

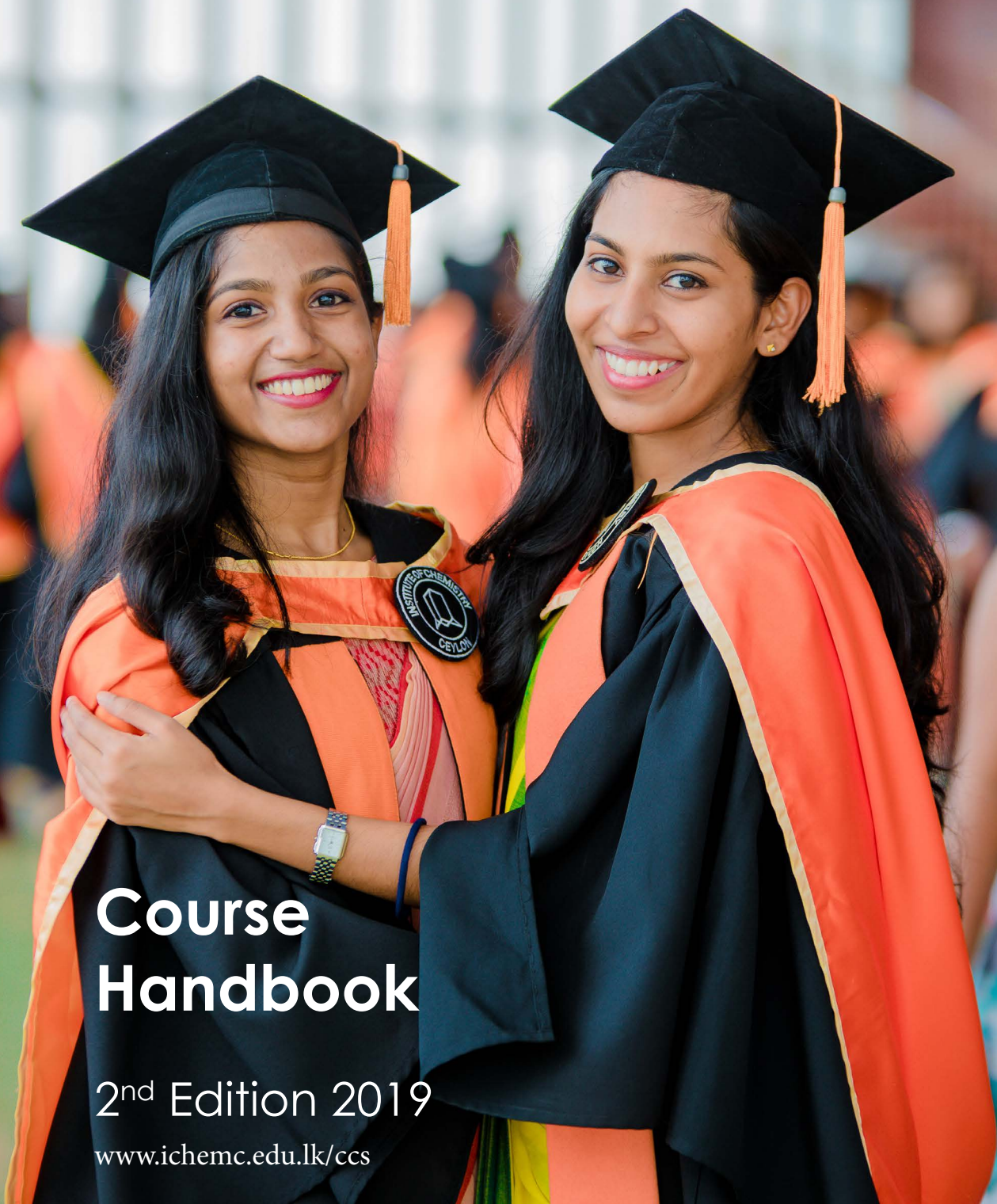


College of
Chemical Sciences



Institute of Chemistry Ceylon

Graduateship Programme in Chemistry



Course
Handbook

2nd Edition 2019

www.ichemc.edu.lk/ccs

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Message from the Dean



The College of Chemical Sciences of Institute of Chemistry Ceylon is committed to excel in teaching, research, services and public outreach. It provides a highly diverse and nourishing environment which enables students to actively participate technologically-based society and job market as top priority. The College activities are empowered through the skills and creativity of the academic staff members who have completed their PhDs in multi-disciplinary areas related to chemistry and they offer quality services in teaching and research in the areas of physical/analytical chemistry, organic, inorganic chemistry and biochemistry/molecular biology. Therefore, the college has a dynamic, vibrant and highly stimulating teaching and research environment which is achieved through a blend of high quality academic staff members who are committed to learning and scientific discovery.

The range of courses reflects the 'centre stage' that Chemistry occupies within the sciences and many of these courses facilitate our students to pursue postgraduate studying abroad or to gain wide range of career opportunities available to Chemistry graduates. The College also offers Diploma in Laboratory Technology Programme (DLTC) to provide middle level technical expertise which involves chemical analysis and research as it is a pressing need for students who cannot enter the university. I am also proud of our current students and our alumni as some of their achievements are highlighted in previous newsletters or in the journal, 'Chemistry in Sri Lanka'. I invite you to join us in our journey to continually strive for excellence in teaching, learning, scientific discovery and transformative knowledge translation.

Prof. H M K K Pathirana

Dean, College of Chemical Sciences

Institute of Chemistry Ceylon

The Institute of Chemistry Ceylon is the successor to the Chemical Society of Ceylon (founded 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 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. A statutory committee known as the Academic Board of the College of Chemical Sciences 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 Board which is headed by the Chairman and includes Vice Chairman, Secretary for Educational Affairs, Assistant Secretary and eleven other elected members. Additionally, the President of the Institute, 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 *ex-officio* members of the Academic Board. The Chief Executive Officer of the Board is the Honorary Rector appointed annually by the Council. Day to day administration is carried out by a full-time Dean also appointed annually by the Council. Full time Academic Staff Members constitute the internal academic staff (please see appendix V) 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. (see pages 67-69 for list of staff, officers & officials)

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 College of Chemical Sciences

The educational and allied activities of the College are carried out under the authority of the Academic Board of the College which is appointed annually by the Council. The Academic Board of the College of Chemical Sciences 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 College of Chemical Sciences.
- (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 College of Chemical Sciences.
- (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.

Internal Academic Staff



Dr. U. Sisira K. Weliwegamage
*B.Sc., Ph.D. (Peradeniya), C.Chem.,
M.I.Chem.C.
Senior Lecturer I*



Dr. (Mrs) Chandani Udawatte
*Grad. Chem., Ph.D. (Loyola),
C.Chem., M.I.Chem.C.
Senior Lecturer I*



Dr. (Mrs.) T. Gobika
*Grad.Chem., Ph.D. (Heriot-Watt),
C.Chem., M.I.Chem.C.
Senior Lecturer I*



Dr. Udaya K. Jayasundara
*B.Sc. (Peradeniya), Ph.D. (Nevada),
C.Chem., M.I.Chem.C.
Senior Lecturer II*



Dr. Sameera R. Gunatilake
*Grad. Chem., Ph.D. (Mississippi State),
C.Chem., M.I.Chem. C.
Senior Lecturer II*



Dr. (Mrs.) Dinusha N. Udukala
*B.Sc. (Colombo), Ph.D. (Kansas State),
C.Chem., M.I.Chem.C
Senior Lecturer II*



Dr. Chinthaka N. Ratnaweera
*B.Sc. (Colombo), M.Sc. (Kelaniya),
Ph.D. (Mississippi State),
C.Chem., M.I.Chem.C.
Senior Lecturer II*



Dr. (Ms.) Medha J. Gunaratna
*Grad.Chem., B.Sc. (Colombo),
Ph.D. (Kansas State)
Senior Lecturer II*

Visiting Lecturers – Names & Qualifications

University of Colombo

Department of Chemistry

Prof. M. D. P. de Costa: *B.Sc. (Colombo), Ph.D. (Dalhousie), C.Chem., F.I.Chem.C.*

Senior Professor

Prof. R. S Dassanayake: *B.Sc.(Peradeniya), Ph.D. (Hong Kong), M.I.Chem.C.*

Professor

Prof. (Ms.) S. A. Deraniyagala: *B.Sc. (Colombo), Ph.D. (Dalhousie), C.Chem., F.I.Chem.C.,*

Senior Professor

Dr. (Ms.) H. I. C. De Silva: *B.Sc. (Colombo), Ph.D. (Mississippi State), C.Chem., M.I.Chem.C.*

Senior Lecturer II

Dr. M. N. Kaumal: *B.Sc. (Colombo), Ph.D. (Mississippi State)*

Senior Lecturer II

Dr. (Ms.) B. G. K. Perera: *B.Sc. (Colombo), M.Sc.(UW, Seattle), Ph.D.(UW, Seattle)*

Senior Lecturer II

Prof. M. S. S. Weerasinghe: *B.Sc. (Colombo), Ph.D. (Maine, USA), M.I.Chem.C.*

Professor

Prof. (Ms.) R. Wijesekara: *B.Sc. (Colombo), Ph.D. (ANU), M.I.Chem.C.*

Senior Professor, Head of Department of Chemistry

Dr. G. Abayaweera, *B.Sc. (Colombo), Ph.D. (Kansas State)*

Senior Lecturer

Dr. A. Elvitigala, *B.Sc. (Colombo), M.Sc. (Jeju, Korea), Ph.D. (Jeju, Korea)*

Senior Lecturer

Department of Physics

Prof. T R Ariyaratne, *B.Sc. (Ceylon), Ph.D. (Durham)*

Emeritus Professor

Prof. S. R. D. Rosa: *B.Sc. (Colombo), M.Sc. (Pittsburgh, USA), Ph.D. (Pittsburgh, USA)*

Associate Professor

Dr. Hiran H E Jayaweera, *B.Sc. (Colombo), Ph.D. (Colombo)*

Senior Lecturer

Department of Plant Science

Dr. (Ms.) H. S. Kathriarachchi: *B.Sc.(Peradeniya), M.Phil (Peradeniya), Ph.D. (Vienna)*

