye Hückel theory of ion-ion interactions, activity coefficient and ion-ion interaction, mean activity, limiting and extended forms of Debye-Huckel equation; Electrode-electrolyte interface, electrocapilary equation, experimental evaluation of surface excess, charge density and interfacial capacitance; Structure, theories and models of electrical double layer: Helmoltz-Perrin model, Gouy-Chapman model, Gouy-Chapman-Stern model, Grahame model, Bockris-Devanathan- Muller model, zeta potential; Kinetics of electrode reactions: One step-one electron process, standard rate constant and transfer coefficient, implications of the Butler-Volmer model for the one step-one electron transfer process: Equilibrium condition, exchange current, current over potential equation and characteristics, charge transfer resistance, Tafel plots.

2. Advanced surface chemistry (8 h)

Adsorption theories: Adsorption isotherms, isobars and isosteres, Gibbs and Langmuir adsorption isotherms and their applications, introduction to multilayer adsorption.

Drawbacks and inadequacy of the Langmuir and other simple adsorption models; variation of enthalpy of adsorption with coverage; multilayer physical adsorption; Brunauer-Emett-Teller (BET) adsorption isotherm; Determination of enthalpies of adsorption using isosteric, calorimetric and desorption energy methods; Use of Lennard-Jones potential energy diagram in understanding adsorption and desorption phenomena; Measurement of pressure; measurement of dose size; Determination of Knudsen number.

3. Advanced thermodynamics (8 h)

Free energy functions: Helmholtz free energy A and Gibbs free energy G; Spontaneity and reversibility; The four fundamental thermodynamic equations; Temperature, volume and pressure coefficients of ΔA and ΔG; Maxwell relationships; Thermodynamic equation of state; Gibbs-Helmholtz equation; Standard free energies; Univariant phase

transformations: Clapeyron and Clausius-Clapeyron equation; Colligative properties: Ebullioscopy and cryoscopy; Derivation of equation for free energy changes in general chemical reactions in terms of activity/fugacity; Relationship between standard free energy change and equilibrium constant, influence of temperature on equilibrium constant.

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning

Recommended Readings:

- Atkins, P.; de Paula, J. (2009). Physical Chemistry, 9th Edition, W H Freeman.
- Bard, A. J.; Faulkner, L.R. (2000). Electrochemical Methods, 2nd Edition, Wiley.
- Bockris, J. O. M.; Reddy. A. K. N. (1998). Modern Electrochemistry, 2nd Edition, Springer.
- Duncan Shaw (2013). Introduction to Colloid and Surface Chemistry, 4th Edition, Elsevier.
- Ott, J. B.; Goates, J. B. (2000). Chemical Thermodynamics Principles and Applications, 1st Edition, Academic Press.

C 32022/CHE 32022 - Advanced Chromatography

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: appraise principles, instrumentation, and operation and troubleshooting of gas chromatography and high performance liquid chromatography;

ILO2: compare different mass analyzers, detectors and different operations of mass spectrometry;

ILO3: appraise hyphenated chromatographic techniques in analysis;

ILO4: compare extraction and cleanup techniques for different residues;

ILO5: propose and justify analytical methodologies to determine an analyte in a given matrix;

ILO6: describe basic concepts;

Note: ILO means intended learning outcome.

1. Gas chromatography and high performance liquid chromatography (12 h)

1.1. Components and their functions of a GC

Gas-liquid chromatography and gas-solid chromatography; GC columns: Packed and open tubular columns: Wall-coated, support-coated and porous-layer open tubular columns; Polarities of open tubular columns, common stationary phases, typical column lengths; Sample injection in GC: Split, splitless and on-column injection; Carrier gasses in GC and the application of Deemter equation in GC; Retention index; GC detectors: Types of detectors, applications and sensitivities: Thermal conductivity, flame ionization, flame photometric, electron capture, nitrogen-phosphorus, etc.; Method development in GC analysis; GC troubleshooting.

1.2 Components and their functions in a HPLC system

HPLC columns: Packing material for reversed and normal phase HPLC, particle diameter, guard columns; HPLC mobile phases: Common mobile phases, mixed mobile phases, selecting a mobile phase, degasing of solvents; HPLC pumping systems: Basic requirements of the pumping system, types of pumps and advantages and disadvantages, reciprocation pump, displacement pump, pneumatic pump; HPLC sample injection: Six port injection valve and its mechanism; Extra column dispersion; HPLC detectors: UV-Vis detectors, fixed wavelength and multi wavelength detectors, fluorescence detectors, refractive index detectors, evaporative light scattering detectors; HPLC troubleshooting; densitometry, HPLC, FPLC, MPLC.

2. Other chromatographic methods (3 h)

Ion chromatography: Ion pair chromatography, ion exclusion chromatography, ion exchange chromatography, detectors in ion exchange chromatography, role of ion suppressors in ion exchange chromatography.

3. Molecular mass spectrometry (4 h)

Components of a mass spectrometer; Ionization methods: Electron impact, electro spray ionization, atmospheric pressure chemical ionization, desorption electro spray ionization and matrix assisted laser desorption ionization; Hard and soft ionization; Selecting a ion source. Mass analyzers: Quadrupole, time of flight, ion trap, magnetic sector and Fourier transform ion cyclotron resonance; Scan, selected ion monitoring and multiple reaction monitoring mass spectrometry; Tandem mass spectrometry: Triple quadrupole, quadrupole-time of flight mass spectrometers; Chromatography hyphenated with mass spectrometry: GC/MS,LC/MS, GC/MS/MS, LC/MS/MS.

4. Preparative chemical separation and chromatographic method development (6 h)

Benefits of sample preparation: Making the sample suitable for analysis, trace enrichment, elimination of matrix interferences and sensitivity enhancement; Overview of sample pretreatment process: Sample collection, storage and preservation, transport, preliminary sample processing, extraction and derivatization; Preliminary sample processing; Method validation: Extraction efficiency, matrix effect and method detection limit; Extraction of non-volatiles and semi-volatiles in liquid samples: Liquid-liquid extraction (LLE), discontinuous and continuous LLE; Solid phase extraction (SPE): Types of SPE, five steps of reversed phase SPE and dispersive SPE; Extraction of non-volatiles and semi-volatiles in solid samples: Solid-liquid extraction, soxhlet extraction, super critical fluid extraction and pressurized liquid extraction; Extraction of volatiles: Grab sampling, impinging, solid phase trapping, static headspace analysis, purge and trap, pyrolysis, solid phase micro extraction (SPME); Active and passive SPME.

5. Thermal analysis (5 h)

Thermogravimetry (TG) and derivative thermogravimetry (DTG), differential thermal analysis (DTA) and differential scanning calorimetry (DSC); Theoretical aspects of thermometric titrimetry, thermometric titration in non-aqueous systems; Catalymetric thermometric titrimetry; Aqueous system and the application in analysis of coloured industrial effluents; Direct injection enthalpimetry, unfavorable kinetics and the development direct injection enthalpimetry (DIE); Applications of DIE in clinical area.

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning.

Recommended Readings

- Harris, D. C. (2010). Quantitative Chemical Analysis, 8th Edition, W. H. Freeman,
- Skoog, D. A.; Holler, F. J.; Crouch, S. R. (2007). Principles of Instrumental Analysis, 6th Edition, Thomson Brooks/Cole.
- Majors, R. (2013). Sample Preparation Fundamentals for Chromatography. Agilent Technologies, Mississauga.
- Arsenault, J. C. (2012). Beginner's Guide to SPE: Solid-phase Extraction.

C 32032/CHE 32032 - Research Methodology

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:
ILO1: develop a research proposal for an identified research problem;
ILO2: carry out a complete literature survey;
ILO3: interpret the research data using statistical tools;
ILO4: identify the requirement for scientific writing;
ILO5: cite references in a scientific document using a proper style;
LO6: identify the ethical issues with respect to research.
Note: ILO means intended learning outcome.

1. **Scientific method**

   Identification of a problem, building a hypothesis, designing experiments to test the hypothesis, analyze data, interpret data, draw conclusions, publish results.

2. **Literature survey**

   Search scientific literature, critical understanding, and organize collected information.

3. **Scientific writing**

   Identify major components in a research paper, details to be included in each section.

4. **Research proposal writing**

   Major components to be included in a research proposal.

5. **Research ethics**

   Practical applications of statistics, graphing, spreadsheet analysis, multi-variant analysis.

6. **Data analysis**

   Honesty, objectivity, integrity, openness, respect for intellectual property, confidentiality, authorship of a publication.

7. **Research presentations**

   Writing a dissertation/publication and an oral presentation in a scientific way.

Methods of Teaching and Learning
Lectures, tutorials, assignments, self-studying, Group work

Recommended Readings

- The ACS Style Guide: effective Communication of Scientific information, An American Chemical Society presentation.
- Anne M Coghill, Lorrin R Garson. (2006). American Chemical Society.

C 32042/CHE 32042 - Advanced Organic Chemistry Laboratory

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: synthesize heterocyclic compounds and carry out a photochemical reaction;
ILO2: identify natural products using chromatographic and spectroscopic techniques;
ILO3: apply environmental friendly methodologies in the organic synthesis;
ILO4: present results of the group assignments based on natural products;
ILO5: prepare a report and a presentation on the chemical processes involved in the manufacture of products of a particular industry.

Note: ILO means intended learning outcome.

1. **Synthesis heterocyclic compounds.**
2. **Photochemical reactions in organic synthesis.**
3. **Column and preparative plate chromatography to separate organic compounds.**
4. **Microwave assisted synthesis of organic compounds.**
5. **Phytochemical screening for classes of natural products (alkaloids, steroids, terpenoids, flavonoids and saponins).**
6. **Visits to chemical based and natural product industries; Group assignment based on visits.**

Methods of Teaching and Learning

A combination of laboratory classes, combination of pre-laboratory and post laboratory assignments, laboratory reports.

Recommended Readings

- Schoffstall, A. M.; Barbara, B. A.; Gaddis, A.; Druelinger, M.L.; Schoffstall, A.; Gaddis, B.; Druelinger, M. (2004). Microscale and Miniscale Organic Chemistry Laboratory Experiments, 2nd Edition, Mc- Grawhill.
- Pavia, D.L.; Lampman, G.L.; Kriz, G.S.; Engel, R.G. (1999). Introduction to Organic Laboratory Techniques: A Microscale Approach, 3rd Edition, Brooks/Cole.
- Moting, J. R.; Mofrrill, T. C.; Hammond, C. N.;Neckers, D. C. (1999). Experimental Organic Chemistry, Freeman.
- Williamson, K.L. (1994). Macroscale and Microscale Organic Experiments, 2nd Edition, Heath and Company.

C 32052/CHE 32052 - Advanced Physical Chemistry Laboratory

Intended Learning Outcomes

At the end of the course unit student will be able to:

ILO1: perform experiments to determine thermodynamic and kinetic parameters;

ILO2: simulate experimental data using computational modeling;

ILO3: compare various experimental methods and results;

ILO4: obtain hands on experience on different instruments used in physical chemistry laboratory;

ILO5: apply computer based software to analyze data.

Note: ILO means intended learning outcome.

Experiments on,

1. Chemical kinetics.
2. Thermodynamics.
3. Phase equilibria.
4. Electrochemistry: Conductometry, potentiometry, voltammetry.
5. Spectrometry (Colorimetry).
6. Computational chemistry and quantum chemistry.
7. Surface and colloid chemistry.

Methods of Teaching and Learning

16-18 practical sessions and two practical assessments, practical reports

Recommended Readings

- Shoemaker, D. P., Garland, C. W., & Nibler, J. W. (1996). Experiments in physical chemistry. New York: McGraw-Hill.

C 32061/CHE 32061 - Seminar Presentation and Report Writing

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: survey scientific literature critically;

ILO2: prepare an overview of the relevant literature for a specific research topic;

ILO3: deliver a scientific presentation.

Note: ILO means intended learning outcome.

Search, select and gather information and organize information on a given topic selected by an academic staff member; Prepare a suitable presentation and present it to an audience of academics; Submission of a survey report.

Methods of Teaching and Learning

Literature survey, self-study, small group discussion, use of feedback from appointed academic staff member.

Recommended Readings

- A review article on a selected topic, identified by a senior academic staff member and other related literature.
- Text books, research papers, review articles related to a given topic.

S 32072/ALS 32072 - Basic Chemical and Process Engineering

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: apply mass and energy balances for simple practical systems;

ILO2: estimate the mass transfer in binary systems;

ILO3: estimate the heat transfer in simple industrial applications;

ILO4: describe applications, equipment, and theory related to unit operations, such as distillation, drying, mixing and extraction.

Note: ILO means intended learning outcome.

1. **Introduction**

   Concepts in unit operations, mass and energy balance.

2. **Mass transfer theory**

   Fick's law and two film theory with applications.

3. **Heat transfer**

   Modes of heat transfer (conduction, convection and radiation) with applications.

4. **Distillation**

   Principle of binary distillation; Application of McCabe Thiele method for sizing binary distillation column.

5. **Drying**

   Drying theory, use of psychrometry, calculation of drying time, drying equipment.

6. **Fluid flow**

   Bernoulli's equation and its applications, selection of pumps for a given application.

7. **Extraction**

   Liquid-liquid extraction, solid-liquid extraction, equipment and their selection according to the use.

8. **Mixing and agitation**

   Principle of mixing, equipment used and sizing.

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning.

Recommended Readings

- Grant R. Fowles, Introduction to Modern Optics, Dover, 1975.
- Eugene Hecht, Optics, 4th Edition, 2001.
- Hugh, Young; Roger Freeman (2013), Sears & Zemansky's University Physics with Modern Physics (13th Edition). Pearson Education.
- James J. Brophy, Basic Electronics for Scientists,1983.

APM 32082 - Innovation and New Product Development

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: identify importance of new product development to organizational performance;

ILO2: describe the marketing and technology interface in the process of innovation;

ILO3: demonstrate the ability to apply the methods of generating, evaluating and testing the product ideas and bringing them into the market.

Note: ILO means intended learning outcome.

1. **Unit I (5 h)**

   Types of new products; New products & product life cycle; Product platforms; The innovation process.

2. **Unit II (5 h)**

   Market creation; Market disruption; Stage-gate process; Assessing market potential.

3. **Unit III (20 h)**

   Idea generation methods; Concept development; Product positioning; Industrial design; Product architecture; Prototyping; Product and market testing; Product launch.

Methods of Teaching and Learning

Lectures, assignments, case studies, mini-projects

Recommended Readings

- Paul, T (2010), Innovation Management and New Product Development, 4th Edition, Pearson.
- Ettlie, J E (2010), Managing Innovation: New technology, new products and new services on a global economy, 2nd Edition, Butterworth-Heinemann.
- Material provided in CAL.

C 32092 -
Chemical Laboratory: Design, Operation and Management

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: design different types of chemical laboratories;

ILO2: demonstrate knowledge on laboratory record keeping;

ILO3: analyze experimental measurements and present results;

ILO4: calibrate laboratory glassware;

ILO5: explain standardization procedures of laboratory instruments;

ILO6: follow accreditation procedures.

Note: LO means Learning Outcomes

1. **Laboratory design (10 h)**

   Different types of laboratories and BSL classifications; Design of different types of laboratories; Customization of laboratory depending on type of analysis; Storage of chemicals/samples; Selection of laboratory glassware and instrumentation; Ventilation and pressure gradients; Legal requirements and approval from various authorities to function; Preparation for laboratory leadership.

2. **Laboratory sustainability (4 h)**

   Documentation, procurement procedures; Human resource development and technical management; Laboratory ethics.

3. **Data handling, representation and reporting (4 h)**

   Methods of data representation: Tabulation, linear and nonlinear correlations, bar graphs, pi-charts; Systematic reporting of experimental results; Examples from industrial applications.

4. **Calibration and standardization aspects (8 h)**

   Sampling for multipurpose analysis; Standardization methods: traceability, standard reference materials (SRM) and certified reference materials (CRM); Quality control and quality assurance; Calibration of glassware/instruments, basic electronics; Method validation and development.

5. **Introduction to laboratory accreditation (4 h)**

   ISO 9001 (General Management Systems), ISO 17025 (Testing and Calibrating Laboratories), ISO 15189 (Medical Laboratories).

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning

Recommended Readings

- B. Griffin, Laboratory Design Guide, 3rd Edition, Architectural Press Publications, 2005.
- C.A. Kinkus, Laboratory Management: Quality in Laboratory Diagnosis , Demos Medical Publishing, 2012.
- L.J. DiBerardinis, J.S. Baum M.W. First G.T. Gatwood and A.K. Seth, Guidelines for Laboratory Design: Health, Safety, and Environmental Considerations, 4th Edition, John Wiley & Sons, 2013.
- S. Sanders, Your Practical Guide to Basic Laboratory Techniques, Custom Publishing, 2018.
- D.M. Harmening, Laboratory Management: Principles and Processes, 2nd Edition, 2020.

LEVEL 4

C 41022/CHE 41022 - Advanced Inorganic Chemistry II

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: explain substitution reactions in square planar and octahedral complexes;

ILO2: predict possible electron transfer reactions between octahedral complexes;

ILO3: explain role of metals in biological systems;

ILO4: postulate structures of cluster compounds and thereby predict properties.

Note: ILO means intended learning outcome.

1. Kinetics and mechanisms of inorganic reactions (14 h)

1.1 Introduction to kinetics and mechanisms: Stoichiometric and intimate mechanisms related to substitution reactions of square planar and octahedral complexes (A, D, Ia, Id), kinetic and thermodynamic aspects of reactivity of complexes; Activation parameters.

1.2 Substitution reactions of square planar complexes: General rate law, intimate mechanisms, factors affecting rates of square planar substitution reaction.

1.3 Substitution reactions of octahedral complexes: Water exchange, acid hydrolysis, base hydrolysis and anation reactions, rate laws and their interpretation, Eigen-Wilkins mechanism, leaving and entering group effects, effects of spectator ligands, steric effects, effect of charge, stereochemical changes in octahedral substitution; Mechanism of isomerization.

1.4 Electron transfer reactions between octahedral complexes: Elementary steps and rate expressions for outer sphere and inner sphere mechanism, Frank Condon principle, Marcus Theory.

1.5 Reaction mechanisms of organometallic systems: Oxidation addition reaction, reductive elimination reactions, insertion reaction, ligand substitution reactions.

2. Bioinorganic chemistry (10 h)

2.1 Introduction: Role of metals in biological systems, speciation and specificity of metal complexes in vivo.

2.2 Transition metals in biological redox reactions: General mechanism of electron transfer, blue copper proteins, iron sulphur proteins, cytochromes, photosynthetic pathway.

2.3 Dioxygen carriers: Dioxygen complexes of transition elements, haemoglobin, nature of haem dioxygen binding, model system; transition metals in biological redox reactions.

2.4 Distribution and functions of metals in vivo: Storage and transport of iron, chemistry and biochemistry of nitrogen fixation, Mechanisms & action of zinc, copper, cobalt

and molybdenum containing enzymes, enzyme containing vanadium, chromium and nickel

3. Advanced molecular polyhedra (6 h)

Metal clusters, capping rule, isolobal anology, ^{11}B NMR and ^{1}H NMR of simple boron hydrides.

Methods of Teaching and Learning

Lectures, tutorials, group discussions and computer assisted learning.