Senior Lecturer

Department of Biochemistry and Molecular Biology, Faculty of Medicine

Prof. C. P. D. W. Mathew: *B.Sc. (Kelaniya), M.Sc. (Colombo), Ph.D. (Colombo), Diploma (Microbiology and Biotechnology)(Osaka), C.Chem., F.I.Chem.C.*

Senior Professor

Prof. (Ms.) S. S. B. D. Preethi Soysa: *B.Sc.(Sri Jayawardenapura), M.Sc.(Colombo), Ph.D. (Colombo)*

Associate Professor

Dr. (Ms.) T. Thoradeniya: *B.V.Sc. (Peradeniya), Ph.D. (Colombo)*

Senior Lecturer II

Prof. (Ms.) S. Wijesundara: *B.Sc. (Colombo), M.Sc.(Bristol), Ph.D. (Colombo)*

Professor

University of Sri Jayawardenapura

Department of Chemistry

Prof. S. P. Deraniyagala: *B.Sc. (Colombo), Ph.D. (Dalhousie), C.Chem., F.I.Chem.C.*

Senior Professor

Prof. P. P. M. Jayaweera: *B.Sc. (Sri Jayawardenapura), Ph.D. (Belfast), C.Chem., M.I.Chem.C.*

Professor, Head, Department of Chemistry

Prof. S. S. L. W. Liyanage: *B.Sc. (Sri Jayawardenapura), Ph.D. (Cardiff), C.Chem., F.I.Chem.C., M.R.S.C.*

Professor, Dean, Faculty of Applied Sciences

Dr. S. D. M. Chinthaka, *B.Sc. (Sri Jayawardenapura), Ph.D.(Wayne State, USA), M.I.Chem.C.*

Senior Lecturer

Department of Biochemistry, Faculty of Medicine

Prof.(Ms.) S. Ekanayake: *B.Sc. (Peradeniya), M.Phil. (Sri Jayewardeneapura), Ph.D. (Lund) C.Chem., F.I.Chem.C.*

Professor

Instrument Center

Dr. T. N. B. Etampawala, *B.Sc. (Peradeniya), Ph.D. (Clemson University, USA)*

Senior Lecturer

Department of Accounting

Prof. K. B. M. Fonseka: *B.Sc. (Colombo), M.B.A. (Colombo), F.C.M.A. (UK), F.C.M.A*

Senior Professor

Postgraduate Institute of Management

Prof. Tilak Fonseka: *B.A. (Ceylon), L.L.B. (Colombo), M.B.A. (PIM-USJP), M.A. (Colombo), Ph.D. (PIM-USJP)*

Professor

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Department of Chemistry

Prof. G. Bandarage: *B.Sc. (Colombo), Ph.D. (Alberta), C.Chem., F.I.Chem.C., Chartered Physicist*
Senior Lecturer I

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Senior Lecturer I

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Senior Lecturer II

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Department of Chemistry

Dr. A. M. T. Amarakoon: *B.Sc. (Peradeniya), Ph.D. (Southampton)*
Senior Lecturer I

Dr. M. P. Deeyamulla: *B.Sc. (Kelaniya), Ph.D. (Cambridge), M.R.S.C.*
Senior Lecturer II

Prof. (Ms.) J. A. Liyanage: *B.Sc. (Sri Jayawardenapura), Ph.D. (Cardiff), C.Chem., C.Sci., F.I.Chem.C., F.R.S.C.*
Senior Professor, Head, Department of Chemistry

Dr. W. A. P. J. Premaratne: *B.Sc. (Kelaniya), Ph.D. (Birmingham)*
Senior Lecturer I

Prof. N. A. K. P. J. Seneviratne: *B.Sc. (Kelaniya), Ph.D. (Wayne State), M. I. Chem.C.*
Senior Professor

Dr. S. Sri Skandaraja, *B.Sc. (Kelaniya), Ph.D. (Oklahoma State University)*
Senior Lecturer II

Department of Microbiology

Dr. (Ms.) R. Amarakoon: *B.Sc. (Peradeniya), M.Sc. (Peradeniya), Ph.D. (Zlin, Czech Republic)*
Senior Lecturer II

Department of Zoology

Prof. (Ms.) Asoka Pathiratne: *B.Sc. (Kelaniya), Ph.D. (North Dakota State)*
Senior Professor

University of Ruhuna

Prof.(Ms.)H.M.K.K. Pathirana, *B.Sc.(Vidyodaya University of Sri Lanka) Ph.D. (Aston in B'ham, U.K.)*
Professor

University of Peradeniya

Department of Chemical and Process Engineering, Faculty of Engineering

Dr. D. G. G. P. Karunaratne: *B.Sc. Eng.(Peradeniya), Ph.D. (Nova – Portugal)*
Senior Lecturer II

University of Moratuwa

Department of Information Technology

Mr. B. H. Sudantha: *B.Sc. (Sri Jayawardenapura), M. Phil.(Sri Jayawardenapura)*
Senior Lecturer I

General Kotalawala Defence Academy, Preclinical Science Department

Prof. J. Welihinda: *B.Sc. (Colombo), Ph.D.(Colombo), C.Chem, M.I.Chem.C., C.M.I (Biochemistry)*
Professor Biochemistry, Head Preclinical Sciences

South Asian Institute of Technology and Medicine

Dr. A. A. P. Keerthi: *Grad.Chem., Ph.D. (Sri Jayawardenapura), C.Chem., M.I.Chem.C.*
Senior Lecturer I, Head, Department of Biochemistry

Police Hospital. Sri Lanka Police

Mr. N. M. S. Hettigedara: *Grad. Chem., M.Sc. (Kelaniya), C.Chem., F.I.Chem.C., M.R.A.C.I., M.N.S., M.H.S.M., F.R.S.H*
Nutritionist /Superintendent of Police

Industrial Technology Institute

Dr. (Ms.) R. Samarasekara: *B.Sc. (Colombo), Ph.D. (IACR- UK), M.I.Chem.C.*
Deputy Director

Sri Lanka Institute of Nanotechnology

Research Scientist, Herbal Technology Division.

Professor Nalin De Silva, *B.Sc. (Colombo), Ph.D. (Cambridge, UK)*
Science Team Leader

Dr. Nuwan De Silva: *B.Sc. (Colombo), Ph.D. (Mississippi State)*
Senior Research Scientist

Dr. Lahiru Wijenayake, *B.Sc. (Colombo) Ph.D. (Iowa, USA)*
Senior Research Scientist

4ever Skin Naturals (PVT) LTD.

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Chief Operating Officer, 4Ever Skin Naturals (Pvt) Ltd.

Other Visiting Staff

Emeritus Professor University of Colombo H.D. Gunawardhana: *B.Sc. (Ceylon), Ph.D. (Salford), C.Chem., F.I.Chem.C., F.N.A.S.S.L.*

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Retired Professor, Department of Chemistry, University of Sri Jayawardenapura

Ms. S. Wimalasena: *B.Sc. (Ceylon), M.Sc. (Western Australia), C.Chem., F.I.Chem.C.*
Retired Professor, Department of Chemistry, University of Kelaniya.

Mr. Raja Amaratunga: *BSc (Chemical Engineering, Belgarade),*
Consultant to Public Utility Commission (Petroleum)
Retired Operation Manager, Refinery Petroleum Cooperation, Sapugaskanda.

Dr. (Ms.) L. S. R. Arambewela: *B.Sc. (Ceylon), Ph.D. (Colombo), C.Chem., F.I.Chem.C.*
Retired Head, Herbal Technology Division, Industrial Technology Institute

Mr. Amal Dissanayake: *B.Sc. (Colombo), M.Sc. (Sri Jayawardenapura), P.G. Dip. (Chartered Institute of Business and Administration)*

Dr. (Ms.) L. M. De Zoysa Ariyananda: *Grad. Chem., Ph.D. (Delaware), A.I.Chem.C.*

Mr. K. R. Dayananda: *Grad.Chem., M.Phil. (Kelaniya), C.Chem., M.I.Chem.C.*
Senior Research and Development Manager, Silvermill group

Dr. E.D. de Silva: *B.Sc. (Colombo), Ph.D. (Hawaii), C.Chem., F.I.Chem.C., F.N.A.S.S.L.*
Retired Senior Professor and Chair of Organic Chemistry, University of Colombo

Mr.P.R.K.Fernando: *Grad.Chem., M.Sc. (Peradeniya), P.G.D. (Colombo), M.I.Chem.C., M.G.A. SL,*
Ceylon Mineral Research Laboratory, Mineralogist

Dr. (Ms.) S. Hewage: *B.Sc. (Ceylon), Ph.D. (Newcastle), C.Chem., F.I.Chem.C.*

Retired Professor, Department of Chemistry, University of Colombo

Professor K.A.S.Pathiratne: *B.Sc. (Ceylon), M.Sc. (Dalhousie), Ph.D.(North Dakota)*

Retired Professor, Department of Chemistry, University of Kelaniya

Mr. H. S. M. Pieris: *MBA (PIM), M.Sc. (USJP), FIM, C.Chem., F.I.Chem.C.*

Chairman, Gensoft Pvt. Ltd.

Consultant Technologist, Polymers, Silvermill Group

Mr. K. Sivarajah: *B.Sc. (Ceylon), M.Sc. (Reading), F.I.Chem.C., C.Chem.*

Retired Government Analyst, Government Analyst Department.

Mr. E. G. Somapala: *B.Sc. (Peradeniya), M.Sc. (Strathclyde), C.Chem., F.I.Chem.C.*

Retired Government Analyst, Government Analyst Department.

Dr. L. M. K. Thilakaratne: *B.Sc.(Ceylon), Ph.D. (Aston), F. I.Chem.C., C.Chem.*

Retired Associate Professor, Department of Chemistry, University of Sri Jayawardenapura

Mr. Walter Wickramasinghe: *B.Sc. (Colombo), Dip. In Leather (Leatherseller College London)*

Retired General Manager Leather Products Ltd.

Mr. S. K. C. Suduwella: *B.Sc. (Peradeniya), PG Dip in Petroleum Chemistry, C.Chem., M.I. Chem.C*

Jet Fuel Advisor, Sri Lankan Airlines Ltd.

Retired Chief Chemist and Head Laboratory, Ceylon Petroleum Corporation

External Foreign Examiners

Emeritus Professor J. R. Hanson

University of Sussex, UK

Prof. David M Smith

Dean, School of Chemistry, University of Bristol, UK

Prof. P. D. Lickiss

Professor, Department of Chemistry, Imperial College of Science, Technology & Medicine, London

Administrative Staff



Mr. N I N S Nadarasa

Registrar

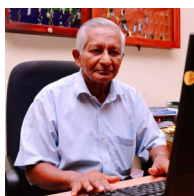
*B.Sc. (Ceylon), M.Tech. (Brunel)
Retired Deputy Government Analyst*



Mr. A M Jayasekara

Additional Registrar

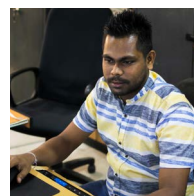
*B.Sc. (Ceylon), M.Sc. (Philippines)
Dip. Aquaculture (SEAFDEC, Philippines),
Retired Director General, NAQDA*



Mr. J M R Banda

Deputy Registrar

*B.Sc. (SJP), M.Sc Eng. (Moratuwa),
Dip. Stat. (SJP), M.I.M. (UK), C.Eng.,
Retired Chief Metallurgist, Steel Corporation.*



Mr. G W C S Perera

Senior Assistant Registrar (R & D)

B.Sc.(SJP), M.Sc.(Colombo), Buss.Mgt.Dip. (SJP)



Ms. N K B S S K Narasinghe

Senior Assistant Registrar (DLTC)

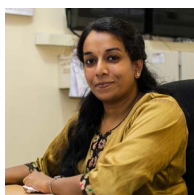
Grad. Chem, M.Sc.



Ms. M C Kaushalya

Assistant Registrar (Examinations)

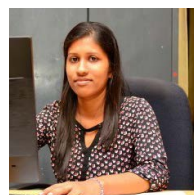
B.Sc.(SJP)



Ms. K Anootheya

Assistant Registrar

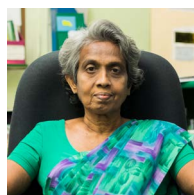
Grad. Chem, M.Phil.(Peradeniya)



Ms. M D H D Gunathilake

Assistant Registrar

B.Sc.(NSBM)



Ms. B I Hendriwithana

Librarian

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



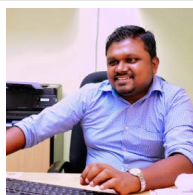
Mr. K A A Kolonnage

Finance Manager

Non-Academic Staff



Ms. A C Wijesuriya
Senior Accounting Officer
AAT



Mr. D I S H Jayasingha
Publications Officer



Mr. U R J P Bandara
Assistant Accounting
Officer
HNDA



Mr. H L R H Abeyrathna
Education Assistant
DLTC



Mr. E A D Ishantha
Assistant Accounting
Officer
HNDA



Mr. U J N Chandana
Office Assistant



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



Mr. W R R Perera
Laboratory Assistant



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



Mr. P U P Perera
Laboratory Assistant



Ms. F A Azmeer
Library Attendant



Mr. G S M R Perera
Laboratory Attendant



Mr. H H Lionel
Maintenance Assistant



Mr. M G S Sankalpa
Attendant



Ms. Mallika
Office Assistant



Mr. I W Sunil
Laboratory Assistant



Mr. Milton
Hall Attendant

Course Content

Theory Course Units

Level 1 – 21 Credits – Core Course Units

C 11000	Language Course – Non-credit course (30Hrs)
C 11003	Basic Concepts (45 Hrs)
C 11013	General & Inorganic Chemistry (45 Hrs)
C 11023	Principles of Physical Chemistry (45 Hrs)
C 11033	Principles of Organic Chemistry (45 Hrs)
C 11042	Mathematics for Biological Science Students (30 Hrs) OR
C 11052	Biology for Physical Science Students (30 Hrs)
C 11063	Mathematical Applications for Chemists (45 Hrs)
C 11072	Fundamentals of Physics for Chemists (30 Hrs)
C 11082	Analog & Digital Electronics for Chemists (30 Hrs)

Level 2 Courses – 21 Credits – Core Course Units

C 21012	Physical Chemistry
C 21022	Principles of Quantum Chemistry and Molecular Spectroscopy
C 21023	Inorganic Chemistry
C 21032	Organic Chemistry I
C 21062	Organic Chemistry II
C 21042	Titrimetric and Gravimetric Methods in Analysis
C 21082	Separation Methods and Spectroscopic Applications
C 21053	Biochemistry
C 21073	Introduction to Management, Economics and Finance

Level 3 – 29C – Core Course Units

C 31003	Energetics & Kinetics
C 31012	Special Topics in Physical Chemistry I
C 31022	Special Topics in Physical Chemistry II
C 31033	Advanced Topics in Organic Chemistry
C 31043	Physical Organic Chemistry
C 31053	Special Topics in Inorganic Chemistry I
C 31062	Special Topics in Inorganic Chemistry II
C 31072	Analytical Chemistry: Instrumental Methods I
C 31082	Analytical Chemistry: Instrumental Methods II
C 31092	Environmental Chemistry
C 31363	Fundamentals of Chemical and Process Engineering
C 31102	Research Methods

Level 4 – Either 9C or 6C – Compulsory Course Units

C 41152	Literature Survey in Chemical Sciences
	OR
C 41172	Internship
	OR
C 41185	Research Project
	AND
C 41001	Seminar
	AND
C 41193	General Chemistry Paper

Level 3/4 Optional Course Units

C 31313/41313	Analytical Industrial Biochemistry
C 31323/41323	Biochemistry II
C 31333/41333	Chemical Education
C 31353/41353	Food Chemistry & Technology
C 31373/41373	Industrial Chemistry & Technology
C 31383/41383	Natural Products
C 31393/41393	Pharmaceutical & Medicinal Chemistry
C 31342/41342	Further Topics in Environmental & Green Chemistry
C 31403/41403	Polymer Chemistry & Technology
C 31413/41413	Further Management, Economics and Finance
C 31422/41422	Agrochemicals
C 31432/41432	Atomic Spectroscopic Methods of Analysis
C 31442/41442	Chemical & Molecular Toxicology
C 31452/41452	Computational Chemistry
C 31462/41462	Electrochemical Technology
C 31472/41472	Industrial Safety, Health and Environmental Technology
C 31482/41482	Information Technology
C 31492/41492	Molecular Biology & Biotechnology
C 31502/41502	Particle Physics
C 31512/41512	Photochemistry
C 31522/41522	Quantum Mechanics
C 31542/41542	Petroleum and Petrochemistry
C 31552/41552	Quality Management
C 31562/41562	Cosmetic Science
C 31572/41572	Nanotechnology
C 31582/41582	Clinical Herbal Products Development
C 31592/41592	Materials Chemistry
C 31602/41602	Chemistry of Gem Minerals & Synthetic Gem Materials

C 31611/41611 Agro Industries

C 31622/41622 Mini Project

Compulsory Practical Course Units

C 11201 General Chemistry

C 21202/31202 Analytical Chemistry

C 21212/31212 Physical Chemistry

C 21222/31222 Organic Chemistry

C 31233/41233 Advanced Analytical & Inorganic Chemistry

C 31243/41243 Advanced Physical Chemistry

C 31253/41253 Advanced Organic Chemistry

LEVEL 1
Core Course Units
21 Credits

C 11003 - Basic Concepts

1. Basic Mathematics (21 hrs)

- 1.1 Introduction: Real Numbers, Integers, Prime Numbers, Rational and Irrational Numbers, Infinity
- 1.2 Basic Algebra : As a generalized form of Arithmetic & Mathematical Operations, Expressions and Terms, Products, Factors and Quotients, Simplification – Expansion, Opening and Insertion of Brackets, Types of Equations – simple (first degree), quadratic (second degree), Simultaneous, Formulae –(eg $A = \pi r^2$), Variables/Constants (illustrate with common examples), Change of subject, Solving of equations
- 1.3 Laws of Indices
- 1.4 Graphing
- 1.5 Classified Data – Histogram, Classified
- 1.6 Introduction to Logarithm and Trigonometry [to include a couple of Open Book Test's]

2. Problem Solving (8 hrs)

- 2.1 Philosophy of problem solving: Identification of defining equation towards the goal in problem solving; Solving problems targeting the goal
- 2.2 Ability to transform equations to alternative forms containing alternate symbols
- 2.3 Stoichiometric calculations

3. Units and Dimensions (6 hrs)

- 3.1 International system of units; Definition of basic, Derived and subsidiary SI units
- 3.2 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
- 3.3 Dimensions of simple physical quantities. Composition variables concentration (molarity); Molality; Mole fraction, Mass fraction, Mole percent and their inter-conversions

4. IUPAC Nomenclature of Typical Organic and Inorganic Compounds (10 hrs)

- 4.1 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 Graduateship Programme

Suggested References:

- 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

Evaluation Criteria: Three hours examination at the end of the semester

C 11013 - General and Inorganic Chemistry

1. Basic Concepts in Inorganic Chemistry (25 hrs)

1.1 Quantum theory and the hydrogen atom

Electromagnetic radiation and spectra, Quantum theory of radiation, Planck's Law, The atomic spectrum of hydrogen and the Rydberg equation, The wave particle duality of matter, de Broglie equation, Pauli exclusion principle, Aufbau principle, Hund's rule, The uncertainty principle, Wave mechanics and atomic orbitals including quantum numbers. Electron configurations of elements.

1.2 Basic Concepts of Chemical Bonding

Chemical bonds, Lewis symbols, Octet rule, Energetics of ionic bonding, Strengths of covalent bonds, Bond polarities & dipole moments, Electronegativity, Drawing Lewis structures of covalent species, Formal charges, Exceptions to octet rule, Resonance structures, Rules to draw resonance structures, Non-valence cohesive forces.