Recommended Readings

- Cartherine E Housecroft and Alan G Sharpe (2012), Pearson, England, Inorganic chemistry, 4th edition.
- Shriver and Atkins (2010), Inorganic Chemistry, 5th edition.

C 41023/CHE 41023 - Advanced Spectroscopy, Synthesis and Photochemistry

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: elucidate the structure of complex molecules using different pulse sequences in NMR spectroscopy;

ILO2: elucidate the structure of an organic molecule;

ILO3: predict the products of a photochemical reaction;

ILO4: design synthetic pathways using modern reagents in synthesizing a target molecule;

ILO5: design a retro-synthetic pathway for a target molecule.

Note: ILO means learning outcome

1. Advanced organic spectroscopy (18 h)

1H NMR: First order spectra, deuterium exchange, isotopic peaks, FID, instrumentation, complex splitting patterns of ^{1}H NMR and J values, NMR of homotopic, enantiotopic and diastereotopic protons, AB, ABC, ABX and AMX spin systems; Non-first order spectra; C NMR: solvent peak, simplification of ^{13}C NMR, proton decoupled spectra, double quantum, single quantum and zero quantum spin relaxations, NOE, population inversion, different types of ^{13}C NMR spectra, NOEDIFF, INEPT, APT, DEPT experiments, 2D NMR; COSY, ROSY, TOCSY, HECTCOR, HSQC, HMBC, NOESY, ROSEY; Mass spectrometry: Ionization methods, GCMS, LCMS, HRMS, fragmentation patterns of selected classes of organic compounds; Joint application of spectroscopic techniques in structure elucidation of organic molecules.

2. Photochemistry (9 h)

Selection rules, Jablanski diagram, singlet and triplet excited states, quenching, energy transfer, triplet sensitization; mechanism of photochemical reactions, secondary reactions, photochemical reactions of carbonyl compounds: Norrish Type I and II reactions, photooxidations, photoreductions, photocycloadditions and photo rearrangements -di-pi-methane rearrangement; industrial and biological application of photochemical reactions.

3. Advanced organic synthesis (18 h)

Use of P, B, S, and Si in organic synthesis; free radical reactions in C-C bond formations; Modern reagents in synthetic organic chemistry: Oxidation and reduction, organometallic compounds; Protection/deprotection groups in organic synthesis; Disconnection approach to organic synthesis: Retrosynthetic approach, concept of synthon, synthetic equivalent, functional group inter conversion, regioselectivity, chemoselectivty, stereospecificity and stereoselectivity, control, activation and protection, one group disconnections, two-group

disconnections, illogical two-group disconnections; Target molecule synthesis; Umpolung synthesis.

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning.

Recommended Readings

- Williams, D. H.; Fleming I. (2007). Spectroscopic Methods in Organic Chemistry, 6th Edition, McGraw- Hill Education.
- Silverstein, R.M.; Webster, F. X.; Keimle, D. J.; Bryce, D. L. (2014). Spectrometric Identification of Organic Compounds, 8th Edition, John Willey.
- Coyle, J. D., (1986) Introduction to Organic Photochemistry, John Wiley.
- McMurry, J. E. (2015). Organic Chemistry, 9th Edition, Brookes Cole.
- Smith, M. B.; March, J. (2001). Advanced Organic Chemistry-Reactions, Mechanisms and Structure, 5th Edition, Wiley Inter-science.
- Carruthers, W. (1996). Modern Aspects of Organic Synthesis, Cambridge press.

C 41032/CHE 41032 - Advanced Topics in Physical Chemistry II

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: describe fugacity and chemical potentials of open systems;

ILO2: predict macroscopic thermodynamic properties using partition functions;

ILO3: determine IR and Raman active modes using character tables.

Note: ILO means intended learning outcome.

1. **Chemical thermodynamics (10 h)**

   Open systems: Partial molar properties, Gibbs-Duhem equation; Chemical potential and its variation with temperature and pressure, application of free energy change for a general reaction; Fugacity with special reference to gaseous system: Determination of fugacity in gaseous mixture; Activities and activity coefficients; Third Law of thermodynamics, determination of the third law entropies, Debye T3 Law, comparison of spectroscopic and colorimetric properties, the molecular basis of entropy, Boltzmann Planck equation.

2. **Statistical thermodynamics (10 h)**

   Introduction to statistical thermodynamics, quantum mechanical picture of a system of non-interacting particles, configuration, weight of a configuration, distinguishable and indistinguishable particles, Boltzmann Factor, molecular partition function, translational and vibrational partition functions, concept of ensemble, definitions of canonical, micro-canonical and grand–canonical ensembles, internal energy, statistical entropy.

3. **Symmetry and group theory (10 h)**

   Applications of molecular symmetry, group multiplication and character tables, two dimensional irreducible representations, predict IR/Raman modes.

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning

Recommended Readings:

- Ott, J. B.; Goates, J. B. (2000). Chemical Thermodynamics Principles and Applications, 1st Edition, Academic Press.
- Seddon, J.M. and Gale,J.D. (2004). Thermodynamics and Statistical Mechanics. RSC Publications.
- Terrell L. Hill. Introduction to Statistical Thermodynamics, Dover Publications.
- "Advanced Chemical Thermodynamics" CHU 3030, Open University of Sri Lanka.

C 41042/CHE 41042 - Frontiers in Chemistry

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: design synthesis of 2D, 3D MOFs based on the requirement;

ILO2: classify the host guest compounds;

ILO3: identify the main intermolecular forces in supramolecular chemistry LO4: describe self-assembly in supramolecular chemistry;

ILO5: suggest analytical methods for supramolecular chemistry;

ILO6: apply principles of green chemistry and concepts of cleaner production.

Note: ILO means intended learning outcome.

1. Metal organic frameworks (MOF) (10 h)

1.1 Introduction: Framework solids: silicates, zeolites, aluminophosphates; Definition, nomenclature and classification of metal-organic frameworks (MOF´s).

1.2 Synthesis and properties: Geometrical and structural versatility of inorganic node, synthesis of MOF, two- versus three-dimensional frameworks, regular networks of p-block elements, physico-chemical properties and catalytic applications of MOF .

1.3 Applications: Multivariate metal organic frameworks (MTV-MOF), post-synthetic modification, molecules encapsulation in MOF´s and its applications – molecular gas cylinders (e.g. hydrogen, methane, acetylene), drug carriers (e.g. ibuprofen); Bulk heterojunction organic solar cells.

2. Advanced supramolecular chemistry (10 h)

2.1 Introduction to supramolecular chemistry: Concepts of supramolecular chemistry; cation- anion- and neutral molecules binding hosts; Nature of supramolecular interactions; Supramolecular chemistry of fullerenes.

2.2 Self-assembly and synthesis: Self-assembly processes in organic systems; Catenanes, rotaxanes, pseudorotaxanes, calaxarenes; Synthetic strategies for their preparation; Main supramolecular forces involved in such assemblies, examples for each type: self-assembling coordination compounds, hydrogen bond self-assemblies, cyclodextrins as mimic.

2.3 Designing and analysis: Concepts in anion host design, binding of neutral molecules, solid state clathrates, intracavity complexes, receptors with stronger interactions, methods of analysis of supramolecules: Microscopy, NMR, UV-VIS, CD, IR, potentiometry.

3. Biochar and its applications in water remediation and agricultural soil amendments (10 h)

Introduction to biochar, production and characterization of biochar, sorption mechanisms, sorption kinetics, thermodynamics and isotherms of biochar, post modification methods, biochar in agricultural soil amendment.

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning.

Recommended Readings

- Balzani, V.; Venturi, M.; Credi, A. Molecular Devices and Machines, Schneider, H.-J.; Yatsimirski, A. Fransisco J Yndurain, (2016), 4th edition, The Chemistry of Metal–Organic Frameworks: Synthesis, Characterization, and Applications, Springer.
- Principles and Methods in Supramolecular Chemistry, Wiley 2000 Wiley VCH 2003.
- Steed, J. W.; Atwood, J. L., Supramolecular Chemistry, Wiley 2000.
- Biochar- industry standard knowledge which is delivered to the students on case by case.

C 41052/CHE 41052 - Advanced Biochemistry

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: explain the mechanisms of ribonuclease, lysozymes and bimolecular enzyme reactions, inhibition kinetics;

ILO2: explain the metabolic pathways involved in microbial carbohydrates, sulphur containing amino acids, and glycerophospholipids;

ILO3: describe photosynthesis;

ILO4: describe changes in DNA that lead to disease development;

ILO5: describe qualitative analysis and sequencing of proteins;

ILO6: explain the action of antibiotics in preventing diseases and molecular changes related to overcoming resistance.

Note: ILO means intended learning outcome.

1. Mechanism of enzyme action and kinetics (6 h)

Mechanism of action of ribonuclease and lysosyme; Bimolecular mechanisms of enzyme reactions; Enzyme kinetics: Enzyme inhibition Ki value using Eadie-Hoftsee and Woolfplots including applications.

2. Microbial and plant metabolism (6 h)

Microbial carbohydrate metabolic pathways: Glyoxalate cycle, enter Duodoroff pathway, acetone-butanol fermentation; Distinguishing pathways of glucose utilization; Metabolism of sulfur containing amino acids, synthesis of cysteine and methionine in plants and bacteria; Shikimic acid pathway, microbial production of glutamate.

3. Photosynthesis (2 h)

Light reactions; Calvin cycle; C-3 and C-4 plants.

4. DNA replication, damage and repair (6 h)

Agents that cause damage to DNA and types of damage; Repair mechanisms: Natural mechanisms available for the repair of damaged DNA; DNA mutations: Basics of DNA mutations and their effects, mutations that cause cancer; DNA replication; Ttranscription and translation of prokaryotes and eukaryotes.

5. Protein structure (4 h)

Determination of amino acid composition of a given protein [ortho-phthaldehyde (OPA) or fluorescamine derivatization]; Edman sequencing (N terminal analysis) of a (enzymatic or chemical digestions, peptide overlapping) single chain protein; Sequencing of a protein with more than one polypeptide chain; Methods of C terminal analysis.

6. Action of antibiotics (6 h)

Classification of antibiotics; Main mechanisms of antibiotic action (inhibition or regulation of enzymes involved in cell wall biosynthesis, nucleic acid metabolism and repair, or protein synthesis, and mechanism involves the disruption of membrane structure); Functional group modification to antibiotic molecules (e.g. derivatives of penicillin).

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and referencing selected articles

Recommended Readings:

- Mathews, C. K.; van Holde, K.E. Aharen, K.G. (1999). Biochemistry, 3rd Edition, Pearson.
- Voet, D.; Voet, J. G.; Pratt, C. W. (2012). Fundamentals of Biochemistry, 4th Edition, Wiley.
- Devlin, Thomas M. (Editor) (2011). Text Book of Biochemistry with Clinical Correlations, John Wiley, New York.
- Becker, W.M.; Kleinsmith L.J.; Hardin, J. (2002). The World of the Cell, 5th Edition, Benjamin Cummmings.
- Nelson, D.L.; Cox, M.M. (2008). Lehninger Principles of Biochemistry, W.H. Freeman and Company Book.
- Rodwell, V.; Bender D.; Botham K.M.; Kennely, P.; Well, P.A. (2014). Harpers Illustrated Biochemistry, 30th Edition, McGraw –Hill Education.
- Mathew, C. D. Enzymes, Ananda Press.

C 41172 - Nanotechnology

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: provide an overview of different nanomaterials and their uses;

ILO2: explain physicochemical characteristics of nanomaterials;

ILO3: describe preparation of nanomaterials;

ILO4: identify suitable characterization techniques and their advantages/disadvantages;

ILO5: summarize applications of nanoscience and nanotechnology in Sri Lankan industries.

Note: ILO means intended learning outcome.

1. Introduction (6 h)

Nanotechnology timeline and milestones, overview of different nanomaterials available, potential uses of nanomaterials in electronics, robotics, computers, sensors in textiles, sports equipment, mobile electronic devices, vehicles and transportation; Medical applications of nanomaterials.

2. Nanochemistry (8 h)

2.1 Novel physical chemistry related to nanoparticles, such as colloids and clusters, different equilibrium structures, quantum effects, conductivity and enhanced catalytic activity compared to the same materials in the macroscopic state; Exploitation of self-assembly and self-organization to design functional structures in 1D, 2D or 3D structures.

2.2 "Top-down" and "Bottom-up" approaches of nanomaterial (nanoparticles, nanoclusters and quantum dots) synthesis; Top-down techniques; Photolithography, other optical lithography (EUV, X-Ray, LIL), particle-beam lithographies (e-beam, FIB, shadow mask evaporation), probe lithographies; Bottom-up techniques: self-assembly, self-assembled monolayers, directed assembly, layer-by-layer assembly; Pattern replication techniques: soft lithography, nanoimprint lithography; Pattern transfer and enhancement techniques: dry etching, wet etching, pattern growth techniques (polymerization, directed assembly); Combination of Top-down and Bottom-up techniques; Current state-of-the-art in nanotechnology.

3. Characterization techniques for nanomaterials (8 h)

Compositional surface analysis: XPS, SIMS, contact angles; Microscopies: Optical microscopy, fluorescence and confocal microscopy, TEM, SEM; Probe techniques: Scanning tunneling microscopy (STM), atomic force microscopy (AFM), scanning nearfield optical microscopy (SNOM), scanning ion conducting microscopy (SICM); Ellipsometry; Neutron scattering and XRD; Spectroscopic techniques: UV-visible, FT-IR, Raman, NMR, ESR; Electrochemical techniques: Voltammetry, AC impedance analysis.

4. Applications of nanomaterials in local industries (8 h)

Garment Industry: Smart textiles with antimicrobial properties, stain-resistant properties, mosquito-repellent properties, nanosensors to detect body temperature, pressure, pulse rate, and so on; Rubber industry: Clay-rubber nanocomposites, carbon nanotube-rubber nanocomposites; Activated carbon industry: Applications of activated carbon nanostructures in supercapacitors, gas separation, catalysis; Local minerals for advanced industries: Graphite, ilmanite, quartz, mica, rutile, zircon, feldspars, gems, etc.; Electronics industry: Solar cells, electronic components, light-emitting diodes, liquid-crystal display devices, electronically conducting polymers, ionically conducting polymers, batteries, fuel cells.

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning.

Recommended readings:

- Rao, M. S. Ramachandra, Nanoscience and Nanotechnology: Fundamentals of Frontiers India Wiley India Private Limited, 2013.
- Ashby, Michael F., Nanomaterials, Nanotechnologies and Design Amtradam Elsevier, 2009.
- Nanotechnology: Basic Science and emerging technology, Mike Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkhard Raguse, CRC Press 2002.
- Nanotechnology: Gregory L Timp, Springer Science and Business media, 1999.
- Nanotechnology: importance and Applications, MH Fulekar, IK International PVT Ltd, 2010.

C 41093/CHE 41093 - Food Chemistry and Technology

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: describe the nature of food components;
ILO2: explain principles of food preservation;
ILO3: apply technologies used to process and manufacture different food products;
ILO4: describe standards used in the food industry;
ILO5: apply safety regulations and quality management;
ILO5: suggest methods to analyze different food items.

Note: ILO means intended learning outcome.

1. Food Chemistry:

1.1 Carbohydrates (3 h)

Occurrence of monosaccharides, disaccharides and polysaccharides in food, their properties and industrial uses; Structure and properties of starch, gelatinization of starch, structure and properties of pectins, gel formation in pectins and uses of pectins in food industry; Food gums, Maillard browning and caramelization reactions; Analysis of carbohydrates in food.

1.2 Proteins (2 h)

Chemistry of amino acids, peptides and proteins with reference to proteins in milk, meat, fish, eggs and wheat, Iso-electric point and its importance in food manufacture; Denaturation of proteins and its effect on food; Determination of proteins in food (Kjeldhal method, chromatographic methods).

1.3 Lipids (2 h)

Occurrence of fats and oils in food, structure and properties of saturated and unsaturated fatty acids in food items, deterioration of fats and oils in food, hydrolytic and oxidative rancidity, chemistry of rancidity and role of antioxidants, determination of saponification value, iodine value, acid value, peroxide value and their importance

1.4 Vitamins and minerals in food (2 h)

Occurrence, food sources and properties of water soluble and fat-soluble vitamins, stability of vitamins during processing and storage, minerals and trace elements in food; Analysis of vitamin C in food; instrumental methods for the analysis of trace elements present in food.

1.5 Sensory properties of food (3 h)

Natural pigments and flavour compounds in food - flavor and coloured compounds; Structural features of carotenoids, anthocyanins, porphyrins (chlorophyll and heme) and curcumins, occurrence and changes during cooking and processing.

1.6 Food additives (2 h)

Preservatives, antioxidants, artificial colours, emulsifiers and stabilizers, flavor enhancers, analysis of food additives; food adulteration.

2. Food spoilage and food preservation (4 h)

Perishability of food related to composition of milk, meat. cereals, nuts, fruits and vegetables, water activity, acidic and non-acidic foods, factors that cause spoilage, chemical and biochemical changes that can occur in food during food manufacturing and processing, methods of controlling spoilage, principles of food preservation, packaging technology.

3. Food quality and safety (4 h)

Standards and food quality management, food safety and regulations.

4. Food Technology (8 h)

4.1 Food processing and preservation technology:

Food processing methods – Heat preservation, dehydration, concentration, freezing, refrigeration, minimal processing, chemical preservation Dairy technology, technology of cereals, technology of fish & meat products, technology of fruits and vegetables, Bakery technology, Confectionary technology

4.2 Technology of spices, essential oils and flavors:

Sri Lankan spices, processing methods, physical and chemical characteristics, unique characteristics, production of essential oils, production of oleoresins, Quality assurance, methods of determinations.

5. Food Chemistry and food technology practical

Proximate analysis of food; Determination of reducing sugars in food; Kjeldahl determination of proteins; Determination of saponification value; Acid value and peroxide value of fats and oils; Analysis of Vitamin C in fruits and vegetables; Determination of minerals in food using AAS and UV spectrophotometry; Bakery technology; Fruit and vegetable technology (Dehydration methods, solar drying).

Methods of Teaching and Learning

Lectures, tutorials, industrial visits, computer assisted learning, laboratory work, group work, Industrial visits

Recommended Readings

- T.Coultate (2009), Food, the chemistry of its components 5th Edition. RSC Publication.
- Nandanie Ediriweera (2016), Food Science & technology Vol 1, S. Godage Bros.
- Nandanie Ediriweera (2016), Food Science & Technology Vol 2, S. Godage Bros.

C 43016/CHE 43016 - Research Project

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: identify a research problem;

ILO2: conduct a literature survey to a related research problem;

ILO3: design and conduct a research project in chemistry/chemistry-related area following scientific methods;

ILO4: interpret the results;

ILO5: write a dissertation;

ILO6: present research findings to a scientific community.

Note: ILO means intended learning outcome.

The following components will be evaluated:

1. Literature survey, proposal writing.
2. Laboratory and/or field work.
3. Data analysis and interpretation.
4. Dissertation, oral presentations.

Methods of Teaching and Learning

Literature survey, Proposal writing, laboratory and/or field work, data analysis and interpretation, writing a dissertation, oral presentations

APM 41062 - Project Management

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: explain how to initiate, specify, and prioritize projects and to determine various aspects of feasibility;

ILO2: explain the foundations of project management, including its definition, scope, and the need for project management in the modern organization;

ILO3: explain the phases of the project management lifecycle;

ILO4: assess different issues that lead to project failures and addressing them;

ILO5: assess the differences between IT/IS projects and general projects.

Note: ILO means intended learning outcome.

1. **Introduction to project management, organizational structures for projects, project selection, defining a project.**
2. **Organizational structures, project times and costs, developing a project plan, project management life cycle.**
3. **Risk management, scheduling of resources, measuring and evaluating performance, project auditing, winding up of projects.**
4. **Introduction to IT project management.**

Methods of Teaching and Learning

Lectures, case discussions and computer assisted learning

Recommended Readings

- Kloppenborg, T (2008),Contemporary Project Management,Cengage Learning.
- James, P Cand Jack, G (2008),Effective Project Management, 3rd Edition, Cengage Learning.
- Meredith, J R and Samuel, J M J (2008),Project Management, A Managerial Approach, 5th Edition, John Wiley & Sons, Inc

CHE 42012 - Molecular Modeling and Molecular Simulations

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: apply electronic structure calculation for small molecules to predict their physical properties

ILO2: describe geometry optimization through energy minimization techniques.

ILO3: simulate macromolecules using molecular dynamics and Monte-Carlo methods

ILO4: estimate binding free energies of receptor ligand complexes

Note: ILO means Intended learning outcome

1. **Electronic Structure Calculations (08 hrs)**

   ab initio, semi empirical and density functional theory calculations; potential energy surfaces, normal modes, and finding transition states; calculate physical and chemical properties of small molecules.

2. **Molecular Mechanics (06 hrs)**

   Potential energy functional forms; molecular mechanics force field of a molecular system; geometry optimization: Simplex, Steepest decent, and conjugate gradient methods; Use of optimization in molecular system.

3. **Molecular Dynamics & MC simulations (06 hrs)**

   Introduction to molecular simulation; Monte Carlo simulation and determining chemical and physical properties; molecular dynamics simulation and determining chemical and physical properties; introduction to Coarse grain and multiscale simulations.

4. **Experiments in Molecular Modelling (20 hrs (P))**

   Numerical differentiation and numerical integration using Microsoft excel or other software; protein visualization and explore the active site using VMD software; homology modeling and BLAST search Molecular docking and virtual screening; Computer aided drug designing, building small molecules using GUIs and Z- matrix with correct symmetry. Geometry optimization and vibrational analysis of small molecules using ab initio, DFT and semi empirical methods; introductory molecular dynamic practical, mini project.

Methods of Teaching and Learning

A combination of lectures, course work, discussions, practical sessions, home assignments, mini project

Recommended Readings:

- Leach, A.R. (2001). Molecular Modeling: Principles and Applications. Pearson.
- Leszczynski, J. Handbook of Computational Chemistry; Springer, 2012.
- Cramer, C. J. Essentials of Computational Chemistry Theories and Models; John Wiley & Sons USA, 2004.

CHE 42022 - Selected Topics in Physical Chemistry II

Intended Learning Outcomes

At the end of the course unit student will be able to:

ILO1: illustrate fundamentals of nanotechnology

ILO2: demonstrate the skills of instruments in nanotechnology

ILO3: analyze theories applicable to reaction dynamics

ILO4: analyze the sonochemical reaction pathways

ILO5: analyze liquid crystal phase to understand the properties and applications

Note: LO means learning outcome

1. Nanochemistry (14 hrs)

Introduction and Applications:

Overview of different nanomaterials available. Potential uses of nanomaterials. Novel physical chemistry related to nanoparticles such as colloids and clusters: different equilibrium structures, quantum effects, conductivity, band theory- electrical and optical properties and enhanced catalytic activity compared to the same materials in the macroscopic state. Exploitation of self-assembly and self- organization to design functional structures in 1D, 2D or 3D structures Nanomaterials (Nanoparticles, nanoclusters, quantum dots synthesis): Preparation and Characterization: "Top-Down" and "Bottom-Up" approaches of nanomaterial (nanoparticles, nanoclusters and quantum dots) synthesis: Top-down techniques: photolithography, other optical lithography (EUV, X-Ray, LIL), particle-beam lithographies (e-beam, FIB, shadow mask evaporation), probe lithographies, Bottom-up techniques: self-assembly, self-assembled monolayers, directed assembly, layer-by-layer assembly. Pattern replication techniques: soft lithography, nanoimprint lithography. Pattern transfer and enhancement techniques: dry etching, wet etching, pattern growth techniques (polymerization, directed assembly).

Combination of Top-Down and Bottom-up techniques: current state-of-the-art.

2. Reaction Dynamics (8 hrs)

Kinetic theory of collision, relationship between critical energy and the activation energy, probability factor; activated complex theory and its applications, thermodynamic interpretation of the overall rate constant; theories of unimolecular reactions: Lindermann theory, the $[M]_{1/2}$ value of the unimolecular reactions, weaknesses of Lindermann theory, calculation of k value from Hinshelwood method, treatment of Rice-Ramsperger and Kassel, energized complex, Slater's treatment, Rice –Ramsperger-Kassel-Marcus theory; liquid phase reactions, theories of diffusion- controlled reactions and absolute reaction rates, influence of solvent in liquid phase reactions, single and double sphere models; influence ofionic strength in solutions on reactions.

3. Sonochemistry (4 hrs)

Properties of sound waves and ultrasound waves, and their applications such as bubble chemistry, surface cleaning, production of new materials.

4. Liquid crystals (4 hrs)

Mesophase: an intermediate phase between liquid and solid phases, comparative description of smectic, nematic and cholestic phases, biological liquid crystals, applications of liquid crystals.

Methods of Teaching and Learning

A combination of lectures, tutorials, small group discussions and computer assisted learning.

Recommended Readings:

- Rao M.S., Ramachandra, Nanoscience & Nanotechnology: (2013) Fundamentals of Frontiers India Wiley India Pvt. Ltd.
- Ash by, Michale F, Nanomaterials (2009) Nanotechnologies and Design, Amsterdam Elsevier.
- Sonochemistry, New opportunities for Green chemistry Gregory Chatel (https://doi.org/10.1142/q0037 |February 2017.

E 42032/ENH 42032 - Comprehensive Chemistry (Theory)

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:
ILO1: comprehend theoretical aspects of chemistry learned throughout;
ILO2: disseminate knowledge on basic aspects of chemistry.
Note: ILO means intended learning outcome.

The paper C 42252 is designed to test student's knowledge of principles of chemistry covered during the GCE (A/L) Chemistry examination, Level 1, Level 2, and some parts of Level 3 of the GIC programme. It constitutes questions based on the theoretical aspects of organic, inorganic, analytical and physical chemistry. Additionally, the application and problem-solving skills of students will be examined. Students are required to undergo two-hundred notional hours of self-studying to recall the basics in key areas of chemistry. The paper consists of multiple-choice questions.

E 42042/ENH 42042 - Comprehensive Chemistry (Practical)

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: comprehend practical aspects of chemistry learned throughout;

ILO2: disseminate knowledge on basic aspects of chemistry in relation to laboratory experiments;

ILO3: solve a practical problem using principles of chemistry.

Note: LO means intended learning outcome.

The paper C 42262 is structured to evaluate a student's knowledge of the all practical components covered in the GIC program. Students are required to undergo two-hundred notional hours of self-studying to recall the basics in practical aspects of chemistry. Evaluation is based on a four-hour practical examination.

APM 42052 - Professional Practices

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: describe the characteristics of a professional;

ILO2: communicate at a professional level;

ILO3: discuss the role of ethics in industry;

ILO4: appreciate how to accept responsibility and ownership for yourself and other people under your direction;

ILO5: describe the role of professional associations;

ILO6: apply own level of social intelligence to his/her own position related to other professionals in the work place and thereby make informed decisions aligned to the professional practice in the industry s/he is involved in.

Note: LO means intended learning outcome.

1. **Characteristics of a professional.**
2. **Communication; Inter-relationships between communication and professionalism.**
3. **Ethics, differentiation between law, morals and ethics, using standards, codes of ethic, inter-relationships between professionalism and ethics.**
4. **Introduction to decision making, professionalism.**
5. **Professional associations.**
6. **Social intelligence, professional judgment, inter-relationships between ethics and professional judgment, the inter-relationships between professional judgment and social intelligence.**

Methods of Teaching and Learning

Lectures and case analysis

Recommended Readings

- Bazerman, M H and Moore, D A (2009), Judgment in Managerial Decision Making, 7th Edition, John Wiley.
- Fisher, A (2001), Critical Thinking: an introduction, Cambridge University Press.

C 44063/CHE 44063 - Analytical Industrial Biochemistry

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: explain laboratory practices and instrumentation in clinical analysis;

ILO2: determine enzyme concentration by activity assays;

ILO3: determine the total carbohydrate, dietary fibre and selected vitamins in a given sample;

LO4: explain immunotechnological applications and DNA based diagnostics;

ILO5: describe fermentation technology;

ILO6: carry out routine clinical laboratory determinations;

Note: ILO means intended learning outcome.

1. Safe laboratory practices for handling of radioactive and biological samples

Use and safe handling of radioactive substances, safe handling of biological samples, blood borne pathogens.

2. Enzyme assays

Principles of enzyme assaying, use of immobilized enzymes, assays for coenzymes.

3. Assay of serum and urin

ALT, AST, acid phosphatase, alkaline phosphatase, isoenzymes, troponins, cholesterol, lipoproteins (lipid profile), glucose, uric acid, urea, bilirubin, urobilinogen, creatinine, electrolytes, amino acids and proteins.

4. Assay of total carbohydrates, dietary fibre and vitamins

5. Immunotechnology

Experimental systems used in basic immunological studies, immunoassays, applications of cells and molecules of the immune system.

6. DNA based diagnostics

Infectious diseases, genetic diseases, applications in forensic science, applications in cancer, biomarkers.

7. Fermentation technology

Principles of fermentation technology, aerobic and anaerobic fermentation.

8. Laboratory work

Spectroscopic determination of enzyme activity, assay of serum, assay of urine, assay of total carbohydrates, dietary fibre and selected vitamins, extraction of DNA, agarose gel electrophoresis.

Methods of Teaching and Learning

A combination of lectures, tutorials and discussions, and laboratory practical

Recommended Readings

- Buckingham and Flaws "Molecular Diagnostics, Fundamentals, Methods and Clinical Applications" 2007, EA Davis Company, Philadelphia.
- Janeway, C. A., Walport, M. J., Travers, P., Shlomchik, M. J. "Immunobiology: The Immune System in Health and Disease" 6th Edition.
- Whitaker, Stanbury and Hall "Principles of Fermentation Technology" 2nd Edition.

C44073/CHE 44073 - Electrochemical Technology

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: explain basic concepts of corrosion;
ILO2: identify different types of corrosion;
ILO3: make use of energy storage applications and theory related in energy conversions;
ILO4: describe different types of electrochemical industrial applications;
ILO5: evaluate corrosion types using electrochemical impedance spectroscopy;
ILO6: explain principles of quartz balance techniques and electrochemical techniques in bio molecules.

Note: ILO means intended learning outcome.

1. Corrosion and the stability of metals (8 h)

Mechanisms of corrosion, thermodynamics of corrosion and the stability of metals, Pourbaix diagrams and their limitations, corrosion current and corrosion potentials, mixed potential theory of corrosion, use of Evan's diagrams for understanding corrosion; Corrosion reactions under cathodic control, anodic control, diffusion control and in flowing solutions; Corrosion control by passivation; Kinetics of corrosion, determination of rate of corrosion; Types of corrosion: Galvanic corrosion, crevice corrosion, pitting corrosion, intergranular corrosion, selective corrosion, erosion corrosion, stress corrosion, hydrogen damage; Corrosion control methods: Anodic, cathodic and mixed inhibitors; Cathodic protection - sacrificial anode method, impressed current method; Anodic protection - galvanic protection and impressed current protection.

2. Electrochemical energy conversion & electricity storage (6 h)

Terminology related to energy conversion and storage; Primary batteries an examples; Secondary batteries and examples (lead acid battery, reserve batteries - lithium batteries, nickel cadmium batteries, etc.); Fuel cells and examples (hydrogen-oxygen cell, hydrogen-air cell, natural gas Co – Air cells, etc.).

3. Electrochemistry in industry (12 h)

Electrochemical reactors, examples for industrial electrolysis and electrosynthesis: Chloro alkali process, metal extraction, metal finishing electrodialysis and its applications, metal recovery by ion exchange, electrochemical ion exchange, electrowining, electrocatalysts and electro synthesis; Metal extraction and refining: Extraction of aluminium, silicon, magnesium and lithium, manufacturing process, metal finishing; Electroplating: Requirements for electroplating, mechanism of electroplating bath; Macro throwing power, micro throwing power; Plating from non-aqueous solutions; Metal processing: Electroforming, electrochemical machining, electrochemical etching.

4. Electrochemical impedance spectroscopy (4 h)

Detection and measurement of impedance, equivalent circuit and electrochemical cell, Faradaic impedance and total impedance, impedance plots.

5. Electrochemical quartz crystal micro/nano balance technique (2 h)

Introduction, instrumentation and applications electrochemical quartz crystal micro/ nano balance.

6. Solar energy (5 h)

Photo electrochemical (PEC) and photogalvanic (PG) conversion; PEC cells, PG cells, photovoltaic cells of first, second, third and fourth generation; Hybrid solar cells.

7. Bioelectrochemistry (4 h)

Electrochemical interface between biomolecules, nerve impulse and cardiovascular electrochemistry, oxidative phosphorelation, bioenergetics, bioelectrocatalysis, bloelectroanalysis.

8. Electrochemical catalysis and electrochemical sensors (2 h)

Types of electrocatalysts, different types of electrochemical sensors and their applications.

9. Scanning probe techniques (2 h)

Theory of scanning electrochemical microscopy and its applications.

Methods of Teaching and Learning

Lectures, tutorials, group assignments

Recommended Readings

- Bockris J.O.M.R Reddy A.K.N, "Elementary Electrochemistry" A plenum / Rostta Edition.
- Perez Nestor, Electrochemistry & corrosion, 2004, Kluwer Academic Publishers.

C 42081/CHE 42081 - Mineral Resources in Sri Lanka - Chemistry and Applications

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: identify the difference between rocks and minerals;

ILO2: discuss geological formations in Sri Lanka;

ILO3: classify minerals in Sri Lanka;

ILO4: discuss possible industries based on mineral resources and value addition in Sri Lanka.

Note: ILO means intended learning outcome.

1. Rocks and minerals (5 h)

Difference between rocks and minerals, geological formations in Sri Lanka, igneousm sedimentary and metamorphic rocks.

2. Classification of minerals (2 h)

Classification as ferroalloy group, nonferrous group and non-metallic group.

3. Industries based on mineral deposits in Sri Lanka (8 h)

Mineral deposits in Sri Lanka and chemical composition of those minerals, chemistry relevant to industries based on some selected minerals - clay, quartz, calcarious materials, beach mineral sands, apatite, gem stones, graphite; Value addition and aspects of value addition: Potential industries.

Methods of Teaching and Learning

Lectures, tutorials, self-studying, industrial visits

Recommended Readings

- Sri Lankan Mineral and Industries: Resources, Potentialities and current issues (2003), M.M.J.W. Hearth Geological survey and mines bureau.
- Silica based industries – Future Prospectus (1999), Proceedings of a seminar, Natural Resources, Energy and Science Authority of Sri Lanka.
- Mineral resources of Sri Lanka (1980), J. W. Herath, Geologicak survey Department.

CHE 44102 - Agrochemicals

Intended Learning Outcomes

Upon the successful completion of the course unit, learners will be able to:

ILO1: classify pesticides

ILO2: explain chemistry of pesticides

ILO3: compare synthetic pesticides with biopesticides

ILO4: compare synthetic fertilizers with biofertilizers

Note: LO means learning outcome

1. Pesticides(10 hrs)

1.1 Introduction: Classification of pesticides, Formulation & Application of Pesticides, additives, spraying equipment, packaging & labeling, toxicology of Pesticides

1.2 Chemistry: Classification, synthesis, mode of action and metabolism of synthetic Insecticides, synthetic Herbicides and synthetic fungicides; Synthesis of Rodenticides, Nematocides, Acracides, Molluscicides

2. Bio –pesticides(10 hrs)

Definition, Mode of action

3. Fate of Pesticides in the environment and Pesticide Residue Analysis (5 hrs)

Fate of pesticides in the environment, methods used in pesticide residue Analysis

4. Fertilizers (5 hrs)

Chemistry of synthetic and bio-fertilizers

Methods of teaching and learning

A combination of lectures, tutorials, small group discussions.

Recommended readings

- Michael, F. "The Agrochemical and Pesticides Safety Handbook" 1998, Waxman, CRC Press.
- "Pesticide Recommendations", A Publication of the Department of Agriculture, Sri Lanka.
- Wimalasena, S. "Insecticides" Institute of Chemistry Ceylon Publication.

C 44113/CHE 44113 - Chemical Education

Intended Learning Outcomes

Upon the successful completion of the course unit, learners will be able to:

ILO1: design teaching, learning and assessment activities according to psychological theories in education;

ILO2: differentiate distinct types of learning and teaching methodologies

ILO3: plan course modules in line with taxonomies of education

ILO4: explain fundamental aspects of curriculum design

ILO5: use historical aspects of chemistry in clearer understanding of chemistry;

ILO6: demonstrate fundamental teaching techniques in chemistry education.

Note: ILO means intended learning outcome.

1. **Psychological and aspects of science education (8 h)**
   Attention span and forgetting curve, components of critical thinking, Kolb's cycle of experimental Learning, SQ4R (survey, question, read, recite, relate, and review), reading method, Curry's onion model of education, Johari Window (Student and peer evaluation), Covey's time management.

2. **Technical aspects of teaching, learning and assessment (8 h)**
   Deep and surface learning; Active and passive learning; Teacher-centred vs. student-centred teaching; Taxonomies of education: Cognitive, affective and psychomotor domains of Bloom's Taxonomy; Solo Taxonomy; Perry Model of cognitive development; Chemistry education in the ICT age.

3. **Designing curricula (6 h)**
   Content-based vs. objective-based teaching; Biggs' constructive alignment; Introduction to Sri Lanka Qualifications Framework (SLQF).

4. **Historical & philosophical development of chemistry (8 h)**
   Historical landmarks of chemistry; Inspirational life stories of eminent personalities in chemistry; Industrial revolution and the history of global chemical industry, identifying significant human mistakes in the past and the prediction of future based on history; Basic IQ in roots of chemistry.

5. **Demonstrations in chemical education (15 h)**
   Demonstrations in chemistry: Demonstrations to reinforce classroom material, demonstrations to entertain thermochemistry, chemiluminescence, polymers, coloured metal ion complexes, etc. Use of everyday objects in chemical demonstrations; Classroom assessment: Teaching practice and seminar presentations which carries 20% of the marks for the course.

Methods of Teaching and Learning

Lectures, tutorials, self-studying

C 44122/CHE 44122 - Industrial Chemistry and Technology

Intended Learning Outcomes

Upon the successful completion of the course unit, the student should be able to:

ILO1: account for metal-based industries and properties of metal-based products;
ILO2: classify types of cement and brief on chemical characteristics of cement;
ILO3: identify types of glass and manufacturing process of glass;
ILO4: classify clay products and identify properties of clay;
ILO5: describe materials used in paint industry and different paint formulations;
ILO5: brief on process technology of leather industry.