1.3 Molecular shapes and Bonding

Molecular shapes from the VSEPR model, Valence Bond Theory, Orbital overlap, Positive, negative and zero overlap, hybridization of atomic orbitals, sp , sp^2 , sp^3 , dsp^3 , d^2sp^3 , hybridization, Multiple bonds, Predicting the nature of covalent bonds, Molecular Orbital Theory, LCAO method (s-s, s-p, p-p, p-d and d-d combinations of atomic orbitals). Molecular orbital energy level diagrams for homonuclear diatomic molecules. (H_2 , He_2 , Li_2 , Be_2 , B_2 , C_2 , N_2 , O_2 , F_2 , Ne) Molecular orbital diagrams for hetero diatomic molecules (CO , NO , HCl) Molecular orbital diagrams for polyatomic molecules-molecules with σ & π delocalized bonds (CO_3^{2-} , CO_2 , NO_2^- , NO_3^- , SO_3 , O_3) Prediction of bond order and magnetism of molecules based on molecular orbital diagrams

1.4 Pauling's Electronegativity scale, Polarizations of ions & Fajan's rules, Screening (shielding) and Slater rules

1.5 The ionic lattice

Lattice energy, Madelung constant, Born exponent, Born - Lande' equation and Born-Mayers equation

1.6 Hard/Soft Acid Base Theory (HSAB Theory)

1.7 Intermolecular Forces - Ion-Dipole, Dipole-Dipole, Ion-Induced dipole, Hydrogen bonding, Dipole-Induced dipole, Instantaneous Dipole-Induced dipole (London dispersion forces)

2. Chemistry of Main Group and Transition Elements (20 hrs)

- 2.1 Trends in the variation of physical and chemical properties of the main group elements down their respective groups. Anomalous properties of the first member of a group and diagonal relationships.
- 2.2 Trends in the chemistry of their compounds explained on the basis of their thermodynamic and structural properties (hydrides, oxides, sulphates, carbonates, hydroxides, halides as representative examples)
- 2.3 compounds of rare gases
- 2.4 Chemistry of Transition group elements.
Occurrence and extraction of transition group elements, Properties and uses, Oxidation states, Compounds of chromium, Cobalt and Copper
- 2.5 Chemistry of lanthanides (4f): Occurrence, Electronic configurations, Oxidation states, Lanthanide contraction effects, Colour of lanthanides and magnetic properties. Industrial uses
- 2.6 Chemistry of the actinides (5f): Occurrence, Electronic configuration, Valence states, Actinide contraction, Colour of actinides and magnetic properties. Radioactivity of actinides with special reference to thorium and uranium, General properties of actinides, Occurrence, Separation of lanthanides and Industrial uses.
- 2.7 Chemistry of the actinides (5f): Occurrence, electron configuration, Oxidation states, Actinide contraction, Colours of actinides and magnetic properties. Radioactivity of actinides with special reference to thorium and uranium, General properties of actinides, Industrial uses, Separation of transuranium elements.

Suggested References:

- Theodore E. Brown, H. Eugene H. LeMay, Bruce E. Bursten and Catherine Murphy, Chemistry: The Central Science, 13th edition
- J. D. Lee, Concise Inorganic Chemistry, 5th Edition
- F. Albert Cotton, Geoffrey Wilkinson, Carlos A. Murillo, Manfred Bochmann, Advanced Inorganic Chemistry, 6th Edition

Evaluation Criteria: Three hours examination at the end of the semester

C 11023 - Principles of Physical Chemistry

1. Energetics in Chemistry (15 hrs)

- 1.1 Introduction: What is thermodynamics and why it is important in chemistry, Description of a state of a system, Intensive and extensive variables, Zeroth law of Thermodynamics
- 1.2 The gaseous state: Review of the ideal gas equation of state, Principle of equipartition of energy, Thermal capacities of ideal gases, Deviation of gases from ideal behaviour, van der waals equation of state and other equations of state, Boyle temperature; Liquefaction of gases, Critical state; Andrew's isothermals, Reduced equation of state, Law of corresponding states
- 1.3 First law of Thermodynamics: Relationship to the principle of conservation of energy, Concepts of work, Heat and energy, Different types of work, Free, reversible and irreversible expansions, Isochoric, Isobaric and adiabatic processes, Thermal capacity, Enthalpy, Variation of internal energy and enthalpy with temperature, Thermochemistry: Hess' law of constant heat summation, Standard state, Standard enthalpy, Determination of enthalpy (e.g. bomb calorimeter), Standard enthalpy of formation, Combustion, Neutralization, Displacement, Solution, Hydration etc., Kirchoff's equation
- 1.4 Univariant systems
Internal energy and enthalpy changes in univariant phase transformations
- 1.5 Isoenthalpic processes Joule-Thomson effect, Temperature and pressure variations of Joule-Thompson coefficient, Inversion temperature
- 1.6 Second law
Need for the second law, Qualitative and quantitative expressions of the second law, Entropy function, Calculation of entropy changes in isothermal; Univariant, Isochoric, Isobaric and adiabatic processes, Entropy of an ideal gas, Entropy as a criterion for spontaneity and equilibrium, Entropy changes in isolated systems, Entropy changes in surroundings, Temperature coefficient of ΔS , Standard entropy; Introduction to the concept of free energy

2. Reaction Kinetics (10 hrs)

- 2.1 Review of basic concepts
Relevance of reaction kinetics in chemistry, Viewing a reaction as a collision process, Effects of energy and relative orientation of colliding molecules on reaction rate, Definition of rate of a reaction, Elementary reactions, Molecularity and complex reactions, Zeroth order reactions

2.2 Elementary reactions

Rate expression, Dependence of rate on concentration, Order of a chemical reaction, First order and second order 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

2.3 Introduction to complex reactions, Parallel and consecutive reactions, Definition of mechanism of a reaction, Rate determining step, Action of a catalyst explained in terms of mechanism, Influence of EM radiation

2.4 Complex reactions

First order reversible reactions, First order consecutive reactions and the quantitative description of the rate determining step, Steady state approximation and its applications, Enzyme catalyzed reactions, Kinetics of atom and free radical reactions, Introduction to chain reactions

3. Electrochemistry I - Galvanic Cells (12 hrs)

3.1 Introductory concepts

How a potential difference across an interface is created, Factors affecting the potential difference across interface, Definition of a Galvanic cell, Processes that occur when electrodes are interconnected, Definition of terminals of a cell, Factors affecting the emf of a Galvanic cell: Liquid/liquid interface in a cell and the origin of liquid junction potential

3.2 Representation of Galvanic cells

Cell diagrams, half-cell diagram, IUPAC convention on cell reaction, Cell reaction and charge number, Emf assigned to a cell diagram, Assignment of an emf to a chemical reaction, Spontaneity and emf of a reaction, Experimental measurement of cell emf, Assignment of experimentally measured emf to a cell diagram

3.3 Chemically reversible electrodes and cells

Chemical reversibility, Types of chemically reversible electrodes (metal- metal ion, metal amalgam *etc.*), Construction of Galvanic cells, Role of a salt bridge in a cell, Representation of a cell with a salt bridge, Chemically reversible cells.

3.4 Thermodynamics of Galvanic cells

Electrical work done by a Galvanic cell, How to discharge a cell reversibly, Relationship between Gibbs free energy and emf, Dependence of emf on the concentration of ions, Definition of activity, Activity of a molecular or ionic species in solution, Nernst equation, Nernst equation and equilibrium constant of a cell reaction, Simplifying approximations for activity (unity for a solid *etc.*), Calculation of activity coefficients, Debye-Huckel limiting and extended laws for activity coefficient, The relationship between E & ΔS and E & ΔH

3.5 Electrode potentials

Standard emf and its significance, electrode potential and standard electrode potential, The reaction corresponding to a standard electrode potential, Working with electrode potentials, Electrode potentials and Nernst equation

3.6 Applications of emf measurements

Determination of thermodynamic parameters, Solubility product of sparingly soluble salts, Measurement of pH, Potentiometric titrations, Determination of mean activity coefficient of an electrolyte. Some day-to-day and industrial applications of cells, The common units of electrical energy, Characteristics of batteries, Operating voltage, Capacity, Energy Capacity, Storage density, Energy density, Efficiency, Cycle life, Primary cells, Secondary cells, Lead accumulator, Nickel-Cadmium cell, Fuel cells. Electrochemistry of corrosion, Introduction to the measurement of corrosion rates, Passivation, Corrosion inhibition

4. Phase Equilibria (8 hrs)

4.1 Introduction

Phase rule, phase transition, First and second order transition

4.2 Two component liquid systems: Ideal and non-ideal solutions, Zeotropy and azeotropy, distillation of liquid mixtures

4.3 Two-component solid-liquid systems

Eutectic mixtures, Compound formation, Congruent and incongruent melting points

4.4 Two component solid solutions

4.5 Experimental methods for constructing phase diagrams, Thermal analysis

4.6 Henry's Law

4.7 Applications of phase equilibria in industry and technology, Steam distillation, Fractional distillation, Metallurgy

Suggested References:

- P. W. Atkins & J. De Paula, Physical Chemistry, 8th edition; Oxford, 2006
- G.F. Liptrot, J. J. Thompson and G. R. Walker, Modern Physical Chemistry, Collins Educational, 1992
- Donald A. MsQuarrie; John D. Simon, Physical Chemistry: A Molecular Approach, University Science Books
- Basic Principles of Chemistry Unit V: Electrochemistry (CMU 1220), Open University if Sri Lanka Publication

Evaluation Criteria: Three hours examination at the end of the semester

C 11033 - Principles of Organic Chemistry

1. Structure, bonding and Stereochemistry (15 hrs)

- 1.1 Bonding in organic molecules, Hybridization, Shapes of molecules, Localized and delocalized bonds, Resonance theory, Stabilities of molecules
- 1.2 Bond strength, Intermolecular and intramolecular attractive forces, Homolytic and heterolytic bond cleavages, Energy diagrams
- 1.3 Stereochemistry: Conformational isomerism: Conformations of alkanes, Relative stabilities of conformers of alkanes. Conformations and relative stabilities of cyclohexane and substituted cyclohexanes. Structures of some cycloalkanes (e.g. Adamantane)
- 1.4 Configurational Isomerism: Geometrical isomerism, Stereochemistry of alkenes, Cahn-Ingold-Prelog rules: E/Z nomenclature
- 1.5 Optical isomerism, Chirality and enantiomers, Optical activity, Configurations, R/S Nomenclature, Diastereomers, Meso compounds, Fischer and Newman projection formulae, Formation of racemic mixtures and their resolution. Chirality of allenes, Biphenyls and cyclic compounds. Use of models in understanding stereochemistry

2. Chemistry of Aliphatic Compounds (23 hrs)

- 2.1 Alkanes, alkenes and alkynes (3 hrs)
Synthesis of alkenes and alkynes, Substitution reactions of alkanes (Free radical mechanism), Addition reactions to alkenes and alkynes (including stereochemical considerations), Oxidations of alkenes (ozonolysis, cold ad hot alkaline KMnO_4 and osmium tetroxide), Diels-Alder reaction of dienes, Acidity of terminal alkynes - reasoning in terms of hybridization
- 2.2 Alkyl halides (5hrs)
Synthesis of alkyl halides, Nucleophilic substitution reactions ($\text{S}_{\text{N}}1$, $\text{S}_{\text{N}}2$ and $\text{S}_{\text{N}}\text{i}$) and elimination reactions (E1 and E2), Preparation of Grignard Reagents
- 2.3 Alcohols (3 hr)
Synthesis of alcohols, Elimination reactions of alcohols, Nucleophilic substitution reactions, Oxidation reactions of alcohols
- 2.4 Ethers and Epoxides (1 hr)
Synthesis, Reactions
- 2.5 Carbonyl compounds (Aldehydes and Ketones) (6 hrs)
Synthesis of carbonyl compounds, Nucleophilic addition reactions (with hydroxide ion, hydride ion, carbanions such as Grignard reagents, alkoxide ion, cyanide ion and neutral molecules such as water, alcohols (as protecting groups), Addition-elimination reactions (reactions with NH_3 and its derivatives

- formation of imines, hydrazones and semicarbazones), Reactions at α -carbon atoms (e.g. aldol condensations and iodoform reactions)

2.6 Carboxylic acids and acid derivatives (3 hrs)

Synthesis, Acidity of carboxylic acids, Nucleophilic substitutions at sp^2 carbon atoms of CO_2H and its Derivatives – mechanism for ester hydrolysis O-18 labeling experiment, Relative rates of reaction at $C=O$ groups in acids and its derivatives, Reactions at α -carbon atoms in esters (Claisen condensations)

2.7 Amines (2 hrs)

Synthesis, Hofmann exhaustive elimination, Reactions with nitrous acid (comparative study), Comparative basicities of primary, secondary and tertiary amines, Amino acids

3. Chemistry of Aromatic Compounds (7 hrs)

3.1 Structure of benzene (delocalization; substitution reactions vs addition reactions)

3.2 Aromaticity and Aromatic Character including Huckel rule. Some examples of non-benzenoid aromatics (Pyrrole, Furan, Thiophene, Pyridine and Annulenes)

3.3 Electrophilic substitution reactions (nitration, chlorination: sulphonation, alkylation, acylation *etc.*)

3.4 Substituent effects on reactivity of the aromatic ring towards electrophilic reactions

3.5 Substituent effects on regioselectivity in electrophilic reactions (ortho- para directives; meta directing groups)

3.6 Other important reactions of aromatic reactions (e.g. oxidation of the side chain *etc.*)

3.7 Nucleophilic substitution reactions - addition -elimination mechanism (e.g. reactions of nitro-substituted halo benzenes)

3.8 Elimination - Addition mechanism (Benzyne mechanism)

3.9 Phenols and aromatic amines (including acidity and basicity)

3.10 Diazotisation of aniline; use of diazonium salts in organic synthesis of simple compounds

Suggested References:

- T. W. Graham Solomons, Craig B. Fryhle, Scott A. Snyder, Organic Chemistry, 11th edition, Wiley, 2003
- J. McMurry, Organic Chemistry, 8th edition, Mary Finch, 2011
- L.G. Wade Jr., Organic Chemistry, 8th edition, Prentice Hall, 2012
- Paula Yurkanis Bruice, Organic Chemistry, 7th edition, Pearson, 2012
- W, H. Brown, W.H. Organic Chemistry, Harcourt Brace, 1995

Evaluation Criteria: Three hours examination at the end of the semester

C 11042 - Mathematics for Biological Science Students

1. Numbers (1 hr)

Real numbers, Complex numbers, Some properties of complex numbers

2. Partial Fractions (3 hrs)

3. Factorials (1 hr)

Infinity (∞), Binomial theorem; apply binomial theorem to expand

4. Functions (2 hrs)

4.1 Variables: Dependent and independent

4.2 Function with one variable, Function with more than one variable, Linear and non-linear functions

4.3 Polynomials in x: Linear and non linear; binomial, trinomial

4.4 Exponentials: e^x

4.5 Logarithms: Laws & properties of logarithms, Natural logarithms (ln), Negative logarithms (pH, pKa), Logarithmic functions, Relationship between logarithms and exponential terms

5. Trigonometry (3 hrs)

Pythagoras theorem, Definition from coordinates, Signs of trigonometric functions, Trigonometric formulae

6. Limits (1 hr)

Definition of a limit, Limits involving infinity, Limits not involving infinity

7. Calculus (19 hrs)

7.1 Differentiation (6 hrs)

Introduction; Illustration, First principles, Notations. Short Cut method; for Polynomial functions, Sums, Products (UV). Quotients (U/V), Functions of functions, Composite functions, Method of substitution. Log functions, Exponential functions, Trigonometric functions ; sine & cosine

7.2 Partial and total differentiation (2 hrs)

Illustrate use in Thermodynamics, Further derivatives

- 7.3 Turning Points (stationary points) (2 hrs)
Maxima, minima, point of inflexion (two criteria)
- 7.4 Integrations (4 hrs)
As a converse of differentiation, by parts, By partial fractions, Definite integrations;
Area
- 7.5 Differential Equations (3 hrs)
Introduction; Illustrate use in kinetics, solving of differential equation, exact
differential equations; Eulers criterion.
- 7.6 Homogeneous Functions (2 hrs)
Eulerstheorem on homogeneous functions

Suggested References:

- Robert T. Smith, Roland B. Minton, Calculus : Concepts & Connections, McGraw-Hill
- Alex Himonas, Alan Howard, Calculus : Ideas & Applications, John-Wiley
- James F, Connelly and Robert A. Fratangelo, Elementary Technical Mathematics with Calculus
- M. R. M. Hanifa, Mathematics for Chemistry and Biology students (PSE3117), Open University of Sri Lanka publication, 2009

Evaluation Criteria: Two hours examination at the end of the semester

C 11052 - Biology for Physical Science Students

1. The Cell (2 hrs)

- 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 hrs)

- 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 hrs)

- 3.1 Classification of living organisms according to Margulis and Schwartz
- 3.2 Introduction to Kingdoms Prokaryotae, Protocista, 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 hrs)

- 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 hrs)

- 5.1 DNA and RNA
- 5.2 Protein synthesis

6. Genetics (4 hrs)

- 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 hrs)

- 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 hrs)

- 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

Suggested References:

- 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 Edition
- Bettelheim, Brown, Introduction to General, Organic and Biochemistry, 7th Edition

Evaluation Criteria: Two hours examination at the end of the semester

C 11063 - Applications of Mathematics for Chemists

Statistical Analysis

1. Statistical Methods (4 hrs)

- 1.1 Measure of central tendency and measure of dispersion, Mean, Median, Mode, Weighed mean, Mean deviation, Standard deviation, Relative standard deviation, Coefficient of variation
- 1.2 Accuracy and precision
- 1.3 Ways of expressing accuracy, Absolute error, Relative errors

2. Errors (5 hrs)

- 2.1 Random error, System error, Gross error, Instrumental error, Operative error, Error of methods
- 2.2 Rejection of data (Q test)
- 2.3 Propagation of errors
- 2.4 Significant f figures

3. Distribution of Random Errors (6hrs)

- 3.1 Sample and population
- 3.2 Normal distribution curve, Standard normal distribution
- 3.3 Confidence limits
- 3.4 Significance tests; Q test, t test, F test, χ^2 test
- 3.5 Use of Z – table, t – table, F-table, χ^2 – table
- 3.6 Hypothesis Testing, Type (I) error, Type (II) error

Application of Mathematics

4. Kinetics, Thermodynamics, Electrochemistry, etc (illustrative)- (6 hrs)

5. Calibration and Linear Regression (4 hrs)

- 5.1 Calibration
- 5.2 Correlation coefficient
- 5.3 Linear regression

6. Matrices and Determinants (6 hrs)

- 6.1 Definition
- 6.2 Addition and multiplication of matrices
- 6.3 Transpose, Inverse, Diagonal and Unit matrix
- 6.4 Rules of determinants
- 6.5 Minors and Cofactors

7. Coordinate Geometry.(4hrs)

- 7.1 Circle and straight line-polar coordinates. Relations between Cartesian and polar coordinate
- 7.2 Ellipse and Hyperbola-Tangents and normal at a point, The point of intersection of tangents, Tangents which are parallel to the diameter

8. Problem solving in Chemical Analysis (10 hrs)

- 8.1 Amount or concentration of an analyte based on a titration analysis
- 8.2 Differentiation between the end point and equivalence point of a titration
- 8.3 Key features of a reaction suitable to be used in a titration
- 8.4 Key features of a primary standard
- 8.5 Calculation of the pH at key points during a titration of monoprotic acids and bases
- 8.6 EDTA titrations are carried out at constant known pH
- 8.7 EDTA is used for many metal analyses
- 8.8 Calculation of EDTA –metal conditional formation constant at a given pH and use it in calculation of pM during a EDTA titration
- 8.9 Methods for making an EDTA selective titration
- 8.10 Titration curves for simple redox titrations based on electrode potential
- 8.11 Action of the different indicators used in acid-base/ complexometric/ redox titrations