Note: ILO means intended learning outcome.

1. Metal industry (6 h)

Iron & steel: Allotropic forms of iron, constituents of iron & steel, iron – carbon equilibrium diagram, types of cast iron (grey, white, malleable and nodular cast iron), types of steel, heat treatment of steel and mechanical properties; Light metal properties and their applications; Beryllium, magnesium and titanium; Nonferrous metals, alloys and their applications; Copper and its alloys; Aluminum and its alloys.

2. Cement (4 h)

Classification of cement (natural cement, Puzzolana cement, slag cement, Portland cement, special cements, masonry cement); Manufacture of Portland cement; Chemical composition of cement: Setting & hardening of Portland cement (sequence of chemical reactions during hardening of cement, including heat of hydration of cement).

3. Ceramics & Glass (4 h)

Types of glass (soft glass, potash lime, flint, pyrex, safety, insulating glass, wired glass, laminated glass, glass wool); Manufacturing techniques of glass; Classification of clay products; Properties of clay; Glazing – purpose of glazing, methods of glazing.

4. Paint Industry (8 h)

Definitions of a paint and introduction of materials used; Definitions of types of paints (varnish, lacquer, enamel paints, top coat , undercoat, filler paints, primers, surfaces or undercoats, sealers, etc.); Compositions of emulsion & enamel paints and formulation principles; Manufacture of alkyd resins and binders for water born emulsion paints; Various drying / film formation mechanisms of paints; Different paint formulations (water based & solvent based); Details of some important raw materials used; Colour & colour chemistry; Chemistry of rheology modifiers; Self-healing coatings.

5. Leather Industry (8 h)

Raw materials; Process technology; Preservation of skins, soaking, liming, unhairing,

scudding, de-liming, bathing, pickling, degreasing, tanning (vegetable & chrome); Environmental issues.

Methods of Teaching and Learning

Lectures, tutorials, industrial visits, computer assisted learning, group work, Industrial visits

Recommended readings

- Reading material prepared and issued by the lecturers
- Blackley, D. C. "Polymer Latices : Science & Technology: Fundamental Principles" Vol 1, 02nd Edition, 1997.
- Blackley, D. C. "Polymer Latices :Science & Technology: Types of Lattices"Vol 2, 02nd Edition, 1997.
- Blackley, D. C. "Polymer Lattices : Science & Technology: Applications of Latices" Vol 3, 02nd Edition, 1997.
- Lakhtin, Y. "Engineering Physical Metallurgy" 5th Edition, 2000.
- Allen, D. K. "Interaction to Engineering Materials" 5th Edition, 1998.
- Higgins, R. A. "Engineering Materials" 5th Edition, 1992.
- Dustavson, K. H. "Chemistry of Tanning Processes" 1966.
- Bentley, J. and Turner, G. P. A. "Introduction to Paint Chemistry" 4th Edition, 1998.
- Surface Coatings [paint and their applications] - Surface coatings association Australia Inc : ISBN 0-64641711-8.
- Surface Coatings [Raw materials and their usage] - published by tafe educational books : ISBN 0-86840-253-2.
- Surface coatings - Science & technology by Swaraj Paul.

C 42132/CHE 42132 - Quality Management

Intended Learning Outcomes

Upon the successful completion of the course unit, the student should be able to:

ILO1: demonstrate the basic concepts in quality policy;

ILO2: compare various certifying organizations;

ILO3: know the basic standards for any process or service;

ILO4: apply suitable standards to accredited laboratories;

ILO5: demonstrate key aspects of various management systems.

Note: ILO means intended learning outcome.

1. Quality of substances and quality of services (15 h)

1.1 The International Organization for Standardization (ISO), Sri Lanka Standards Institution (SLSI) and The International Electrotechnical Commission (IEC). What is quality? Quality assurance and quality control; Sequence of approaching quality product; Quality management system; Benefits of quality management system; Plan – Do – Check – Act.

1.2 The Plan – Do – Check – Act (PDCA) cycle as the operating principle of ISO's management system standards.

1.3 ISO 9000 series: ISO 9001-2008, Eight principles of ISO; Involvement of people, customer focus, leadership, mutual beneficial supplier 9001:2000, 2008 Standard; System approach to management; Process approach to management relationship; Factual approach to decision making and continual improvement.

1.4 Applications of ISO 9001-2008 to one of the following industries: Cement, TiO2 in paint industry, mineral waters and ball point pen.

1.5 ISO 14000 series; Applications of ISO 14001-2005 Environmental Management Standard to one of the following industries: Discharge of effluents in pesticide packing industry, leather industry, rubber processing industry.

1.6 Hazard Analysis and Critical Control points (HACCP) Incorporation of HACCP principles into the quality management system (ISO 9000) results ISO 22000. ISO 22000:2005 is to ensure that the organization conforms to its stated food safety policy; To demonstrate such conformity to relevant interested parties; To seek clarification or registration of its food safety management system by an external organization or make a self-assessment or self-declaration of conformity to ISO 22000:2005.

1.7 A brief account on ISO 18000 -Occupational health and safety management standard OHSAS 18001.

1.8 ISO 17020 and ISO 17021 Standards for certifying and inspecting bodies in brief.

2. Laboratory management (15 h)

2.1 Sri Lanka Accreditation Board for conformity assessment (SLAB)

Introduction: Sri Lanka Accreditation Board for conformity assessment (SLAB) accredited by the International Organization for Standardization (ISO); International Electro-technical Commission (IEC); Asia Pacific Laboratory Accreditation Co-operation (APLAC); International Laboratory Accreditation Cooperation (ILAC). General requirements for accreditation bodies and accrediting conformity assessment bodies as per International Standard ISO/IEC 17011 ISO/IEC 17025-Laboratory Accreditation; ISO 15189-Medical Laboratory Accreditation; Chemical, microbiological and calibration laboratories accredited by SLAB based on ISO/IEC 17025 whereas medical laboratories are accredited by SLAB based on ISO 15189. ISO 17043 is a new standard on proficiency testing; Inter-laboratory comparisons.

2.2 ISO/IEC 17025: Clause 1-Scope, Clause 2-References, Clause 3-Terms and Definitions. The two main Clauses are: Clause No. 4.0 Management Requirements (Derived from ISO 9001:2008) Clause No. 5.0 Technical Requirements.

2.3 Clause No. 4.0 Management Requirements (derived from ISO 9001:2008) 20 Elements from 4.1 to 4.20 Description of these elements as applied to chemical laboratories

2.4 Clause No. 5.0 Technical requirements 10 Elements from 5.1 to 5.10 Description of these elements as applied to chemical laboratories.

2.5 ISO 17043 Proficiency testing and inter-laboratory comparison with some examples and calculation Z-score. Q-Test and rejection of some laboratory results

Methods of Teaching and Learning

Lectures, tutorials, industrial visits, computer assisted learning, group work

Recommended readings

- Evans, J.R. "Total Quality" 4th Edition, 2007, Thomson – South-Western.
- Evan, J.R. and Lidsay "The Management of the Control of Quality" 6th Edition, 2005, Cincinati South-Western Publication.
- Leevov, W. and Ersoz, C.J. "Healthcare Guide to Continuous Quality Implementation" 1991, American Health association.
- Freigerbaun, A.V. "Total Quality" Mc Graw-Hill, New York.

C 42142/CHE 42142 - Further Topics in Environmental and Green Chemistry

Intended Learning Outcomes

Upon the successful completion of the course unit, the student should be able to:

ILO1: judge the fate of pollutants using concepts of material balance in the environment;
ILO2: identify different pollutants and their behavior and fate in the environment;
ILO3: explain environmental concerns of chemical industry;
ILO4: solve problems in risk assessment of carcinogenic and noncarcinogenic toxins;
ILO5: summarize fundamental aspects of solid waste management.
ILO6: Illustrate fundamentals of green chemistry and sustainable technology

Note: ILO means intended learning outcome.

1. Material balance in the environment (4 h)

Mass transfer of pollutants in the environment, steady-state conservative systems; Non-conservative pollutants: Batch, steady-state and non-steady state systems.

2. Pollutants in the environment (6 h)

Organic pollutants in the environment: Stockholm convention and persistent organic pollutants (POPs); Persistent, bioaccumulative and toxic Pollutants (PBTs); Polychlorinated biphenyls (PCBs); Pesticides in the environment; Dumping of banned chemical weapons of mass destruction; Contaminants of emerging concern (CECs); Pharmaceutical pollutants and endocrine disruptors in aqueous systems; Biogenic and anthropogenic organic chemicals in the atmosphere; Heavy metal pollutants: The big four - cadmium, lead, mercury and arsenic; Industrial explosions and release of chemicals into the environment - Bhopal disaster; Dioxin release (Seveso, Italy); Minamata disease (methyl mercury); Asbestos diseases; Fetal alcohol syndrome; Bioconcentration, biomagnification and bioaccumulation of pollutants in the environment; Nuclear waste: harmful effects of radiation on humans; Factors influencing radiation damage; Units of radiation; Harmful limits of radiation; Effect of chain reactions and nuclear accidents.

3. Risk assessment (6 h)

Epidemiologic rate comparison: 2×2 matrix method, relative risk, attributable risk, and odds ratio; Dose response assessment - dose response curves for acute toxicity; Median lethal dose and lethal concentration; Carcinogens: UC EPA classification and NIH classification of carcinogens; Potency factor for carcinogens; Incremental lifetime cancer risk; Chronic daily intake; Non-carcinogenic toxins: reference dose and hazard quotient; Exposure limits: permissible exposure limit; Short-term exposure limit; Immediately dangerous to life and health; Signal words: Caution, warning and danger.

4. Chemical aspects of solid waste management (4 h)

Types of solid waste: industrial, municipal, hazardous, radioactive and clinical; Treatment (processing) of solid waste: composting and biogas production, monitoring environmental impact and quality assurance.

5. Fundamentals of green chemistry and sustainable technology (10 h)

Fundamentals: concept of green chemistry; Green solvents, earth-friendly plastics, replacing chlorine, replacing toxic materials and environmentally benign pesticides; Carbon footprint and carbon neutrality; Renewable energy: Importance of renewable energy; Biofuels and green fuels; Sustainable consumption and production: Five axioms of sustainability; Putting sustainability into practice.

Methods of Teaching and Learning

Lectures, tutorials, industrial visits, computer assisted learning, group work

Recommended readings

- Girard, J. E.; Girard, J., Principles of Environmental Chemistry. Jones & Bartlett Learning: 2014.
- Manahan, S. E., Environmental Chemistry, Eighth Edition. Taylor & Francis: 2004.
- Sotheeswaran, S. "Environmental Organic Chemistry" 03rd Edition, 2012, Institute of Chemistry Publications, Monograph No: 11.

C 44152/CHE 44152 - Pharmaceutical Technology

Intended Learning Outcomes

Upon the successful completion of the course unit, the student should be able to:

ILO1: apply knowledge gained in pharmaceutical chemistry to pharmaceutical technology;
ILO2: explain preparation methods of various pharmaceutical preparations;
ILO3: calculate the strength of pharmaceutical preparations;
ILO4: describe quality control and quality assurance procedures of pharmaceutical preparations;
ILO5: brief on essential components of pharmaceutical industry.

Note: ILO means intended learning outcome.

1. Introduction (4 h)

Importance of pharmaceutical technology; Usage of pharmaceutical products; Classification of dosage forms; method of administration, GMPs.

2. Preparation aspects (12 h)

Theory and preparation of various pharmaceutical products, such as tablets, suspensions, emulsions, ointments, gels, pastes, semisolid preparations, suppositories, powders, inhaled products, veterinary preparations; Problems associated with pharmaceutical preparations; Incompatibility issues.

3. Quality control and quality assurance (10 h)

Good laboratory practices, good manufacturing practices, good documentation practices; ISO series; Preservation, packaging and storage procedures; Sampling and application of analytical techniques in quantification; Bioequivalence studies; Methods validation.

4. Pharmaceutical industry (4 h)

History of pharmaceutical industry, modern pharmaceutical industry and challenges faced; Pharmaceutical unit operations, Optimization and scaling up; Pilot scale considerations

Methods of Teaching and Learning

Lectures, tutorials, industrial visits, computer assisted learning, group work

Recommended readings

- S.H. Rasheed, Pharmaceutical Technology-I, SIA Publishers and Distributors (P) Ltd., 2015.
- G. Agarwal and A. Kaushik, Pharmaceutical Technology I, CBS Publishers & Distributors Pvt Ltd., 2017.
- Fah, Voigt's Pharmaceutical Technology, J. Wiley & Sons, 2018.
- R.K. Yadav, A Textbook Of Pharmaceutical Technology-I, Vardhans Publishers.

C 44163/CHE 44163 - Pharmaceutical and Medicinal Chemistry

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: explain the mode of action of a drug belonging to different classes of drugs;

ILO2: differentiate a metabolic pathway depending on the functional group of the drug;

ILO3: write a mechanism for the metabolic pathway of the drug having a particular functional group;

ILO4: detect harmful metabolites during the biotransformation and explain how it is destroyed;

ILO5: highlight the advantages of using prodrug approach to drug delivery.

Note: ILO means intended learning outcome.

1. General principles (6 h)

Introduction; How do drugs work – enzyme inhibition, interaction at receptors, interaction with nucleic acids, physicochemical properties of drugs; Pro drugs and Drug delivery systems: Drug latentiation; Carrier linked prodrugs (bipartite and tripartite, mutual) advantages; Bioprecursor prodrugs; Different methods of drug administration, their advantages.

2. Drug metabolism (14 h)

Introduction; Phase I reactions: Oxidative reactions involving Cytochorme P-450 and flavin monooxygenase with example of common drugs, reductive reaction and hydrolytic reactions; Scavengers of harmful electrophilic intermediates; The need to synthesize enantiomerically pure dugs; Variation in metabolism depending on the animal; Phase II transformations: Glucuronidation, amino acid conjugation, sulfate conjugation, glutathione conjugation, methyl and acetyl conjugation.

3. Drug discovery and development (15 h)

Screening of natural products and discovery of lead compounds; Synthetic analogs of the lead compounds; Structure activity relationships; Chirality and drug action: Realization that stereoselectivity is a pre-requisite for evolution; Role of chirality in selective and specific therapeutic agents; Case studies; Enantioselectivity in drug absorption, metabolism, distribution and elimination. Role of biotechnology in drug discovery; Pharmacodynamics and quantitative structure activity relationships; Pharmacokinetics; Pharmacological process for drug discovery (nutraceuticals and herbal drugs/products); Chemical and biochemical basis of drug discovery and development; Use of computational chemistry in drug development.

4. **Mode of Action of the Following Topics (4 h)**

   Analgesics, steroids, sulfonamides, non-steroidal anti-inflammatory drugs, antibacterial, antifungal and antiviral agents; Anticancer drugs; Drugs acting on the central nervous system.

5. **Pre-clinical development and clinical development (6 h)**

   Process of pharmacological development; Chemical aspects of drug protein interactions, Process of clinical development; Cross reactivity; Different levels of clinical trials.

Methods of Teaching and Learning

Lectures, tutorials, computer assisted learning, group work

Recommended readings

- Silvermann, R. "The Organic Chemistry of Drug Design & Drug Action" 02nd Edition, 2004, Elsevier Academic Press.
- Samuelsson, G. and Bohlin, Lars "Drugs of Natural Origin - A Treatise of Pharmacognosy" 06th Revised Edition, 2010, Division of Pharmacognosy, Department of Medicinal Chemistry, Uppsala University, Sweden.

C 34012/44012 - Petroleum and Petrochemicals

Intended Learning Outcomes

Upon the successful completion of the course unit, the student should be able to:

ILO1: describe origin and classification of crude oil;

ILO2: describe grease and lubricants with reference to transformer oil and transmission oil;

ILO3: apply the knowledge of petroleum analytical techniques to express the quality of refined petroleum products;

ILO4: identify key steps in the petroleum refinery process;

ILO5: identify applications of natural gas, LPG and chemical naptha in power generation, and industry;

ILO6: identify alternative fuels as a solution to depletion of petroleum.

Note: ILO means intended learning outcome.

1. **Definition of crude oil, origin and classification of crude oils (2 h)**
2. **Grease and lubricants including transformer oil and transmission oils (12 h)**

   Refinery process, refining of crude oil into refined petroleum products such as LPG, naphtha, gasoline, kerosene and jet fuels, diesel fuels, power generation fuels, marine fuels, base oils.

3. **Petroleum analytical techniques and significance of quality of petroleum refined products (6 h)**
4. **Natural gas (LNG/CNG) and its uses in power generation, automobiles and petrochemical industries (6 h)**
5. **LPG, Chemical Naphtha and LNG/CNG as petrochemical feed stock. World Oil depletion and alternative fuels (4 h)**

Methods of Teaching and Learning

Lectures, tutorials, computer assisted learning, group work

Recommended readings

- Speight James G "Petroleum Chemistry and Refining" 1998, Taylor and Francis Publishers.

C 34022/44022 - Chemical Toxicology

Intended Learning Outcomes

Upon the successful completion of the course unit, the student should be able to:

ILO1: be confident in fundamental aspects of toxicology;

ILO2: summarize toxicological testing methods for drugs and consumable products;

ILO3: explain the use of analytical techniques in toxicological studies;

ILO4: high-light biotransformation reactions;

ILO5: brief on molecular and environmental toxicological aspects.

Note: ILO means intended learning outcome.

1. Fundamentals of toxicology (6 h)

Classification of poisons: Corrosives, irritants, poisonous substances; Definition and basic concepts, description and terminology of toxic effects; Concepts in toxicodynamics and kinetic parameters (toxicokinetics); Disposition of toxic compounds, ADME studies, clearance of toxicological materials, apparent volume of distribution, factors influencing toxicity, transport across the cell membrane; Dose-response relationship, effective dose, margin-of-safety and the relationship of effective dose (ED) vs. toxic dose (TD), therapeutic index (TI).

2. Toxicological testing for drugs and consumable products (4 h)

Toxicological testing for drugs and products assays for toxicity in vitro and in vivo, cell culture assays, microbiological assays and animal experiments.

Toxicological testing for cosmetics products Hypersensitivity and immunological skin reactions; applied microbiology and pharmacology, toxicology, cosmetic safety.

3. Analytical applications in toxicological studies (4 h)

Spectroscopic methods in analytical toxicology; Chromatographic techniques; Electroanalytical methods.

4. Role of Cytochrome P-450 monoxygenases in biotransformation (4 h)

Biotransformation of xenobiotics; Phase I and Phase II biotransformation reactions; Role of monoxygenases in biotransformation reactions

5. Molecular toxicology (6 h)

Review of oxidative stress, DNA damage, DNA repair and DNA methylation; Chemical carcinogenesis, molecular carcinogenesis, role of drug metabolizing enzymes in carcinogenesis; Genetic polymorphism and carcinogenesis, cell cycle delay, perturbations to the cell cycle, cell signaling & sensing toxicant stress; Perturbations to intra- and inter-cellular signaling, apoptosis; Toxicogenomics and toxicoproteomics.

6. Environmental toxicology (6 h)

Air, aquatic and soil toxicology; Environmental hazards, pesticides, hazard evaluation and risk assessment; Toxic substances of plant and animal origin; Heavy metal toxicity.

Methods of Teaching and Learning

Lectures, tutorials, computer assisted learning, group work

Recommended readings

- Hazardous Waste Chemistry, Toxicology and Treatment, Stanley E Manahan, CRC Press, Jul 2, 1990 .
- Toxicological Chemistry : Stanley E Manahan second edition, CRC Press 1992.
- Progress in Chemical Toxicology, Vol 5, Elsevier, Oct 22, 2013.
- Human toxicology of chemical mixtures, Harold Zeliger, William Andrew 2011.

C 34033/44033 – Further Management, Economics & Finance

Intended Learning Outcomes

Upon the successful completion of the course unit, the student should be able to:

ILO 1: explain the concepts, principles and applications in selected topics in Management;

ILO 2: explain the concepts, principles and applications in selected topics in Managerial Economics;

ILO 3: interpret basic financial statements, prepare basic costing statements and explain aspects of budgeting and sources of funds;

ILO 4: explain the salient concepts, principles and applications in the discipline of Marketing;

ILO 5: apply knowledge gained and skills acquired pertaining to Management, Managerial Economics, Accountancy and Finance and Marketing in work situations.

Note: ILO means intended learning outcome.

1. Management (10 h)

1.1 Emotional intelligence in management (2 h)

1.2 Team work and team management (2 h)

1.3 Features of excellent organizations (2 h)

1.4 Time management (2 h)

1.5 Change management (2 h)

2. Managerial Economics (8 h)

2.1 Demand and supply analysis (2 h)

Determinants of demand and supply, factors that cause movements along a demand or supply curve and shift of these curves, market equilibrium.

2.2 Concept of elasticity and applications (2 h)

Definition of elasticity, different types of elasticity, elasticity coefficients, practical applications in business, inflation and its impact on business.

2.3 Market structures (2 h)

Perfect competition, monopolistic competition, oligopoly and monopoly; Strategies for business success.

2.4 Pricing decisions (2 h)

Economist's model and its limitations, full-cost pricing, target return on investment (ROI) pricing, marginal cost pricing, pricing under different market structures and pricing strategies.

3. Accountancy and Finance (12 h)

3.1 Interpretation of financial statements (4 h)

Accounting equation, assets, liabilities and equity; Accounting process, understanding and interpreting financial statements. Manufacturing – profit and loss account and balance sheet.

3.2 Costing methods (4 h)

Prime cost, production overheads, total production cost, job and batch costing, characteristics of process industries, losses in processes (normal and abnormal losses) and process costing.

3.3 Budgeting and budgetary control (2 h)

Stages in the budgeting process; functional budgets (sales budget, raw materials budget, labour budget, overhead budget) and cash budget; budgetary control & variance analysis (fixed budget, volume and expenditure variance)

3.4 Sources of funds (2 h)

Capital markets vs money markets; Primary vs secondary markets: Working capital management.

4. Marketing (15 h)

4.1 Scope and concepts of marketing, marketing mix. (2 h)

4.2 Orientation towards the market place, production concept, product concept, selling concept, marketing concept, customer concept, societal marketing concept. (3 h)

4.3 Building customer value and satisfaction: customer perceived value, total customer satisfaction, value chain. (2 h)

4.4 The marketing process (2 h); Value delivery sequence, planning process, nature and contents of a marketing plan.

4.5 Market segments (1 h)

Methods used to segment, segment marketing, niche marketing

4.6 Positioning and differentiating the market and product life cycle. (2 h)

4.7 Products and branding strategy (2 h)

Product levels, hierarchy and classification: product mix, product line, brands.

4.8 Marketing channels (1 h)

Levels of marketing channels and its selection.

Methods of Teaching and Learning

Lectures, tutorials, computer assisted learning, group work

Recommended readings

- Management of organizational behavior, Paul Hersey, Kenneth Blanchard, 8th Ed., 2005.
- Emotional Intelligence, Daniel Goleman, 1995.
- Team work is an individual skill, Christopher M Avery, 2003.
- Personal Time Management, 3rd Ed., Marion Hatnes, 2005.
- In search of Excellence, Thomas J Peters & Robert H Watermann, 1993.
- How to manage Organizational Change, 2nd Ed., D E Hussey, 2000.
- Costing an introduction, c Drury, 2000.
- Financial accounting, an introductory course of study, 2004.
- Economics, Lipsey A & Chrystal A, 12th Ed. 2011.
- Financial Decision making, JJ Hampton, 9th Ed, 2009.
- Marketing Management, 11th Edition, Philip Kotler, 2003.

C 34042/44042 - Cosmetic Science and Clinical Herbal Product Development

Intended Learning Outcomes

Upon the successful completion of the course unit, the student should be able to:

ILO1: explain the role of chemistry in cosmetics and herbal products industry;

ILO2: impart the knowledge of colloidal chemistry to herbal product development;

ILO3: demonstrate the knowledge on various products from natural herbal material;

ILO4: explain essential features of cosmetics formulation;

ILO5: identify marketing and legal requirements of cosmetics and herbal products.

Note: ILO means intended learning outcome.

1. Introduction (4 h)

Definitions, global view of product research and development and stakeholders; Role of chemistry in extraction and preservation of herbal products; Introduction to cosmetics industry- myths and trends; synthetic analogs of bioactive herbal products.

2. Colloidal chemistry Emulsion and surfactant science (4 h)

Review of oil, fats and waxes, surfactants thickeners, emulsions, gums and resins, aerosols.

3. Product development (8 h)

Development of cosmeceutical, nutraceutical and pharmaceutical products from natural herbal material, such as tablets, capsules, syrups and creams; Product development; Analysis of finished products; Quality control.

Formulation of herbal products; Testing and evaluation of finished products; Challenges of formulation of herbal products.

[Clinical trials and toxicological testing for above will be covered under C 34292/44292 Chemical and Molecular Toxicology and its compulsory to take both courses together.]

4. Formulation science and process technology for cosmetics (8 h)

Skin biology and hair structure; Histology of the skin and hair, controlling microorganism in order to avoid contamination during manufacturing; Raw materials, formulation techniques, preparation, stability studies, testing and evaluation methods of hair products, oral care products, skin care products, cleansing agents, perfumery products and decorative cosmetics.

5. Marketing and legal requirements (4 h)

Identification of the process to protect intellectual property; Product development, packaging, marketing and quality assurance; Legislation, licensing requirements.

6. Registration activities, post registration activities (2 h)

Process of registration activities, post registration activities.

Methods of Teaching and Learning

Lectures, tutorials, computer assisted learning, group work

Recommended readings

- Kirk-Othmer, Kirk-Othmer Chemical Technology of Cosmetics.
- Amarjit Sahota, Sustainability: How the Cosmetics Industry is Greening Up.
- David Rowe, Chemistry and Technology of Flavours and Fragrances.
- Operational guidance: Information needed to support clinical trials of herbal products. TDR/GEN/Guidance/05.1 Copyright © World Health Organization on behalf of the Special Programme for Research and Training in Tropical Diseases, 2005 (http://apps.who.int/iris/bitstream/10665/69174/1/TDR_GEN_Guidance_05.1_eng.pdf).
- Bulletin of the World Health Organization. Herbal medicine research and global health: an ethical analysis.
- Herbal Medicine: Biomolecular and Clinical Aspects. 2nd Edition. Biomolecular and Clinical Aspects.
- Editors: Iris F. F. Benzie and Sissi Wachtel-Galor. Boca Raton (FL): CRC Press/Taylor & Francis; 2011. ISBN-13: 978-1-4398-0713-2.
- Chemistry, Manufacturing and Controls (CMC): http://www.ppdi.com/Services/Early- Development/Nonclinical/CMC-Consulting.
- Pharmaceutical development: http://www.ich.org/products/guidelines/quality/quality- single/article/pharmaceutical-development.html.
- Handbook for good clinical research practice (GCP): guidance for implementation.1. Clinical trials – methods. 2. Biomedical research – methods. 3. Ethics, Research. 4. Manuals. I. World Health Organization. ISBN 92 4 159392 X (NLM classification: W 20.5).

C 34052/44052 - Industrial Safety, Health and Environmental Technology

Intended Learning Outcomes

Upon the successful completion of the course unit, the student should be able to:

ILO1: identify industrial hazards, risks and risk assessment methods;

ILO2: identify environmental impacts on industry;

ILO3: describe industrial pollution control techniques and pollution prevention strategies;

ILO4: brief on Environmental Management Systems, and Occupational Health and Safety Management Systems;

ILO4: be aware of environmental laws;

ILO5: compare the use of natural dyes with synthetic dyes in textiles industry.

Note: ILO means intended learning outcome.

1. **Introduction, industrial hazards and risks (2 h)**

   Introduction to the importance of safety in industry, physical, chemical and biological hazards in industry, relationship between hazard and risk.

2. **Risk assessment methods (3 h)**

   Hazards and operability (HAZOP) analysis; What if analysis, fault tree method, event tree diagram, tie and bow analysis.

3. **Laws and regulations (2 h)**

   Introduction to Sri Lankan laws and regulation pertaining to occupational health and safety.

4. **Environmental impacts of industry and the concept of sustainability (2 h)**

   Introduction to the environmental impacts from industry, resource depletion and concept of sustainability.

5. **Industrial pollution control techniques (5 h)**

   Wastewater treatment techniques, solid waste management, air pollution control techniques

6. **Pollution prevention and cleaner production (4 h)**

   Introduction to cleaner production as an industrial pollution prevention/reduction strategy

7. **Environmental Management Systems (4 h)**

   Introduction to ISO 14001:2004 and ISO 14001:2015.

8. **Laws and regulations (2 h)**

   Introduction to environmental laws and regulations.

9. **Occupational health and safety management system (4 h)**

   Introduction to OSHAS 18000, OSHAS 18001, OSHAS 18002 and safety culture.

10. **Global Social Compliance Programme (2 h)**

    Introduction to Global Social Compliance Programme.

Methods of Teaching and Learning

Lectures, tutorials, computer assisted learning, group work

Recommended readings

- Asfahl, C. Ray "Industrial Safety and Health Management" 06th Edition, 1984, Prentice Hall.
- Charles D. Reese "Industrial Safety and Health for Infrastructure Services" CRC Press Taylor & Francis Group.

C 34063/44063 - Molecular Biology & Biotechnology

Intended Learning Outcomes

Upon the successful completion of the course unit, the student should be able to:

ILO1: explain basic principles molecular biology;

ILO2: demonstrate adequate knowledge on techniques in molecular biology;

ILO3: brief on basic aspects of immunology and vaccines;

ILO4: describe fermentation technology;

ILO5: comment on applications of gene technology.

Note: ILO means intended learning outcome.

1. **Introduction to Molecular Biology and Biotechnology (6 h):**

   Diverse applications of biotechnology in medicine, food production and environmental protection, Genetically modified organisms and their applications; Emergence of molecular biotechnology, microbial biotechnology, agricultural biotechnology, medical biotechnology, germplasm assessment and conservation, aquatic biotechnology, bioremediation, effective microorganisms, biotechnology as an industry, career prospects in biotechnology; Economic potential and implications for the society, biopharmaceuticals, food and feed, paper and pulp, bio-energy and high-tech food production with GM, bio-refineries.

2. **Basic Principles and Techniques in Molecular Biology (10 h):**

   Recall of basic principles; Principles and methods of DNA/RNA profiling DNA/RNA isolation techniques (bacterial, plasmid & genomic); Agarose & polyacrylamide gel electrophoreses and visualization of DNA; Enzymes in molecular biology; Mitochondrial DNA; Theory of nucleic acid hybridization; DNA labeling; DNA probes and their use; Splicing of DNA from different sources; Vectors used in cloning of DNA; Transformation techniques; DNA cloning; c DNA synthesis and its uses; DNA libraries; DNA sequencing; PCR techniques and their uses; Short interfering RNA, ; STR population data analysis, forensic genetics

3. **Basic Immunology and Vaccines (4 h):**

   Innate and adaptive immunity; Immunoglobulins; Preparation of vaccines, vaccinology;

4. **Fermentation technology (4 h):**

   Industrial fermentation; Isolation and preservation microorganisms used in of pure cultures; Bioreactor design and operation; Fermentation kinetics; Culture media; Sterilization isolation of products; Current applications, synthesis of secondary metabolites, strain improvement applications of functional genomics in fermentation technology.

5. Useful applications of gene technology (6 h):

Genetic disorders; Abiotic stresses; Infectious diseases; Host-parasite interactions; Infectiousness of disease-causing agents; Host response to disease causing agents; diagnosis of disease; Treatment; Molecular aspects to drug resistance; Rational drug design; Plant biotechnology transgenic animals and plants; Gene therapy; Genetically engineered proteins, e.g.: Insulin, growth hormones; Pharmacogenomics for personalized medicine.

Methods of Teaching and Learning

Lectures, tutorials, computer assisted learning, group work

Recommended readings

- Alberts, Bruce, Johnson, Alexander, Lewis, Julian, Raff, Martin, Roberts, Keith and Walter, Peter "Molecular Biology of the Cell" 05th Edition.
- Wilson, John and Hunt, Tim "Molecular Biology of the Cell: The Problems Book" 05th Edition.
- Harvey, Richard A. and Ferrier, Denise "Biochemistry (Lippincott's Illustrated Reviews Series)" 05th Edition.
- Nelson, David L. and Cox, Michael M. "Lehninger Principles of Biochemistry".
- Abbas, Abul K. and Lichtman, Andrew H. H. "Basic Immunology: Functions and Disorders of the Immune System", Updated Edition.
- Abbas, Abul K., Lichtman, Andrew H. H., and Pillai, Shiv "Cellular and Molecular Immunology", Updated Edition.

C 34072/44072 - Textile Science and Clothing Technology

Intended Learning Outcomes

Upon the successful completion of the course unit, the student should be able to:

ILO1: explain raw materials of clothing technology;

ILO2: describe quality control aspects of textiles;

ILO3: provide comprehensive account on modern textiles;

ILO4: impart the knowledge on sustainability in textiles industry;

ILO5: compare the use of natural dyes with synthetic dyes in textiles industry.

Note: ILO means intended learning outcome.

1. Production aspects (6 h)

Production and properties of natural and synthetic fibres, yarns, fabrics and apparels; Modelling, simulation and manufacturing of textiles and clothing; Supply chain management of textiles and clothing.

2. Quality control (8 h)

Textile quality control in various production components, such as selection of raw materials, fiber manufacturing, yarn manufacturing, fabric construction, dye and coloration, printing and designs and finishing components; Determination of the quality of textiles and clothing products.

3. Modern aspects of textiles (6 h)

Textile biomaterials and bioengineering; Nano, micro, smart, sport and intelligent textiles; Various aspects of industrial and technical applications of textiles and clothing; Apparel manufacturing and engineering; New developments and applications of textiles and clothing materials, manufacturing methods of new materials; Textile design aspects.

4. Sustainability in textiles industry (8 h)

Sustainability of textile industry; Environmental pollution due to textile industry and mitigation attempts: Microfiber pollution, chemical pollution; Standards of sustainability in textile manufacturing; Sustainable fashion and textiles; Green textiles and eco-fashion; Environmental assessments of textiles and clothing supply chain; Green composites; Sustainable luxury and sustainable consumption; Waste management in textiles; Sustainability standards and green labels; Social and economic sustainability of textiles and clothing.

5. Natural Dyes in textiles industry (2 h)

Importance of natural dyes, extraction of natural dyes, applications, practical difficulties, value addition.

Methods of Teaching and Learning

Lectures, tutorials, computer assisted learning, group work

Recommended readings

- E. Hannelore, Clothing Technology: from Fibre to Fashion, 5th Edition Verlag Europa-Lehrmittel Nourn, 2008.
- Central Board of Secondary Education, Textile Science, 1st Edition, Kalyan Enterprises, 2013.
- SS Muthu, Roadmap to sustainable textiles and clothing: Eco-friendly raw materials, technologies, and processing methods, Springer, 2014.
- W. Hua and H. Memon, Cotton Science and Processing Technology, Springer, 2020.

C 34081/44081 - Applied Microbiology

Intended Learning Outcomes

Upon the successful completion of the course unit, the student should be able to:

ILO 1: describe the structure of microbial cells, the form and arrangement;

ILO 2: describe the requirements for microbial growth and explain the dynamics of the growth of a microbial population;

ILO 3: illustrate the process of bacterial cell division and relate it to the growth of bacterial populations;

ILO 4: explain the structure and function of bacterial genomes including mechanisms of gene expression and regulation;

ILO 5: categorize the range of habitats in which bacteria are found, the dynamics of bacterial populations, the role of bacteria in biological communities, and the range of symbiotic relationships involving bacteria.

ILO 6: Analyze the importance and use of microorganisms in applications.

Note: ILO means intended learning outcome.

1. **Introduction to microbiology (3 h)**

   History and Scope of microbiology, microscopy, bacterial cell structure and function, archaeal cell structure and function, eukaryotic cell structure and function, virus structure and acellular infections agents. Economic importance of microorganisms.

2. **Microbial nutrition, growth and control and microbial metabolism (2 h)**

   Microbial growth, control of microorganisms in the environment, introduction to metabolism, microbial catabolism.

3. **Microbial genetics (2 h)**

   Bacterial genome replication and expression, regulation of bacterial cellular processes, genetic variation, microbial genomics.

4. **Microbial diversity and ecology (2 h)**

   Taxonomy and diversity, virus, methods in microbial ecology, microbial interactions.

5. **Topics in applied microbiology (3 h)**

   Food microbiology, industrial microbiology, forensics microbiology, environmental bioremediation.

Laboratory topics

6. **Biosafety, equipment and apparatus in microbiology (1 h)**

   Laboratory equipment and apparatus and their uses; Types and parts of microscopes, use and care of microscopes.

7. Aseptic procedures (2 h)

Cleanliness of the laboratory; Sterilization procedures: Use of direct heat, dry heat, moist heat, irradiation, filtration, and chemical sterilization agents.

8. Isolation and culture of microorganisms(2 h)

Definitions, types of culture media, preparation of culture media, isolation and sub-culturing of bacteria and fungi, extraction of nematodes.

9. Microscopic study of microorganisms (2 h)

Definitions, preparation of bacterial smear, staining procedures for bacteria, mounting and staining of fungal specimens, microscopic examination of bacteria, microscopic examination of fungi, microscopic examination of nematodes.

10. Preservation of microorganisms (2 h)

Use of refrigerator (cooling), agar slant culture on fresh media, agar slant culture covered with mineral oil, storage in saline suspension, drying in vacuum, cryo-preservation, freeze dying, use of silica gel.

Methods of Teaching and Learning

Lectures, tutorials, computer assisted learning, group work

Recommended readings

- Joanne Willey, Stanley Fischer, and Richard Startz. 2010. Prescott's Microbiology 11th edition. McGraw-Hill Higher Education.
- Michael T. Madigan, John M. Martinko, Jack Parker. 2006. Brock biology of microorganisms, 21st Edition Pearson Education Limited.
- Goszczynska, T., J. J. Serfontein and S. Serfontein. 2000. Introduction to practical phytobacteriology: A manual for phytobacteriology. SAFRINET, the Southern African(SADC) Loop of BIONET-International, ARC-Plant Protection Institute, Pretoria, South Africa.