Suggested References:

- Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch, Fundamentals of Analytical Chemistry, 8th edition, 2004
- Charles Crouthamel, Analytical Chemistry
- R. A. Day, Jr. A. L. Underwood, Quantitative analysis, 2nd edition, Englewood Cliffs, N.J. Prentice Hall, 1967

Evaluation Criteria: Three hours examination at the end of the semester

C 11072 - Fundamentals of Physics for Chemists

1. Optics (10 hrs)

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 & Vibrations (12 hrs)

Periodic motions: Sinusoidal vibrations, Simple harmonic motion, Superposition of two vibrations with I-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 hrs)

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; Ttransient response of RC and RL circuits, LC oscillations, Integrating and differentiating circuits

Suggested References:

- 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

Evaluation Criteria: Two hours examination at the end of the semester

C11082 - Analog and Digital Electronics for Chemists

1. Analog Electronics (18 hrs)

Introduction to P &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 segment and other display devices and their applications. Bipolar transistors, Operation of an npn 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 hrs)

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

Suggested References:

- 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

Evaluation Criteria: Two hours examination at the end of the semester

LEVEL 2
Core Course Units
21 Credits

C 21012 - Physical Chemistry

1. Further Applications of Energetics in Chemistry (10 hrs)

- 1.1 Review of basic concepts of thermodynamics from Level 1 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 net work 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 & 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

2. Electrochemistry II – Electrolytic Conduction and Electrotechnology (10 hrs)

- 2.1 Electrical quantities and their units
Charge, Potential difference, Current, Current density, Electric field strength
- 2.2 Coulometry Faraday's laws, Silver coulometer, Experimental method and calculations
- 2.3 Macroscopic quantities that characterise electrical flow through a solution resistance, Resistivity, Conductance and conductivity, Measurement of conductivity
- 2.4 Relationship between the conductivity and composition of a solution Ionic mobility and limiting ionic mobility, Experimental determination of ionic mobility
- 2.5 Transport number of an ionic species, Determination of transport number; Hittorf method.

- 2.6 Molar conductivity of an electrolyte
Relationship between the molar conductivity of an electrolyte and the constituent ions, Concentration dependence of molar conductivity, Limiting molar conductivity, Onsagar limiting law, Determination of limiting molar conductivity of weak and strong electrolytes
- 2.7 Introduction to electrotechnology
Metal finishing, Electroplating, Anodising, Electrolysis, Electrocatalysis

3. Surface and Colloid Chemistry (10 hrs)

- 3.1 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
- 3.2 The Kelvin equation and its applications
Vapour pressure above curved surfaces, Super cooling and super heating
- 3.3 Determination of specific surface areas of adsorbents
Use of Langmuir trough method, Monomolecular films, Equation of state for an ideal surface film, Molecular areas, Use of Gibbs adsorption isotherm, Use of Langmuir adsorption isotherm
- 3.4 Comparative description of physisorption and chemisorption
- 3.5 Sticking probability and condensation coefficient
- 3.6 Adsorption theories
Adsorption isotherms, Isobars and isosteres, Gibbs adsorption isotherm and its application, Langmuir adsorption isotherm and its application, Introduction to multilayer adsorption
- 3.7 Colloidal systems
Classification, Physical properties of colloids, Macromolecules and micelles, Lyophilic and lyophobic colloids, Stability of colloids, Foams and emulsions
- 3.8 Electrophoresis and isoelectric point

Suggested References:

- Peter Atkins, De Paula Joulio, Physical Chemistry, 8th Edition, Oxford University Press, 2006
- Ott J Bevan, Goates Juliana Boerio, Chemical Thermodynamics Principles and Applications, Adademic Press, USA, 2012

Evaluation Criteria: Two hours examination at the end of the semester

C 21022 – Principles of Quantum Chemistry and Molecular Spectroscopy

1. Introduction to Quantum Mechanics (15 hrs)

- 1.1 The quantization of light
Planck's concept of quantization, Black-body radiation, Photo electric effect
- 1.2 Wave-like properties of matter
de Broglie's hypothesis - wave particle duality, Electron diffraction and electron microscope, Heisenberg uncertainty principle
- 1.3 Schrodinger time-independent wave equation
- 1.4 Essential mathematics
Operators (Linear and nonlinear operators, Hermitian Operators, Commutative and non-commutative operators), Eigen value equation and its solutions (Eigen functions and eigenvalues, Schrodinger equation as an eigenvalue problem)
- 1.5 Postulates of quantum mechanics
Postulate 1-wave function and probability (Interpretation of the wave function, Well behaved wave functions, Probability of finding a particle, Normalization of the wave function), Postulate 2 - observables in classical mechanics and operators in quantum mechanics (Hamiltonian operator), Postulate 3 - eigenvalue equation, Postulate 4 - average value of an observable
- 1.7 Application of Schrodinger equation to simple systems
- 1.8 Particle in a one dimensional box (Hamiltonian operator, Boundary conditions, Quantization of energy and quantum number, Probabilistic interpretation of the wave function)
- 1.9 Extrapolation of the particle in 1D model to a 2D and 3D box
- 1.10 Introduction to quantum mechanical tunneling
- 1.11 Atomic units and the spherical coordinate system
- 1.12 Simple three dimensional systems, Stationary states of a particle in a three dimensional box, Degeneracy of energy levels of a particle in a cubic box.

2. Molecular Spectroscopy (15 hrs)

- 2.1 Introduction
Absorption of electromagnetic radiation by matter, Definition and importance molecular spectroscopy
- 2.2 Electromagnetic radiation
The wave nature of electromagnetic radiation, Separation of monochromatic

components in a beam of non-monochromatic radiation, Units of c , v and A . Intensity of a beam of electromagnetic radiation, The particulate nature of electromagnetic radiation, Intensity and the number of photons crossing unit, Area in unit time in a monochromatic beam, Intensity and the number density of photons in a monochromatic beam, Electromagnetic spectrum, Regions of the electromagnetic spectrum

- 2.3 Absorption of radiation as a macroscopic phenomenon
Beer-Lambert law, Variation of the molar extinction coefficient as a function of frequency (or wavenumber), Definition of a spectrum, How to obtain an absorption spectrum of a molecule
- 2.4 Electric dipole moment of a molecule
Definition of electric dipole moment, Calculation of the dipole moment of a molecule using the dipole moments of individual bonds, Transition dipole moment
- 2.5 Absorption of radiation as a microscopic phenomenon
Origins of an absorption spectrum and positions of absorption peaks, Decomposition of total energy of a molecule into components
- 2.6 Absorption peak heights and widths
Microscopic processes that determine the absorption peak height, Selection rules, Peak widths, Doppler broadening, Life time broadening
- 2.7 Pure rotational spectra of diatomic molecules
Rigid rotor approximation rotational energy of a diatomic molecule, Pure rotational spectrum of a diatomic molecule, Microwave selection rules for a diatomic molecule, positions of peaks in the microwave absorption spectrum of a diatomic molecule, Height of peaks in the microwave absorption spectrum of a diatomic molecule
- 2.8 Pure vibrational spectra of diatomic molecules
Harmonic oscillator approximation, Classical simple harmonic oscillator, Simple harmonic oscillator approximation for a diatomic molecule, Populations of vibrational energy levels, Vibrational spectrum of a diatomic molecule in harmonic oscillator approximation
- 2.9 Anharmonicity of vibrations of a diatomic molecule
The shortcomings of the harmonic oscillator approximation, Morse potential and the anharmonic oscillator approximation, Vibrational energy levels of a diatomic molecule in anharmonic oscillator approximation, Selection rules in IR spectroscopy in anharmonic oscillator approximation, Hot bands, Estimation of the force constant of a bond and dissociation energy using the IR spectrum
- 2.10 Vibrations in polyatomic molecules
Vibrational degrees of freedom, Normal modes, Triatomic molecules,

Representation of normal modes, Polyatomic molecules with more than 3 nuclei, Parallel and perpendicular vibrations

- 2.11 Effects of non-rigidity on the rotational spectrum of a diatomic molecule
Energy expression for a non-rigid rotor, Selection rules, Calculation of rotational constant, Centrifugal distortion constant and bond length of a diatomic molecule using its microwave spectrum
- 2.12 Vibration-rotation spectra of diatomic molecules
Vibration-rotation energy levels of a diatomic molecule, Approximate energy expressions, Born-Oppenheimer approximation, Degeneracy of vibration-rotation energy levels, Selection rules, Spectrum, P, Q and R branches, Estimation of the temperature using vibration-rotation spectrum

Suggested References:

- I. N. Levine, Quantum Chemistry Pearson Prentice Hall, 2009.
- D. A. McQuarrie, Quantum Chemistry University Science Books, 2008
- P. Atkins, *et al.*, Atkins' Physical Chemistry. OUP Oxford: 2010.
- I. N. Levine, Physical Chemistry. McGraw-Hill: 2009.

Evaluation Criteria: Two hours examination at the end of the semester

C 21023 - Inorganic Chemistry

1. Structures of Inorganic Solids (15 hrs)

- 1.1 Introduction to solids, Types of crystalline solids - ionic, Covalent, Molecular and metallic crystals
- 1.2 Crystal and molecular structures
Crystal types such as simple cubic (c), Body centered cubic (bcc), Face centered cubic (fcc/ccp), Hexagonal close packed (hcp) etc. Tetrahedral and octahedral holes. Determination of the number of formula units in the unit cell, radius ratio and coordination number, packing efficiency
- 1.3 Bonding in metals and semiconductors: Bond theory of metals, extrinsic and intrinsic semiconductors. Conductors, Semiconductors and Insulators
- 1.4 Structural types of inorganic compounds:
Giant structures, Layer structures, Discrete molecules; CsCl, NaCl (rock salt), ZnS (zinc blende & Wurtzite), CaF₂ (fluorite), Na₂O (antifluorite), TiO₂ (rutile), Ilmenite, Spinel, Perovskite structures. Layer structures; CdI₂, NiAs
- 1.5 The atomic, covalent, van der Waals and ionic radii and their determinations. Radius ratio and their determination for coordination numbers, 3, 4, 6 & 8
- 1.6 Diffraction methods in the study of solids, Bragg equation, Unit cell parameters, Number of formula units in the unit cell, Application of powder diffraction data, Unit cell, Crystal systems, Miller indices and their significance
- 1.7 Crystal defects
Stoichiometric, Non-stoichiometric, Schottky and Frenkel defects.

2. Introduction to Nuclear Chemistry (10 hrs)

- 2.1 Structure of the atomic nucleus, Stability - odd-even rule, n/p ratio and magic numbers, Properties of the nucleus – calculation of binding energy, BE curve, Introduction to Shell Model and Liquid drop Model; Elementary particles and their classification, antiparticles mesons and nuclear stability.
- 2.2 Radioactivity
Historical background - phenomenon of radioactivity, Properties of α , β and γ , Types of radioactive decay - α , β^- , β^+ , EC and γ , Writing nuclear equations, Radioactive decay law – derivation of equations, Activity (A), Units of radioactivity - Ci, Bq, Radioactive decay series - $4n$, $4n+1$, $4n+2$ and $4n+3$, Artificial radioactivity
- 2.3 Nuclear reactions
Nuclear reactions with charged particles (α , p) and neutrons, Charged particle

accelerators (linear accelerators, cyclotrons and betatrons), Nuclear cross section, Nuclear fission, Fusion and chain reactions, Calculation of energy released (Q) - energy balance of fission process, Nuclear reactors.

2.4 Radioisotopes as tracers and radiation sources for diagnostic and therapeutic purposes, Radiopharmaceuticals - ^{99m}Tc , ^{131}I , ^{32}P , ^{113m}In

2.5 Radiochemical methods of analysis

Isotope dilution analysis (IDA), Neutron activation analysis (NAA), Radioelement dating methods (U/Pb, $^{87}\text{Rb}/^{87}\text{Sr}$, $^{187}\text{Re}/^{187}\text{Os}$, ^{14}C), Effects and measurement of radiation - interaction with matter, dose, rem, RBE, Measurement of radiation - GM tube, Scintillation counter

3. Introduction to Molecular Symmetry (5 hrs)

3.1 Elements of Symmetry and symmetry operations, Point groups and their determination, Group multiplication tables and character tables.

4. Co-ordination Chemistry (15 hrs)

4.1 Definition of terms. - central metal atom/ion, Ligands, Donor atom, Co-ordination sphere, Types of isomerism in coordination complexes. Nomenclature of coordination compounds, Coordination members and polydentate ligands.

4.2 Stability of complex ions in aqueous solution: Stepwise & overall formation constants, Thermodynamic & kinetic stability, Chelate effect, Macrocyclic effect.

4.3 Hybridization and structural types

4.4 Bonding in co-ordination compounds: Valence bond theory, Crystal field theory-splitting of d orbitals by octahedral and tetrahedral fields, Measurement of crystal field splitting (Δ) ($\Delta = 10 Dq$) in an octahedral environment, Crystal field stabilization energy (CFSE), Pairing energy, Factors affecting the magnitude of Δ , Spectrochemical series, Evidence for crystal field stabilization energy - variation of lattice energy and ionic radii of divalent metal halides of first transition series, Magnetism in coordination compounds, Tetragonal distortion, Jahn- Teller effect, Square planer coordination, Absorption spectra of d^1 and d^9 system, Hole formation, Colours of transition metal complexes, Introduction to molecular orbital theory and Π bonding in octahedral complexes.

Suggested Reference:

- J. D. Lee, Concise Inorganic Chemistry, 5th Edition
- Shriver and Atkins, Inorganic Chemistry.
- Robert H. Crabtree, The Organometallic Chemistry of the Transition Metals, 5th Edition
- Huheey, Inorganic chemistry: Principles of Structure and Reactivity

Evaluation Criteria: Three hours examination at the end of the semester

C 21032 - Organic Chemistry I

1. Organic Reactions (12 hrs)

1.1 C-C bond formation

Use of organometallic reagents (Mg, Na, Li, Cu, Cd and Zn organometallics), Enolate chemistry, Thermodynamic and kinetic enolates, Alkylation reactions of enolates including doubly activated enolates (such as ethyl acetoacetate, acetylacetone, diethyl malonate, cyanoacetic acid), Carbonyl addition reactions of enolates (Aldol, Claisen, Mannich, Dieckman and Michael reactions, Robinson annulation), Alkylation of enamines. Pd catalysed coupling reactions

1.2 C-N bond formation

Electrophilic methods of making C-N bonds (nitration of aromatic compounds, Coupling reactions of diazonium salts, Nitrosation of alkenes and ketones), Nucleophilic methods of forming C-N bonds (nucleophilic alkylation reactions of amines and azides, Gabriel synthesis, reductive amination of ketones and aldehydes, reactions of amines with carboxylic acid derivatives)

1.3 Use of P, B, S, and Si in organic synthesis

Ylide reactions (P- and s-ylide), Sulfoxide eliminations to alkenes, Use of 1,3-dithianes (reversed polarity), Silicon containing reagents (Peterson alkene synthesis, Silyl ethers as protecting groups, Boron containing reagents (hydroboration-oxidation of alkene and alkynes)

1.4 Rearrangement reactions in organic synthesis

Favorski, Hofmann, Curtius, Beckmann, Benzil-benzilic acid and pinacol-pinacolone rearrangements, Baeyer- Villiger oxidation

1.5 Free radical reactions in C-C bond formations

2. Structure Elucidation of Organic Molecules (18 hrs)

2.1 Use of UV- Visible spectroscopy in structure elucidation of organic molecules

2.2 Use of IR spectroscopy in structure elucidation of organic molecules

2.3 Use of ^1H and ^{13}C NMR spectroscopy in structure elucidation of organic molecules

2.4 Use of Mass Spectrometry in structure elucidation of organic molecules

2.5 Joint Application of all techniques in structure elucidation of organic molecules

Suggested References:

- J. M. Sanders, B. K. Hunter, Modern NMR Spectroscopy A Guide for chemists, Oxford University press , 1993
- D. H. Williams, Spectroscopic methods in Organic chemistry, McGraw and Hill, 1989
- D. L. Pavia, G. M. Lapman and G. S. Kriz Introduction to Spectroscopy, Saunders, 1979.
- R.O.C. Norman and J. M. Coxon, Principles of Organic synthesis, Chapman & Hill, 1993.
- I L Finar, Organic Chemistry, Volume 1 and 2, 1991
- F. A. Carey and R. J. Sundberg, Advanced Organic Chemistry, Volume 1 and 2

Evaluation Criteria: Two hours examination at the end of the semester

C 21062 - Organic Chemistry II

1. Heterocyclic Chemistry (10 hrs)

- 1.1 Chemistry of one hetero atom (O, S or N) five membered heterocyclic compounds
- 1.2 Chemistry of six membered heterocyclic compounds
- 1.3 Benzo derivatives of 5- membered heterocyclic compounds
- 1.4 Benzo derivatives of 6- membered heterocyclic compounds
- 1.5 Some simple biologically important molecules
- 1.6 Examples of two hetero atom compounds which are biologically important

2. Polynuclear Aromatic Hydrocarbons (5 hrs)

- 2.1 Properties, Synthesis and reactions of Naphthalene, Anthracene and Phenanthrene

3. Natural Products (15 hrs)

- 3.1 Introduction to Primary and Secondary metabolites
- 3.2 Chemistry of selected Alkaloids (Ephedrine, Hygrine, Arecoline, Nicotine, Atropine, Ecogonine, Quinine, Papaverine, Yohimbine series, Morphine, Codeine series)
- 3.3 Chemistry of selected Steroids (cholesterol, β -sitosterol, testosterone, estrone)
- 3.4 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).

Suggested References:

- W. Voelter, and D. G. Daves, Biologically active principles of natural products. Georg Thieme Verlag, 1984.
- J. Mann, R. S. Davidson, J. B. Hobbs, D. V. Banthorpe and J. B. Harbone, Natural Products: Their chemistry and biological significance, Longman, 1996.
- R. R. Gupta, M. Kumar, V. Gupta, Heterocyclic Chemistry, Springer, 1998.
- R. M. Acheson, An Introduction to the Chemistry of Heterocyclic Compounds, John Wiley, 1977.