C 34092/44092 - Polymer Chemistry and Technology

Intended Learning Outcomes

Upon the successful completion of the course unit, the student should be able to:

ILO1: summarize characterization techniques of polymers;

ILO2: impart knowledge on chemistry of polymers;

ILO3: describe polymerization techniques;

ILO4: brief on industrial uses of polymers.

Note: ILO means intended learning outcome.

1. Characterization and physical chemistry of polymers (15 h)

Determination of molar masses; End- group analysis; Direct measurements of average molar masses; Virial equations; Membrane osmometry; Vapour phase osmometry; Light scattering, scattering from large particles, Zimm method, low angle laser light scattering; Viscosity measurements; Mark-Houwink-Sakurada relationship; Huggins and Kramer equations; Gel permeation chromatography; Instrumentation and experimental methods; Universal calibration; Polymer solutions; Concept of solubility parameters; Flory-Huggins Theory; Compatibility of polymer blends and polymer solutions; Theta conditions and temperature; Amorphous and crystalline states of polymers; Determination of crystallinity; Determinations of thermal transitions; Dialatometry; Differential thermal analysis (DTA); Differential scanning calorimetry (DSC); Dynamic mechanical analysis (DMA).

2. Polymer Technology (15 h)

2.1. Structure-property relationships of plastics (2 h)

Polyethylene, polypropylene, polystyrene, polyvinyl chloride, polymethyl methacrylate, nylons, polyesters, polycarbonates, and polytetrafluoro ethylene.

2.2. Structure-property relationships of rubbers (2 h)

Polyisoprene, polybutadiene, polychloroprene, styrene butadiene copolymer, acrylontrile-butadiene copolymer, ethylene-propylene diene monomer terpolymers, and silicone rubbers.

2.3. Introduction to plastics based product manufacture (4 h)

Melt processing of plastics, extrusion, injection moulding, and blow moulding; Elastomer state processing – vacuum forming; Compression moulding; Blown film manufacture.

2.4. Introduction to dry rubber-based product manufacture (4 h)

Mastication of rubber (mechano-chemical process); Materials used in rubber product manufacture and compounding of dry rubber; Vulcanization of rubbers:

Vulcanizing agents and systems, effect of temperature and time on cross-linking, types of crosslinks relevant to properties; Measurement of cure characteristics; Vulcanizate properties; Introduction to product manufacture with rubber compounds (extruded, moulded and calendered rubber products.

2.5. Polyurethanes (3 h)

Introduction to materials used in the polyurethane industry and chemical reactions of diisocyanates with other materials to produce a polymer network; Manufacture of polyurethane foam; Chemical and physical blowing agents, gas bubble formation, growth and stabilization; Density and load bearing properties of the foam; Chain extenders and their reactions and contribution to strength properties of the polymer system.

Methods of Teaching and Learning

Lectures, tutorials, computer assisted learning, group work

Recommended readings

- Billmeyer Fred W. "Text book of Polymer Science" 03rd Edition, 2005.
- Hiemen Paul C. & Lodge Timothy P. "Polymer Chemistry" 02nd Edition, 2007.
- Stevens Malcolm P. "Polymer Chemistry" 03rd Edition, 2011.
- Blow C. M. & Hepburn C. "Rubber Technology" & Manufacture" 02nd Edition, 1982.
- Brydson J.A. "Plastics Materials" 07th Edition, 1997.

C 43016/CHE 43016 - Research Project

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: work in a research laboratory as a team player or a leader as needed;
ILO2: identify a research problem;
ILO3: conduct literature survey to a research problem;
ILO4: undertake a research project independently;
ILO5: obtain reliable measurements, perform statistical treatment and interpret them;
ILO6: demonstrate writing skills related to assigned projects;
ILO7: demonstrate presentation skills related to assigned projects;
ILO8: display appreciation of good practices in research laboratories.

Note: ILO means intended learning outcome.

1. Time duration of research project is minimum of 600 notional hours (equivalent to 6 months of full-time work).
2. The nature of the research undertaken will vary substantially depending on the subject discipline.
3. Students will be working with a research supervisor who shall provide necessary guidance. In the event a student conducts the research project at an external research laboratory, a co supervisor from the CCS shall be identified.
4. After successful completion of the placement,
   - o A dissertation (minimum 30 pages or 10000 words) should be submitted to the supervisors.
   - o A 15-minute presentation should be delivered with a question-and-answer session.
   - o A 30-minute viva session will be held in front of a panel.
   - o The dissertation produced should summarize details of the research project in which the student was engaged with strong focus of novel findings.
5. The report shall be marked by the research supervisor according to the CCS guidelines

Evaluation Criteria

The following components will be evaluated:

1. Literature survey and proposal writing.
2. Laboratory and/or field work (continuous assessment with respect to punctuality, responsibility, dedication, teamwork, leadership qualities, industrial etiquette, professionalism, etc.).
3. Data analysis and interpretation.
4. Dissertation.
5. Oral presentations.

C 43026/CHE 43026 - Industrial Placement and Scientific Training

Intended Learning Outcomes

On successful completion of the course unit, the student should be able to:

ILO1: work in industry as a team player or a leader as needed;
ILO2: identify problems in industrial processes;
ILO3: conduct literature survey to an industrial problem;
ILO4: undertake an industrial project independently;
ILO5: obtain reliable measurements, perform statistical treatment and interpret them;
ILO6: demonstrate writing skills related to assigned projects;
ILO7: demonstrate presentation skills related to assigned projects;
ILO8: display appreciation of good practices in industrial setting.

Note: ILO means intended learning outcome.

1. Time duration of industrial placement is minimum of 600 notional hours (equivalent to 6 months of full-time work).
2. Students are expected to take an active part, in cooperation with the placement coordinator, to secure an appropriate placement in industry in one of the above methods.
3. The nature of the work undertaken will vary substantially and solely depends upon the industry. However, students will be working with an industrial supervisor and a co supervisor from the CCS.
4. After successful completion of the placement,
    - o A report (minimum 30 pages or 10,000 words) should be submitted to the supervisor(s).
    - o A 15-minute presentation should be delivered with a question-and-answer session. (Students may be asked to present their work in the industry additionally)
    - o A poster will be presented to audience.
    - o A 30-minute viva session will be held in front of a panel.
5. The report produced should summarize the various projects in which the student was engaged, benefits gained and application of theory into practice.
6. The report shall be evaluated by the industrial supervisor according to the CCS guidelines.

Evaluation Criteria

The following components will be evaluated:

1. Literature survey and proposal writing.

2. Laboratory and/or field work (continuous assessment with respect to punctuality, responsibility, dedication, teamwork, leadership qualities, industrial etiquette, professionalism, *etc.*).

3. Data analysis and interpretation.

4. Report

5. Poster and oral presentations.

SCHOLARSHIPS, AWARDS & SUBJECT PRIZES

CCS Scholarships and financial benefits offered for prospective students at the enrollment

1. CCS Financial Aid Scholarships

Criteria

- The candidate must be a fresh applicant requiring financial assistance.
- Should have passed the Advanced level examination (local or London) in one sitting.
- Should have preferably obtained a minimum 'B' grade for chemistry.
- Should not be simultaneously enrolled in another degree programme while study at CCS.

Benefits

- A 100% waive off in composite tuition fee.
- Early bird payment schemes will apply irrespective of the date on which the scholarship is awarded.

Procedure

- The scholarship will be advertised through the website and newspapers.
- Scholarship winners will be selected after an interview, by a committee appointed by the Academic Board of ICHEMC.
- Both A/L results and the financial status of the applicant will be considered.

The number of Scholarships awarded per academic year

- A maximum of two applicants will be selected.

Note

- Awardee should maintain a minimum GPA of 3 at the end of each academic year for the scholarship to be continued. If the criteria are not fulfilled, the regular payments will apply.

2. Payment benefits for children of life cooperate members

Criteria

- The candidate must be an own child or a legally adopted child of the member.
- Membership designation of the parent must be either MIChemC or FIChemC
- The parent must have obtained lifetime membership at the time of application.

Benefits

- A 100% waive off in composite tuition fee.

- The payment schemes relevant to the date on which the payment is made will apply.

Procedure

- The parent should provide the membership certificate. The registrar in charge of membership should certify the life membership status of the parent.

The number of Scholarships awarded per academic year

- Unlimited.

Note

- 50% of the tuition fee should be transferred from the membership ledger and the remaining 50% should be sponsored by CCS.

3. Scholarships for DLT diplomates

Criteria

- Should have obtained honors pass at the DLT programme.

Benefits

- Level 1 and 2 theory tuition fee will be waived off.

Procedure

- Candidates must produce a document certified by the authorized personnel of the DLT program.

The number of Scholarships awarded per academic year

- Unlimited.

4. CCS Sports Scholarships

Criteria

- Should be a prospective student with school colors or any other national-level achievements in cricket, rugby, badminton or basketball.

Benefits

- 100% waive off in composite tuition fee, 50% waive off in fees for all levels registration.
- Early bird payment schemes will apply irrespective of the date on which the scholarship is awarded.

Procedure

- Selected after an interview by a committee appointed by the Academic Board of CCS. The Sports Mentor of CCS should be a part of the interview board.

- Priority will be given for strengthening the already existing sports teams. On such an occasion, priority will be given to the sports skills of the candidate over the academic background possessed by the student.

The number of Scholarships awarded per academic year

- A maximum of two scholarships per academic year.

Regulations for the scholarship

- Awardees must attempt all the compulsory courses offered every semester and maintain a GPA of 2.0.
- The prospective student should attend practices organized by the CCS team, for the respective sport with over 80% attendance.
- The prospective student should be present for all the practice matches and tournament matches organized CCS.
- If one or more of the above regulations are violated by the student, the scholarship will be invalid, and the refundable deposit will be deducted as a penalty.
- Should not be simultaneously enrolled in another degree programme while study at CCS.

5. CCS Entrance Scholarships

Criteria

- Will be based on the CCS entrance examination.

Benefits

- A 50% waive off in composite tuition fee.
- Will be granted on a refund basis after the student enrolls and sits for the scholarship exam.
- If the student has paid for the first two years, the scholarship will be utilized to include the composite fee.

Procedure

- The top two performers will be entitled.

The number of total merit bursaries awarded per academic year

- A maximum of two scholarships will be awarded per academic year.

6. CCS Entrance Merit Bursaries

Criteria

- Will be based on the CCS entrance examination.

Benefits

- Merit bursary I (full): one-year examination fee waive off
- Merit bursary II (partial): one-semester fee waive off

Procedure

- The coordinator and moderator of the entrance examination can decide the students who shall receive Merit Bursary I and Merit Bursary II awards.

The number of total merit bursaries awarded per academic year

- A maximum of 5% of the total student intake for a particular year.

Note:

- These scholarship schemes are valid for both GIC and BSc programmes.
- One candidate is eligible for only one scholarship at the enrollment.

Subject Prizes Prizes for Individual Courses

Criteria

The **highest mark achiever** is awarded the prize for that particular subject.
Note -: This is applied only for level 3 & 4 optional course units

If the first place has gone to level 4 student and the second place for level 3 student for a particular subject, then both of them share the subject prize of that particular course.

Subject prizes are offered for the 1st attempt student

Repeat students and the skipped 1st timers will not be entitled for the award

Prizes are awarded for each subject as given below.

Level 1 Courses

L1 semester 1

CHE 11012 Chemical Principles (Both GIC and BSc)
Graduate Chemist Alumni Prize for Chemical Principles

CHE 11022 Basic Organic Chemistry (Both GIC and BSc)
Professor & Mrs. S. Sotheeswaran Prize for Basic Organic Chemistry

CHE 11031 Classical Methods in Chemical Analysis I (Both GIC and BSc)
Mrs. Deepika Seneviratne and family Prize for Classical Methods in Chemical Analysis I

ALS 11052 Calculus (Both GIC and BSc)
Mr. & Mrs. J. M. Ranasinghe Banda Prize for Calculus

ALS 11062 Fundamentals of Physics for Chemists (Both GIC and BSc)
Abdul Salam Memorial Prize for Fundamentals of Physics for Chemists

APM 11102 Principles of Management (BSc only)
Mr. Sujeewa Lal Dahanayake Prize for Principles of Management

APM 11112 Optimization Methods in Management Science (BSc only)
Mrs. Shanthie Wijethunga Prize for Optimization Methods in Management Science

L1 semester 2

CHE 12012 Chemistry of Main Group and Transition Elements (Both GIC and BSc)
Dr. Gamini Rajanayake and Family Price for Chemistry of Main Group and Transition Elements

CHE 12022 Principles of Physical Chemistry I (Both GIC and BSc)
Emerine Fernando Memorial Prize for Principles of Physical Chemistry I

CHE 12032 Basic Concepts in Biochemistry I (Both GIC and BSc)
Professor Jayantha Welihinda Prize for Basic Concepts in Biochemistry I

CHE 12051 Classical Methods in Chemical Analysis II (Both GIC and BSc)
Tamara and Indunil Prize for Classical Methods in Chemical Analysis II

ALS 12062 Basic Electronics for Chemists (Both GIC and BSc)
Dr. M. N. Kaumal Prize for Basic Electronics for Chemists

ALS 12072 Basic Statistics I (Both GIC and BSc)
Dr. Supriya Warusawithana Prize for Basic Statistics I

APM 12102 Introduction to Industrial Economics (BSc only)
Stanely Kirinde Memorial Prize for Introduction to Industrial Economics

APM 12112 Accounting Concepts and Costing (BSc only)
Mr. & Mrs. Samarakodi Godakanda Prize for Accounting Concepts and Costing

Level 2 Courses

L2 semester 1

CHE 21012 Concepts in Inorganic Chemistry I (Both GIC and BSc)
Professor Samitha P. Deraniyagala Prize for Concepts in Inorganic Chemistry I

CHE 21022 Relative Intermediates in Organic Reactions and Organic Synthesis (Both GIC and BSc)
Nureshan Dias Prize for Relative Intermediates in Organic Reactions and Organic Synthesis

CHE 21032 Principles of Physical Chemistry II (Both GIC and BSc)
Professor J. N. Oleap Fernando Prize for Principles of Physical Chemistry II

CHE 21041 Basic Analytical Spectrometry (Both GIC and BSc)
Mr. Nimal Ratnasiri and Family Prize for Basic Analytical Spectrometry

CHE 21072 Basic Concepts in Biochemistry II (Both GIC and BSc)
IChemC and Clemson University Teachers' Award for Biochemistry II

ALS 21072 Basic Statistics II (Both GIC and BSc)
Mr. & Mrs. M. C. J. Fernando Prize for Basic Statistics II

APM 21102 Principles of Human Resource Management and Leadership (BSc only)
Mr. R. L. Manathunga Memorial Prize for Principles of Human Resource Management and Leadership

APM 21112 Marketing Management (BSc only)
Mr. W. W. Amila Priyadarsana and Family Prize for Marketing Management

L2 semester 2

CHE 22012 Concepts in Inorganic Chemistry II (Both GIC and BSc)
Mr. Wasantha Samarakoon Prize for Concepts in Inorganic Chemistry II

CHE 22022 Heterocyclic Chemistry and Spectroscopy (Both GIC and BSc)
Professor Siromi Samarasinghe Prize for Heterocyclic Chemistry and Spectroscopy

CHE 22032 Principles of Physical Chemistry III (Both GIC and BSc)
Prof. D. T. B. Tennakon Memorial Prize for Principles of Physical Chemistry III

CHE 22051 Separation Methods and Fundamentals of Chromatography (Both GIC and BSc)
Mikhail Tswett Prize for Separation Methods and Fundamentals of Chromatography

CHE 22061 Natural Products (Both GIC and BSc)
Mrs. Yasawathie Satharasinghe Memorial Prize for Natural Products

APM 22082 Computer Based Tools for Management (BSc only)
Dr. Chinthaka Ratnaweera and Family Prize for Computer Based Tools for Management

APM 22092 Total Quality Management (BSc only)
Y K G U Sarath Yatiwelle Memorial Prize for Total Quality Management

APM 22102 Operations Management (BSc only)
S. Ruhunage, J. V. Liyanage, P. K. B. Pathiraja & J. C. Fernando Prize for Operations Management

C 21073 - Introduction to Management Economics and Finance (GIC Only)
Henry Ashmore Pieris Memorial Prize for Introduction to Management, Economics and Finance (This subject is still there for GIC students)

Level 3 Courses

L 3 semester 1

CHE 31013 / C 31013 Advanced Inorganic Chemistry I
Dr. Lakshman Ponnamperuma Memorial Trust Prize for Advanced Inorganic Chemistry I

CHE 31022 / C 31022 Physical Organic Chemistry, Pericyclic Reactions and Natural Products Chemistry
Dr. S. Lakshman De Silva Memorial Trust Prize for Physical Organic Chemistry, Pericyclic Reactions and Natural Products Chemistry

CHE 31032 / C 31032 Quantum Chemistry and Molecular Spectroscopy
K. G. Karunasena Memorial Prize for Quantum Chemistry and Molecular Spectroscopy

CHE 31042 / C 31042 Electroanalytical Chemistry and Optical Spectroscopy
Ms. Poornima Jayasinghe Prize for Electroanalytical Chemistry and Optical Spectroscopy

CHE 31062 / C 31062 Environmental Chemistry
Microchem Laboratories (Pvt) Ltd Prize for Environmental Chemistry

CHE 31082 / C 31082 Polymer Science
Mevan Pieris Prize for Polymer Science

C 31093 Industrial Exposure
Denzil & Christobel Fernando Commemoration Prize for Industrial Exposure

L 3 semester 2

CHE 32012 / C 32012 Advanced Topics in Physical Chemistry I
Prof. Namal Priyantha and Prof. Ayanthi Nawarathne Prize for Advanced Topics in Physical Chemistry I

CHE 32022 / C 32022 Advanced Chromatography
Dharmachandra & Thamarasa Gunawardhana Memorial Prize for Advanced Chromatography

CHE 32032 / C 32032 Research Methodology
Mr. A. G. Gunaratna & Mrs. I. K. S. R. Ratnakalyani Prize for Research Methodology

CHE 32061 / C 32061 Seminar Presentation and Report Writing
K. Thirugnanasampandar Memorial Prize for Seminar Presentation and Report Writing

ALS 32072 / S 32072 Basic Chemical and Process Engineering
Professor Paul & Runy Prize for Basic Chemical and Process Engineering

APM 32082 Innovation and New Product Development
Dr. & Mrs. Swaminathan Memorial Prize for Innovation and New Product Development

C 32092 Chemical Laboratory: Design, Operation and Management
Mr. & Mrs. E. Gajanayake Prize for Chemical Laboratory: Design, Operation and Management

Level 4 Courses

L 4 semester 1

CHE 41022 / C 41022 Advanced Inorganic Chemistry II
Prof. P. P. G. L. Siriwardena Memorial Trust Prize for Advanced Inorganic Chemistry II

CHE 41023 / C 41023 Advanced Spectroscopy, Synthesis and Photochemistry
Pincock Prize for Advanced Spectroscopy, Synthesis and Photochemistry

CHE 41032 / C 41032 Advanced Topics in Physical Chemistry II
Institute of Chemistry Ceylon Alumni Association North American Chapter Prize for Advanced Topics in Physical Chemistry II

CHE 41042 / C 41042 Frontiers in Chemistry
Mr. & Mrs. Gamini Gunasekara Prize for Frontiers in Chemistry

CHE 41052 / C 41052 Advanced Biochemistry
Susila Jayaweera Memorial Prize for Advanced Biochemistry

APM 41062 Project Management
Dharmarathne Wasala Prize for Project Management

C 41172 Nanotechnology
Dr. Premaratne and family Prize for Nanotechnology

CHE 41093 / C 41093 Food Chemistry and Technology
E. G. Somapala Prize for Food Chemistry & Technology

L 4 semester 2

CHE 43016 / C 43016 Research Project
Dr. Lakshmi Arambewela Prize for Research Project Beneficial for the Country

CHE 43026 / C 43026 Industrial Placement and Scientific Training
Mr. P. R. K. Fernando Prize for Industrial Placement and Scientific Training

CHE 42012 Molecular Modeling and Molecular Simulations
Mr. & Mrs. N. I. N. S. Nadarasa Prize for Molecular Modeling and Molecular Simulations

CHE 42022 Selected Topics in Physical Chemistry II
W. R. O. Fernando Memorial Prize for Selected Topics in Physical Chemistry II

APM 42052 Professional Practice
Mr. Dineth Rodrigo Price for Professional Practice

CHE 42081 Mineral Resources in Sri Lanka - Chemistry and Applications
C 42081 Mineral Resources in Sri Lanka – Chemistry and Applications
Lakshmi Award for Mineral Resources in Sri Lanka – Chemistry and Applications

CHE 42132 Quality Management
C 42132 Quality Management
Piyadasa & Kalyanawathi De Silva Memorial Prize for Quality Management

CHE 42142 Further Topics in Environmental and Green Chemistry
C 42142 Further Topics in Environmental and Green Chemistry
Mr. & Mrs. H.S. Dias Memorial Prize for Further Topics in Environmental & Green Chemistry

Level 4 Electives

CHE 44063 / C 44063 Analytical Industrial Biochemistry
Mr. & Mrs. Suppiah & Seethadevi Prize for Analytical Industrial Biochemistry

CHE 44073 / C 44073 Electrochemical Technology
Mr. & Mrs. H. S. Dias Memorial Prize for Electrochemical Technology

CHE 44102 Agrochemicals
Deepa Sotheeswaran Gaschik Prize for Agrochemicals

CHE 44113 / C 44113 Chemical Education
Dr. A. P. De Silva Prize for Chemical Education

CHE 44122 / C 44122 Industrial Chemistry and Technology
Professor Eugene De Silva Prize for Industrial Chemistry & Technology

CHE 44152 / C 44152 Pharmaceutical Technology
Ms. Careen Manel Abeywardena Memorial Prize for Pharmaceutical Technology

CHE 44163 / C 44163 Pharmaceutical and Medicinal Chemistry
N. M. S. Hettigedara Family Prize for Pharmaceutical & Medicinal Chemistry

C 34012/44012 Petroleum and Petrochemistry
Mr. Cyril Suduwela Prize for Petroleum and Petrochemistry

C 34022/44022 Chemical Toxicology
Dr. Rohan Perera Prize for Chemical Toxicology

C 34033/44033 Further Management, Economics and Finance
Vasanthan & Menaka Prize for Further Management, Economics and Finance

C 34042/44042 Cosmetic Science and Clinical Herbal Product Development
E. R. Eratne Memorial Prize for Cosmetic Science and Clinical Herbal Product Development

C 34051/44051 Industrial Safety Health and Environmental Technology
Thambipillai Kandasamy Memorial Prize for Industrial Safety, Health and Environmental Technology

C 34063/44063 Molecular Biology and Biotechnology
Marina & R. O. B. Wijesekara Prize for Molecular Biology & Biotechnology

C 34072/44072 Textile Science and Clothing Technology
Ms. Kumudini De S. Goonetillake Prize for Textile Science and Clothing Technology

C 34081/44081 Applied Microbiology
Dr. Chandani Udawatte Prize for Applied Microbiology

C 34092/44092 Polymer Chemistry and Technology
Vidyajothi H. R. Premaratne Prize for Polymer Chemistry and Technology

AWARDS AND SCHOLARSHIPS

Overall Theory Awards and Scholarships - Level 1

First Prize and Nandawathie Jayaweera Memorial (Open) Scholarship

Second Prize and Charles Jayaweera Memorial (Open) Scholarship

Third Prize and Professor R. S. Ramakrishna Memorial Scholarship

Fourth Prize and Dr. Dilanjan and Ms. Gowrie Soysa Scholarship

Merit Bursaries (In order of merit)

Second Charles Jayaweera Memorial (Southern Province) Scholarship

Second Nandawathie Jayaweera Memorial (Southern Province) Scholarship

J. N. Oleap Fernando Memorial Scholarship (Level 1)

Overall Theory Awards and Scholarships - Level 2

First Prize & W. F. Peiris Memorial Trust Scholarship

Second Prize & Professor W. Pearlyn D. Perera Commemoration Trust Scholarship

Third Prize & Professor G. C. N. Jayasuriya Memorial Scholarship

Fourth Prize & Family Leelarathna Scholarship

Merit Bursaries (In order of merit)

J. N. Oleap Fernando Memorial Scholarship (Level 2)

Overall Theory Awards - Level 3

First Prize and Mandrupa & Oleap Fernando Hall Opening Scholarship

Second Prize and Susila Jayaweera Memorial Scholarship

Third Prize and Graduateship Silver Jubilee Scholarship

Merit Bursaries

Institute of Chemistry Ceylon President's Scholarship for level 4 Awarded for the Best overall performance in the Levels 1, 2 & 3

Overall Theory Awards - Level 3 & 4

First Royal Society of Chemistry (Sri Lanka) Section Award

Second Professor and Mrs. H. W. Dias Award

Third Rasanthika Nayomi Jayathissa Memorial Prize

Awards for Overall Excellence in all Levels of Study (Theory)

Professor J K P Ariyarathne Memorial Award for Overall Excellence in Inorganic Chemistry

Professor Leslie Gunathilake Award for Overall Excellence in Organic Chemistry

Haniffa Award for Overall Excellence in Physical Chemistry

Professors Saman & Asoka Patirathne Award for Overall Excellence in Analytical Chemistry

Best Performer Awards for Overall Excellence in Chemistry Practical

First Professor R. S. Ramakrishna Memorial Award

Second Mr. & Mrs. K. Sivarajah and Family Award

Third B. A. Jayasinghe Memorial Award and CCS Awards

Other Good Performer Awards

Graduateship (Overall) Awards

First Shireen Jayasuriya Memorial Gold Medal, for the best performances in all parts of the Graduateship Examination

Second Graduateship Silver Jubilee Commemoration Award

Third Graduate Chemist (25th Batch passing out) Silver Jubilee Commemoration Award

Graduateship All Rounder Prizes

Dr. R. O. B. Wijesekara Award for the Best All Rounder

Professor Noel G. Baptist Memorial Prize for the Second Best All Rounder

Chamikara Wijesinghe Award for the Third Best All Rounder

Certificate of Honourable Mention

FINANCIAL AID

To all Graduateship Students at all Levels
Grant of Named & CCS Bursaries

The following Bursaries are available for award on the basis of financial need to those students who will study at the levels indicated below.

Level 1

- Two CCS Bursaries (Minimum 40% overall mark at scholarship test is essential for consideration)

Level 2

- Charles Jayaweera Memorial (Open) Bursary
- Nandawathie Jayaweera Memorial (Open) Bursary
- Prof. R S Ramakrishna Memorial (Open) Bursary
- Dr. Dilanjan and Ms. Gowrie Soysa Bursary
- Charles & Nandawathie Jayaweera Memorial (Southern Province) Bursary
  (Specific to those who went to school in Southern Province or were resident there)
- CCS Bursaries

Level 3

- Prof. W P D Pereira Commemoration Bursary
- W F Pieris Trust Bursary
- Dr. G C N Jayasooriya Memorial Bursary
- Leelarathana Family Bursary
- CCS Bursaries

Level 4

- Mandrupa and Olep Fernando Hall opening Bursary
- Susila Jayaweera Bursary
- Graduateship Silver Jubilee Commemoration Bursary
- CCS Bursaries

Note

The names of recipients will be kept confidential and will not be publicized.

Dr and Mrs Sentheshanmuganathan Family Bursary

Criteria:

Students should be preferably from a low income family with a single parent/ Guardian.

The award of bursaries is to cover part of the accommodation and Living Expenses whole pursuing their studies in rented accommodation / boarding place in and around Colombo / Kotte etc.

College's Emergency Fund (earlier called Dean's Emergency Fund)

This fund was set up in the year 2005 with an initial contribution from Professor J N Oleap Fernando, Honorary Dean of the College, to form the nucleus of a fund that could be used to provide limited financial relief and assistance to students in distress in an emergency. Please contact the Rector/Dean/Academic staff/Registrar when necessary.

BY-LAWS

The Degree of Bachelor of Science Honours (Chemical Science)
Institute of Chemistry Ceylon
BY-LAWS

These By-Laws may be cited as the Bachelor of Science Degree or BSc degree By-Laws No: 01 of 2018. This shall apply to all the candidates registered for the Bachelor of Science Honours Degree Programme in Chemical Science in 2020 and thereafter.

INTRODUCTION

1. In terms of the Institute of Chemistry Ceylon, Act No. 15 of 1972, the Council of the Institute of Chemistry Ceylon shall have the authority to confer the Degree of Bachelor of Science Honours in Chemical Science [BSc(Hons)ChemicalSc] for a person who has been recommended for the conferment of the said Degree by the Academic Board of the Institute of Chemistry Ceylon (AB-IChemC).

2. The AB-IChemC shall make such a recommendation only for persons who have successfully fulfilled all requirements and conditions laid down in the By-Laws.

3. The College of Chemical Sciences (CCS), the educational arm of the Institute of Chemistry Ceylon (IChemC), shall offer the degree programme of BSc(Hons) ChemicalSc at SLQF - Exit Level 6.

4. The CCS is headed by the Dean, and comprises two departments, namely, Department of Chemistry and Department of Allied Sciences.

   4.1. Department of Chemistry offers more than 72 credits of course units in the subject area of Chemistry (major subject); Department of Allied Sciences offers 24 credits of Management course units. In addition, Department of Allied Sciences offers supplementary and enhancement course units.

   4.2. The minimum period of study for which a person shall be a registered student of the BSc(Hons)ChemicalSc programme shall be four academic years.

ADMISSION AND REGISTRATION

5.1 Admission: Subject to the By-Laws, a student shall be admitted to the CCS of the IChemC to follow the BSc(Hons)ChemicalSc programme (SLQF – Exit Level 6) if he/she fulfils the following minimum entry qualifications:

   5.1.1 Minimum of three passes in Physical/Biological Science stream subjects which include Chemistry as a subject at the G.C.E. (Advanced Level) Examination (Sri Lanka) in one sitting or

Other equivalent educational qualifications (including a pass in Chemistry) stipulated by the University Grants Commission (UGC) or the Ministry of Higher Education (MoHE) of Sri Lanka.

5.1.2 An aptitude test shall be conducted by the IChemC before the commencement of the programme to screen the basic chemistry knowledge of students.

5.1.3 Lateral entries from institutions recognized by the UGC or the MoHE are possible subject to the approval of the AB-IChemC.

5.2 Registration:

5.2.1 A person who has been admitted to the BSc(Hons)ChemicalSc programme shall register at the IChemC by submitting the duly completed registration form with the registration fee, tuition fee and other necessary deposits.

5.2.2 It is the responsibility of the student to keep his/her registration valid by paying the prescribed fees on or before the stipulated date until he/she completes the programme.

PROGRAMME OF STUDY

6. The BSc(Hons)ChemicalSc programme shall consist of four academic years, encompassing levels 1, 2, 3 and 4. A student shall be eligible to complete the degree within a maximum of eight academic years from the date of commencement of the academic programme.

6.1. An academic year shall consist of two semesters of minimum 15 weeks each of academic instruction under normal circumstances.

6.2. A student shall be eligible to continue from Level-2 to Level-3 of the BSc(Hons) ChemicalSc programme if he/she fulfils the conditions prescribed under paragraph 13 of the By-Laws.

6.3. Under valid reasons, the Academic Board of the CCS (AB-CCS) may recommend permission to extend the maximum allowed period to complete the above mentioned degree by one year.

7. The BSc(Hons)ChemicalSc programme consists of the following types of course units:

(i) Chemistry (CHE) course units;
(ii) Management (APM) course units;
(iii) Supplementary (ALS) course units;
(iv) Enhancement (ENH) course units.

Course units of (i), (ii) and (iii) above shall be used for the computation of Grade Point Average (GPA), and shall be referred to as GPA course units. A letter grade shall be awarded for such course units as described in Paragraph 17, whereas a pass/fail grade shall be awarded for Enhancement course units. The results of Enhancement course units shall not be considered for the computation of GPA.

A course unit has a time-based credit value. Course units could be compulsory or elective. Compulsory course units are the course units which are mandatory to be followed. Elective course units are the course units which can be selected by students to make up a required number of credits. Elective course units provide a broader knowledge of the subject.

8. In the BSc(Hons)ChemicalSc programme, a student shall register for,

   8.1. all the compulsory course units offered under Chemistry, Management and any other compulsory course units recommended for each of the four levels, and

   8.2. minimum of 30 and a maximum of 33 credits from courses used for the computation of GPA at Levels 1, 2 and 3, and

   8.3. minimum of 120 and a maximum of 126 total credits from GPA course units during the four levels, and

   8.4. total of 6 credits of enhancement course units during Level-1 and Level-2.

9. The evaluation methods and other relevant details pertaining to evaluations are given in paragraph 16 of this document.

10. On the recommendation of the AB-CCS, the AB-IChemC has the authority to change or amend or add any regulations and rules relating to any requirements of the BSc(Hons)ChemicalSc programme. Prior notice of one academic year shall be given to the students of such amendments, changes or additions.

11. Teaching of course units (e.g. lectures, laboratory classes, assignments, tutorials, reports, presentations, seminars or research) and their methods of delivery (e.g. face-to-face, virtual or self-learning platforms) shall be approved by the AB-CCS.

12. All lecturers shall be qualified senior academics/researchers/industrialists approved by the AB-CCS.

ELIGIBILITY CRITERIA TO CONTINUE FROM LEVEL-2 TO LEVEL-3 AND TO FOLLOW THE RESEARCH PROJECT/INTERNSHIP

13. A student shall be eligible to continue from Level-2 to Level-3 of the BSc(Hons) ChemicalSc programme provided that he/she has

i) obtained grades of C or better for,

16 credits of Chemistry (CHE) course units,

4 credits of Supplementary (ALS) course units,

8 credits of Management (APM) course units,

and

ii) passed 3 credits of Enhancement (ENH) Course units,

offered at Level-1 and Level-2.

14. A student shall be eligible to carry out a Research Project at Level-4 if he/she has obtained a minimum cumulative GPA of 2.50 for all the compulsory course units in Chemistry offered at Levels 1 and 2. If the cumulative GPA is equal or above 2.00, he/she shall be eligible for internship. If a student is not able to achieve the required GPA to undertake the internship, he/she may repeat relevant course units in subsequent attempts to upgrade the GPA to be eligible for internship.

ATTENDANCE

15.1. To be eligible to sit the end-semester examination of a practical course unit, the minimum attendance requirement shall be 80%. Those who do not fulfil this requirement only due to a valid reason acceptable to the AB-CCS shall be allowed to sit the final practical assessment. Students who do not have a valid reason for having less than 80% attendance shall sit the final practical assessment as repeat candidates, and the maximum grade earned shall be a 'C'.

15.2. If a student re-registers for a practical course unit of the BSc(Hons)ChemicalSc programme due to low attendance, the actual grade earned shall be considered.

EVALUATION

16. The performance of students in each course unit shall be evaluated by continuous assessment and/or end-semester examination as announced at the commencement of the relevant course unit.

16.1. The evaluation at the end of the semester shall be based on a written examination or practical assessment or any other component as published in the Learning Management System (LMS) prior to the commencement of the

semester and in the student prospectus.

16.2. The continuous assessment may be based on a specified combination of assignments, including laboratory work, in-class tests, tutorials, quizzes, presentations, reports, mid-semester written examination(s), oral examination(s) and participation in other course activities. The evaluation criteria for each course unit shall be announced at the commencement.

16.3. Examinations shall be conducted by examiners appointed by the AB-IChemC on the recommendation of the AB-CCS.

16.4. A student in a particular academic year of the BSc(Hons)ChemicalSc programme shall sit the relevant examinations held in that year.

16.5. A student who fails to sit an examination (theory and/or practical) due to medical or any other valid reasons shall inform the Dean with supporting documents within two weeks of the date of the examination. Such a student shall be eligible to sit the next subsequent examination as a first-time candidate, subject to the approval of the AB- IChemC on the recommendation of the AB-CCS.

16.6. If the AB-IChemC is not satisfied with the reason(s) given for failing to sit an examination, such students shall be considered as students who have sat the examination.

16.7. A student who obtains a grade below 'C' for a course unit may re-sit that course unit at the next immediately available examination (for maximum of two attempts) for the purpose of improving the grade. In such situations, the maximum grade obtainable is 'C'. In an event a student obtains a grade lower than the previous grade, he/she shall be entitled to the previous grade. No provision is available for attempts to upgrade grades of 'C' or above.

16.8. When repeating a course unit, the marks obtained by a student for continuous assessments in the first attempt are considered for the calculation of the composite mark in assigning the final grade.

16.9. The marks obtained for the research project or internship shall not be allowed to be improved by repeating these course units.

AWARD OF THE DEGREE

17. Grades for a course unit shall be assigned based on the composite mark of the end-semester examination and other types of evaluations. Each grade shall carry a corresponding Grade Point Value (GPV) as given below:

Grade	Grade Point Value (GPV)
A^+	4.00
A	4.00
A^-	3.70
B^+	3.30
B	3.00
B^-	2.70
C^+	2.30
C	2.00
C^-	1.70
D^+	1.30
D	1.00
E	0.00

18. The performance of a student is determined by the GPA, which shall be calculated taking into account the grades of every GPA course unit for which the student has registered in his/her programme of study, with each such course unit being weighted according to its credit value. The following formula shall be used for computing cumulative GPA:

$$\text{GPA} = \frac{\sum n_i \, \text{GPV}_i}{\sum n_i}$$

where n_i is the number of credits of the i^{th} course unit and GPV_i is the grade point value of the i^{th} course unit earned by the student. The GPA shall be calculated to three decimal places, and reported with two decimal places after being rounded off.

19. The Semester Grade Point Average (SGPA), the performance of a student in a given semester, shall be calculated using the above formula for all course units registered in that semester.

20. A candidate is deemed to have qualified for the award of the BSc(Hons)ChemicalSc, if he/she has:

20.1. completed a minimum of 120 credits out of which minimum of 72 credits are Chemistry and 24 credits are Management, **and**

20.2. completed minimum of 45 credits of compulsory course units in Chemistry in Level-3 and Level-4, **and**

20.3. completed a research project or an internship under the supervision of a qualification holder of SLQF level 10, 11 or 12 and submitted a dissertation/ report for assessment

(Note: If the supervisor of the research project or the internship does not hold the required qualifications as specified above, approval should be granted by the CCS before such supervision is undertaken.), **and**

20.4. completed the degree in minimum of four academic years and maximum of eight academic years from the date of commencement of the degree programme, **and**

20.5. obtained a minimum cumulative GPA of 2.00 for all the course units registered during the academic programme, **and**

20.6. not obtained grades of 'E' for more than 8 credits, **and**

20.7. obtained passing grades for enhancement course units totaling to eight credits which include four credits of Level 4 enhancement course units.

20.8. has no record of violation of "Code of Conduct for Students" of the IChemC. An event of violation of the Code of Conduct by a student shall be dealt with student shall be dealt with the AB-CCS and reported to the AB-IChemC.

Note: 'Completed' a course unit means that the candidate has completed all required assignments and projects, and sat the final examination.

21. A candidate who satisfies the requirements given in the above Paragraph 20 and has the GPA values indicated below, provided that he/she has completed all the requirements within four consecutive academic years and obtained no 'E' grades for any of the course units shall be deemed to have qualified for a class in the BSc(Hons) ChemicalSc programme.

GPA value	Class Awarded
Minimum of 3.70	First Class
Minimum of 3.30	Second Class (Upper Division)
Minimum of 3.00	Second Class (Lower Division)

22. The effective date of the BSc(Hons)ChemicalSc shall be the next day of the date of completion of all examinations.

23. Students who do not qualify for a pass shall be deemed to have repeated/failed the BSc(Hons)ChemicalSc programme.

24. **Verification of Grades**

Students shall be given the opportunity to request for the verification of grade within two weeks of releasing results of course units, by paying the recommended fee. The final recommendation made by the committee appointed for the verification of marks shall be submitted to the AB-IChemC for approval.

INTERPRETATIONS

25. In these By-Laws:
"Institute of Chemistry" means the Institute of Chemistry Ceylon as established by the Act of Parliament No. 15 of 1972.
"Council" means "Council of the Institute of Chemistry Ceylon".
"Dean" means "the Dean of the College of Chemical Sciences".
"AB-IChemC" means the "Academic Board of the Institute of Chemistry Ceylon".
"AB-CCS" means the "Academic Board of the College of Chemical Sciences".

26. All matters concerning interpretation of these By-Laws shall be referred to the Council of the Institute of Chemistry Ceylon which after obtaining the views of the Academic Board of the Institute of Chemistry makes a decision on such questions. The decision of the Council shall be final.

The Graduateship Programme in Chemistry (GIC)
Institute of Chemistry Ceylon
BY-LAWS

These By-Laws may be cited as the Graduateship Programme in Chemistry or GIC By-Laws No: 01 of 2020. This shall apply to all the candidates registered for the Graduateship Programme in Chemistry in 2021 and thereafter.

INTRODUCTION

1. In terms of the Institute of Chemistry Ceylon, Act No. 15 of 1972, the Council of the Institute of Chemistry Ceylon shall have the authority to confer the Graduateship in Chemistry [GIC] for a person who has been recommended for the conferment of the said Degree by the Academic Board of the Institute of Chemistry Ceylon (AB-IChemC).

2. The AB-IChemC shall make such a recommendation only for persons who have successfully fulfilled all requirements and conditions laid down in the By-Laws.

3. The College of Chemical Sciences (CCS), the educational arm of the Institute of Chemistry Ceylon (IChemC), shall offer the GIC Programme.

4. The CCS is headed by the Dean, and comprises two departments, namely, Department of Chemistry and Department of Allied Sciences.

   4.1. Department of Chemistry offers more than 72 credits of course units in the subject area of Chemistry (major subject); Department of Allied Sciences offers course units in other subject disciplines.

   4.2. The minimum period of study for which a person shall be a registered student of the GIC Programme shall be four academic years.

ADMISSION AND REGISTRATION

5.1. **Admission:** Subject to the By-Laws, a student shall be admitted to the CCS of the IChemC to follow the GIC Programme if he/she fulfils the following minimum entry qualifications:

5.1.1 Minimum of three passes in Physical/Biological Sciences stream subjects which include Chemistry as a subject at the G.C.E. (Advanced Level) Examination (Sri Lanka) **or**

Other equivalent educational qualifications (including a pass in Chemistry) approved by the AB-IChemC.

Note: Passing three subjects, including Chemistry, in two sittings is also allowed.

5.1.2 An aptitude test shall be conducted by the IChemC before the commencement of the programme to screen the basic chemistry knowledge of students.

5.1.3 Lateral entries from institutions are possible subject to the approval of the Council upon the recommendation of the AB-IChemC.

5.2 **Registration:**

5.2.1 A person who has been admitted to the GIC Programme shall register at the IChemC by submitting the duly completed registration form with the registration fee, tuition fee and other necessary deposits.

5.2.2 It is the responsibility of the student to keep his/her registration valid by paying the prescribed fees on or before the stipulated date until he/she completes the programme.

PROGRAMME OF STUDY

6. The GIC Programme shall consist of four academic years, encompassing levels 1, 2, 3 and 4. A student shall be eligible to complete the Graduateship after completion of all course units designed for the four academic years.

6.1. An academic year shall consist of two semesters of minimum 15 weeks each of academic instruction under normal circumstances.

6.2. A student shall be eligible to continue from Level-2 to Level-3 of the GIC Programme if he/she fulfils the conditions prescribed under paragraph 13 of the By-Laws.

7. The GIC Programme consists of the following types of course units:

(i) Chemistry and applied chemistry course units;
(ii) Supplementary course units;
(iii) Enhancement course units.

Course units in the categories of (i) and (ii) above shall be used for the computation of Grade Point Average (GPA), and shall be referred to as GPA course units. A letter grade shall be awarded for such course units as described in Paragraph 17, whereas a pass/fail grade shall be awarded for Enhancement course units. The results of Enhancement course units shall not be considered for the computation of GPA.

A course unit has a time-based credit value. Course units could be compulsory or elective. Compulsory course units are the course units which are mandatory to be followed. Elective course units are the course units which can be selected by students

to make up a required number of credits. Elective course units provide a broader knowledge of the subject.

8. In the GIC Programme, a student shall register for,

   8.1. all the compulsory course units offered under Chemistry and other compulsory course units recommended for each of the four levels, and

   8.2. maximum of 126 total credits from GPA courses during the four levels, and

   8.3. total of 9 credits of enhancement course units during Level-1 and Level-2.

9. The evaluation methods and other relevant details pertaining to evaluations are given in paragraph 16 of this document.

10. On the recommendation of the AB-CCS, the AB-IChemC has the authority to change or amend or add any regulations and rules relating to any requirements of the GIC Programme.

11. Teaching of course units (e.g. lectures, laboratory classes, assignments, tutorials, reports, presentations, seminars or research) and their methods of delivery (e.g. face-to-face, virtual or self-learning platforms) shall be approved by the AB-CCS.

12. All lecturers shall be qualified senior academics/researchers/industrialists approved by the AB-CCS.

ELIGIBILITY CRITERIA TO CONTINUE FROM LEVEL-2 TO LEVEL-3 AND TO FOLLOW THE RESEARCH PROJECT/INTERNSHIP

13. A student shall be eligible to continue from Level-2 to Level-3 of the GIC Programme provided that he/she has

   i) obtained grades of C or better for,

      (a) 18 credits of Chemistry course units,

      (b) 6 credits of Supplementary course units,

   and

   ii) passed 4 credits of Enhancement course units,

   offered at Level-1 and Level-2.

14. A student shall be eligible to carry out a Research Project at Level-4 if he/she has obtained a minimum cumulative GPA of 2.50 for all the compulsory course units in Chemistry offered at Levels 1 and 2. If the cumulative GPA is equal or above 1.50, he/she shall be eligible for internship. If a student is not able to achieve the required GPA

to undertake the internship, he/she may repeat relevant course units in subsequent attempts to upgrade the GPA to be eligible for internship.

ATTENDANCE

15.1 To be eligible to sit the end-semester examination of a practical course unit, the minimum attendance requirement shall be 80%. Those who do not fulfil this requirement only due to a valid reason acceptable to the AB-CCS shall be allowed to sit the final practical assessment. Students who do not have a valid reason for having less than 80% attendance shall sit the final practical assessment as repeat candidates, and the maximum grade earned shall be a 'C'.

15.2 If a student re-registers for a practical course unit of the GIC Programme due to low attendance, the actual grade earned shall be considered.

EVALUATION

16. The performance of students in each course unit shall be evaluated by continuous assessment and/or end-semester examination as announced at the commencement of the relevant course unit.

16.1. The evaluation at the end of the semester may be based on a written examination or practical assessment or any other component as published in the Learning Management System (LMS) prior to the commencement of the semester and in the student prospectus.

16.2. The continuous assessment may be based on a specified combination of assignments, including laboratory work, in-class tests, tutorials, quizzes, presentations, reports, mid-semester written examination(s), oral examination(s) and participation in other course activities. The evaluation criteria for each course unit shall be announced at the commencement of the course unit.

16.3. Examinations shall be conducted by examiners appointed by the AB-IChemC on the recommendation of the AB-CCS.

16.4. A student who obtains a grade below 'C' for a course unit may re-sit that course unit for the purpose of improving the grade. In such situations, the maximum grade obtainable is 'C'. In an event a student obtains a grade lower than the previous grade, he/she shall be entitled to the previous grade. No provision is available for attempts to upgrade grades of 'C' or above.

16.5. In the event of a student having the overall GPA less than 2.00, the actual grade(s) earned by repeating course unit(s) shall be considered to re-compute the overall GPA up to a maximum value of 2.00.

16.6. When repeating a course unit, the marks obtained by a student for continuous assessments in the first attempt are considered for the calculation of the composite mark in assigning the final grade.

16.7. The marks obtained for the research project or internship shall not be allowed to be improved by repeating these course units.

AWARD OF THE GRADUATESHIP IN CHEMISTRY

17. Grades for a course unit shall be assigned based on the composite mark of the end-semester examination and other types of evaluations. Each grade shall carry a corresponding Grade Point Value (GPV) as given below:

Grade	Grade Point Value (GPV)
A^+	4.00
A	4.00
A^-	3.70
B^+	3.30
B	3.00
B^-	2.70
C^+	2.30
C	2.00
C^-	1.70
D^+	1.30
D	1.00
E	0.00

18. The performance of a student is determined by the GPA, which shall be calculated taking into account the grades of every GPA course unit for which the student has registered in his/her programme of study, with each such course unit being weighted according to its credit value. The following formula shall be used for computing cumulative GPA:

$$\text{GPA} = \frac{\sum n_i \, \text{GPV}_i}{\sum n_i}$$

where n_i is the number of credits of the i^{th} course unit and GPV_i is the grade point value of the i^{th} course unit earned by the student. The GPA shall be calculated to three decimal places, and reported with two decimal places after being rounded off.

19. The Semester Grade Point Average (SGPA), the performance of a student in a given semester, shall be calculated using the above formula for all course units registered in that semester.

20. A candidate is deemed to have qualified for the award of the GIC Programme, if he/she has:

20.1. completed a minimum of 120 credits out of which minimum of 72 credits are Chemistry and

20.2. completed minimum of 48 credits of course units in Chemistry in Level-3 and Level-4 and

20.3. completed a research project or an internship under the supervision of a qualified person upon the recommendation of the CCS, and submitted a dissertation/report for assessment, and

20.4. obtained a minimum cumulative GPA of 2.00 for all the course units registered during the academic programme, and

20.5. not obtained grades of 'E' for more than 8 credits and

20.6. obtained passing grades for enhancement course units totaling to eight credits which include four credits of Level 4 enhancement course units.

20.7. has no record of violation of "Code of Conduct for Students" of the IChemC. An event of violation of the Code of Conduct by a student shall be dealt with AB-CCS and reported to AB-IChemC.

Note: 'Completed' a course unit means that the candidate has completed all required assignments and projects, and sat the final examination.

21. A candidate who satisfies the requirements given in Paragraph 20 and has the GPA values indicated below, provided that he/she has completed all the requirements within four consecutive academic years, and that he/she has earned no 'E' grades shall be deemed to have qualified for a first class in the GIC Programme. Further, maximum of 3 credits of 'E' grades shall be allowed to be qualified for a second class in the GIC Programme.

GPA value	Class Awarded
Minimum of 3.70	First Class
Minimum of 3.30	Second Class (Upper Division)
Minimum of 3.00	Second Class (Lower Division)

22. The effective date of the GIC Programme shall be the next day of the date of completion of all examinations.

23. Students who do not qualify for a pass shall be deemed to have repeated/failed the GIC Programme.

24. **Verification of Grades**

Students shall be given the opportunity to request for the verification of grade within two weeks of releasing results of a course unit, by paying the recommended fee. The final recommendation made by the committee appointed for the verification of marks shall be submitted to the AB-IChemC for approval.

INTERPRETATIONS

25. In these By-Laws:

"Institute of Chemistry" means the Institute of Chemistry Ceylon as established by the Act of Parliament No. 15 of 1972.

Council" means "Council of the Institute of Chemistry Ceylon".

"Dean" means "the Dean of the College of Chemical Sciences".

"AB-IChemC" means the "Academic Board of the Institute of Chemistry Ceylon".

"AB-CCS" means the "Academic Board of the College of Chemical Sciences".

"GIC Programme" means the "Graduateship Programme in Chemistry".

26. All matters concerning interpretation of these By-Laws shall be referred to the Council of the Institute of Chemistry Ceylon which after obtaining the views of the Academic Board of the Institute of Chemistry makes a decision on such questions. The decision of the Council shall be final.

CODE OF CONDUCT FOR STUDENTS

Code of Conduct for Students
College of Chemical Sciences, Institute of Chemistry Ceylon

1. **Introduction**

This Code of Conduct shall apply to all students at the IChemC. In addition to all academic and social activities at the IChemC premises, the code of conduct also applies to IChemC sponsored or supervised events outside, which may affect the reputation of the IChemC. Rules and regulations of the IChemC that are not listed below, are also applicable. When a student is considered to be a threat to another person, to himself or herself, to the property or to the orderly functioning of the IChemC, section-3 of this document shall be followed. The IChemC expects its student community to be well disciplined. Severe disciplinary action will be taken for unethical and illegal behaviors of the students.

2. **Prohibited Conduct**

Examples of prohibited conduct include, without limitation:

- Plagiarism, copyright infringement and cheating of academic work
- Examination offences (as listed in pages 207-208)
- Aggressive behavior, violence towards human and physical resources
- Being disrespectful and disobedient
- Damaging, unauthorized use of property, services and information
- Possession of alcohol or narcotics, and being intoxicated in the IChemC premises
- Discrimination against race, colour, gender, religion and ethnic background
- Mental and physical harassment for others
- Theft
- Ragging and bullying

2.1. Ragging and bullying

Ragging and bullying is completely prohibited for students of the IChemC. Suitable disciplinary action will be taken for any student/ students who is/are charged with these activities.

IChemC defines ragging as any act which causes, or is likely to cause physical or psychological injury, fear or mental pain to a student of IChemC. Any student who behaves in such a manner will be accused of ragging.

IChemC defines bullying as electronic, written, verbal, or physical act or a series of acts consisting of physical, social, or emotional domination of a

student or a group of students. Any student who behaves in such a manner will be accused of bullying.

2.2. Use of alcohol, tobacco and drugs

Usage or distribution of cigarettes, alcohol and narcotic substances at IChemC events and activities are strictly prohibited. The IChemC defines above events as academic, intellectual, cultural or social gatherings, which are open to all students, alumni, academic staff and/or non-academic staff of the IChemC.

3. **Disciplinary Action**

If any student is accused of not adhering with the code of conduct, he/she shall be requested to face a hearing before a disciplinary committee, and the following sanctions or disciplinary action may be imposed separately or in combination. This list of sanctions or disciplinary action is not exhaustive. The IChemC reserves the right to impose additional sanctions or disciplinary action not listed herewith.

Procedure to be followed for disciplinary action

- When a complaint is received by the Dean, a three member committee shall be appointed by the AB-IChemC.
- This committee shall gather evidence regarding the incident and determine whether it is a violation of conduct.
- The committee shall inform their observations to the President who in turn shall report to the Council.
- If the violation is not deemed to be serious, it shall be resolved through a discussion between the involved parties.
- If it is a violation of conduct, the Council shall authorize a preliminary inquiry and appoint a board of inquiry. Based on the report of the preliminary inquiry, the Council shall authorize a formal inquiry and appoint the board.
- Based on the report of the formal inquiry, the Council shall implement the recommendations.
- These recommendations may include, though not limited to the following:
- Termination of Privileges
- Health and Wellness Assessment: for certain code violations
- Suspension from IChemC premises and all its activities
- Dismiss from the IChemC

Examination offences and punishments

1. Any candidate who violates any of the conditions stipulated in the Code of Conduct shall be considered as having committed an examination offence.

2. Examination offences shall include the following:

   (a) Possession of unauthorized material

   (b) Possession of any written material relevant or irrelevant to the respective exam, concealed or noted down on body parts or clothing, or any other authorized material such as admission card, calculator, stationery etc.

   (c) Removal of examination stationery

   (d) Disorderly conduct

   (e) Copying

   (f) Disturbing other candidates

   (g) Obtaining or attempting to obtain improper assistance

   (h) Cheating or attempting to cheat

   (i) Impersonation

   (j) Aiding and abetting the commission of any of these offences

   (k) Violation of any of the requirements or conditions stipulated above

3. In the event that a student has been in possession of any unauthorized material at an examination hall, he/she shall be presumed to have made use of such material.

4. In case of disorderly conduct, the Supervisor may exclude the candidate from the examination hall and issue him/her a letter cancelling his/her candidature from the examination, and submit a formal report to the Registrar of Examinations.

5. In all other cases of examination offences detected, the Supervisor of the examination shall obtain a statement from the candidate and write his/her report on the matter in the form provided for this purpose.

6. In all cases of examination offences detected, the Supervisor of the examination shall submit a formal report to the Registrar of Examinations within 24 hours of the finishing time of the examination.

7. The Registrar of Examinations shall place all reports of examination offences submitted by the Supervisors for the consideration of the Dean, who shall refer them to the Examination Disciplinary Committee for further action. The Examination

Disciplinary Committee chaired by the Dean of College of Chemical Sciences (CCS), shall investigate and make suggestions, including possible punishments regarding examination offences. The punishments recommended by the Examination Disciplinary Committee shall be submitted to the Educational Committee of the Institute of Chemistry Ceylon (IChemC) for the final decision.

8. Any allegations regarding committing of examination offences, submitted by the Registrar of Examinations to the Dean, shall decide whether these shall be referred to the Examination Disciplinary Committee for necessary action.

9. A candidate who is found guilty of an examination offence is liable to any one or more of the following punishments.

   a) Removal of his/her name from the pass list.

   b) Cancellation of his/her candidature from whole or part of the examination, or

   c) Suspension from any examination conducted by CCS for such period as the IChemC may decide, or indefinitely, or

   d) Suspension from the CCS for such period as the IChemC may decide, or indefinitely.

10. Any candidate found aiding and abetting any examination offence, shall be liable to the same punishment as that applicable to the offence.

11. Any appeal against the decision of the Educational Committee shall be made to the Council.

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