Evaluation Criteria: Two hours examination at the end of the semester

C 21042 - Titrimetric and Gravimetric Methods in Analysis

1. Acid – Base and Precipitation Equilibria (13 hrs)

1.1 Acid – Base titrations

Gibbs energy, Enthalpy and entropy in the dissolution of a salt in water e.g. NaCl. Review of accuracy and precision, The analytical process, Sensitivity, Selectivity, Specificity, Gibbs energy, Enthalpy and entropy in a neutralization reaction, Titration and the conditions required for a reaction to be used in titrations, Titration of a strong acid with a strong base, Calculation of the equivalence point pH value and sketches (drawing) of the titration curves with the change in concentrations, Effect anions in the medium, A weak acid concept based on the nature of the anion in the medium, Calculation of the equivalence point pH value and sketches (drawing) of the titration curves, The presence of a cation, The weak base concept depending on the nature the cation, The feasibility of an acid base titration based on the Gibbs energy, Applications to mixtures of acids and poly functional acids and bases, $\frac{K_{a1}}{K_{a2}} \geq 10^4$ Two step titration curves, The weak base concept, Titration of weak bases with strong acids, $\frac{K_{a1}}{K_{a2}} \geq 10^4$ Two steps titration curves, Hydrolysis of salts, Titrations of solutions of salts with strong acids/bases, $\frac{K_{a1}}{K_{a2}} \geq 10^4$ Two steps titration curves, Theory of indicators, Selection of an indicator for a particulate acid base titration, Apparent indicator constant concept

1.2 Buffer solutions

Formation of a buffer solution during an acid base titration, Derivation of following equation for buffers $pH = pK_a + \log \frac{[A^-(aq)]}{[HA(aq)]}$ and $pH = (14 - pK_b) + \log \frac{[MOH(aq)]}{[M^+(aq)]}$ Applications to poly functional acids and bases, Buffer capacity, Calculation of the buffer value for a buffer system, Calculation of the concentration of buffer components required to prepare a buffer solution of the given capacity and *vice versa*

1.3 Precipitation methods

Qualitative analysis: Dissolution of precipitate, Conditional solubility product for a precipitate $K'_{sp} = \frac{K_{sp}}{\alpha_M \alpha_X}$, Derivation of equations for α_M and α_X if the metal ion forms a soluble complex with a ligand A the precipitate MX is soluble in a solution of A, If HX is a weak acid the precipitate MX is soluble in a solution containing hydrogen ions (acid), The precipitation of Group II (Copper/Tin Group) metal sulphides, $K'_{sp} = \frac{K_{sp}}{\alpha_{S^{2-}}}$. Derivation of an equation to determine and the interpretation of dissolution of metal sulphides based on the values solubility products and the position of the metal in the periodic table, The precipitation of Group III (Iron Group) metal hydroxides, Electronic configuration and the solubility of metal hydroxide, Effect of ammonium ions,

Gravimetry: The requirements for a precipitate to be used in gravimetric analysis, Introduction, Weighing, Precipitation and formation of a precipitate, Particle size of a precipitate, Nucleation, Von Weimarn's theory, Common ion effect, Properties of a good precipitate, Completion of precipitation, Filtering, Washing, Drying and igniting, Applications, Contamination of a precipitate, Methods of co-precipitations, Methods to minimize co-precipitations, Precipitation from homogeneous solution (PFHS).- Post-precipitation. Methods to minimize post-precipitation

2. Complexometric and Redox Titrations (13 hrs)

2.1 Complexones

EDTA, NITA, DCTA, EGTA and TTHA, The complex formation of EDTA with metal ion in aqueous medium, Thermodynamic formation constants

2.2 Complexometric titrations

Equivalence point pM and theoretical titration curves, Conditional formation constant, K'_{MY} Derivation of $K'_{SP} = \alpha_M \alpha_{Y^{n-}} K_{MY}$

2.3 Effect of pH on conditional formation constant

Derivation of an equation to calculate $\alpha_{Y^{n-}}$ dependence on the pH of the medium

2.4 Effect of complex formation and hydrolysis on conditional formation constant:

Derivation of equations to calculate M α based on one step complex formation with an auxiliary ligand L, $M^{n+}(aq) + L(aq) \rightarrow ML_n^+(aq)$, Derivation of an equation for α_M based on one step hydrolysis, $M^{n+}(aq) + H_2O(l) \rightarrow M(OH)^{(n-1)+}(aq) + H^+(aq)$

2.5 Titration Curves

Gibbs energy change: Titration curve equivalence point pM values, Metallochromic indicators and selection of indicators based on log K values, In MIn

2.6 Redox titrations

Redox titration curves, Gibbs energy, calculation of equivalence point potentials (E_{ep}) values and the selection of redox indicators, Iodometry

2.7 Formal potential (E_o')

Effect of pH on redox equilibria, Calculation of formal potential of systems involving cations and anions at different pH values, Effect of complex formation and precipitation etc. on redox equilibria, Effect of the side reactions on equivalence point potentials (E_{ep}) and consequent influence on redox titrations including iodometry

3. Non-Aqueous Solvents in Analysis (04 hrs)

- 3.1 Classification of solvents, Self ionization (autoprotolysis)
- 3.2 Acid –base equilibria in non-aqueous solvents. pK_a is independent of the solvent, Determination of moisture content using non- aqueous solvents, Karl-Fisher method
- 3.3 Solubility of substances including some metals in liquid ammonia

Suggested References:

- D. A. Skoog, D. M. West, Fundamentals of Analytical Chemistry, Hold Rinehart and Winston, New York
- G. H. Jeffry, J. Basset, J. Mendhan, R. C. Denney, Vogel's Textbook of Quantitative Inorganic Analysis, (ELBS), Longman,
- G. Schwarzabach, Complexometric Titrations
- H. A. Laitinen and W. E. Harris, Chemical Analysis, 2nd Edition Mc-Graw–Hill Kogakusha Ltd, Tokyo
- D. G. Peters, J. M. Hayes and G. M. Heiftje, Chemical Separations and Measurements, pages 315-316 Saunders Golden Series. W.B. Saunders Company Philadelphia
- R. Belcher, and A. J. Nutten, Quantitative Inorganic Analysis, 3rd Edition, 1970, Butterworths, London

Evaluation Criteria: Two hours examination at the end of the semester

C 21082 - Separation Methods and Spectroscopic Applications

1. Separational methods (8 hrs) 1.1. Solvent extraction

- 1.1 Distribution ratio, Extraction constant, Relationship between formation constant and extraction constant in a metal chelate extraction. $pH_{1/2}$ values, Selectivity
- 1.2. Ion exchange
Organic ion exchangers and their applications in Industry. Ion exchange capacity and selectivity, Soils as ion exchangers

2. Chromatography Basics (6 hrs)

- 2.1. Introduction to chromatography: Frontal, Displacement and elution chromatography; Components of elution chromatography: The stationary phase, The mobile phase and the analyte
- 2.2. Planar and column chromatography
- 2.3. Adsorption, Partition, Ion exchange and permeation chromatography
- 2.4. Reversed phase and normal phase chromatography
- 2.5. Basic terminologies in chromatography: Retention time, Capacity factor, Selectivity factor, Volumetric flow rate
- 2.6. Zone broadening: Gaussian shape of chromatographic peaks, The plate theory, Quantitative description of column efficiency, The rate theory, Van Deemter equation for plate height
- 2.7. Column efficiency and resolution
- 2.8. Thermodynamics of elution chromatography: Enthalpy driven and entropy driven chromatograms

3. Spectroscopic Applications (16 hrs)

- 3.1 Atomic spectroscopy (12 hours)
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, Wavelength selection devices: Monochromators, Polychromators and their figures of merit, Radiation detectors: Photomultiplier tube, Interferences in atomic spectrometry; Chemical and physical interferences, Spectral Interference, Matrix interference: Recovery test and standard addition method, Instrument performance characteristics:

Calibration curves, Linear range, Linear dynamic range, Sensitivity, Limit of detection and practical quantitation limit, Preparation of samples for atomic spectrometry; Atomic Mass Spectroscopy: Fundamental principles of mass spectrometry; Types of atomic mass spectrometry; Transducers in atomic mass spectrometry; Mass analysers, Isotopic ratio mass spectrometers (IRMS); Inductively coupled plasma mass spectrometry (ICP-MS); Introduction to other atomic mass spectrometric techniques: Spark source mass spectrometry, Glow discharge mass spectrometry.

3.2 Molecular spectroscopy (04 hours)

Principles related to molecular absorption, Fluorescence and phosphorescence spectroscopic techniques, Instrumentation for molecular spectroscopy: Single and double beam spectrophotometers, Interferences in molecular spectrometry, Preparation of samples for molecular spectrometry

Suggested References:

- D. A. Skoog, D. M. West, "Fundamentals of Analytical Chemistry", Hold Rinehart and Winston, New York
- Gary D. Christian, "Analytical Chemistry", 6th Edition, Wiley India Edition

Evaluation Criteria: Two hours examination at the end of the semester

C 21053 - Biochemistry

1. Introduction to Biomolecules (10 hrs)

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, Important phospholipids of the biological world, Phosphatidic acid and its derivatives such as lecithin, phosphatidylinositol, cardiolipin, Sphingomyelins, Cholesterol and its biological importance, Interactions of amphipathic lipids with water-micelles, liposomes, lipid bilayers

1.3 Amino acids & Proteins

Amino acids: Properties- Zwitter ions & isoelectric point, Peptide bond formation, Ninhydrin reaction, Essential amino acids, Proteins: Primary, Secondary, Tertiary & quaternary structure of proteins, Isoelectric pH of proteins, Curd formation, Denaturation of proteins, Buffering action of proteins, Importance of histidine in the buffering action, Biological importance of myoglobin, hemoglobin, collagen

2. pH, Buffers and Biological Buffers (2 hrs)

2.1 Physiological pH and its importance

2.2 Biological buffers

3. Enzymes (5 hrs)

3.1 Introduction & classification

3.2 General characteristics of enzymes: Physical properties, Active site, Specificity; Mechanism of action, Enzyme activity

3.3 Enzyme kinetics

3.4 Inhibition of enzymes: Competitive, Non competitive and suicide inhibition

3.5 Isoenzymes

3.6 Important diagnostic enzymes

4. Structure and Function of Nucleic Acids (6 hrs)

- 4.1 Nucleosides & nucleotides
- 4.2 Introduction to DNA replication
- 4.3 Transcription and translation: Prokaryotes and eukaryote

5. Introduction to DNA damage, repair mechanisms & mutations (2 hrs)

- 5.1 DNA damage: Agents that cause damage to DNA and types of damage
- 5.2 Repair mechanisms: Natural mechanisms available for the repair of damaged DNA
- 5.3 DNA mutations: Basics of DNA mutations and their effects, Mutations that cause cancer

6. Structure & functions of Biological membranes (2 hrs)

- 6.1. General structure: Structure and function of a biological membrane, Major components
- 6.2. Significance of degree of unsaturation of lipids
- 6.3 Contribution of cholesterol to the characteristics of the membrane
- 6.4 Role of proteins: Membrane proteins, Glycated membrane proteins

7. Transport Across Membranes (2 hrs)

- 7.1 Methods of transport: Simple diffusion, Mediated transport - Types, Principles and properties
- 7.2 Voltage & ligand gated channels
- 7.3 Important transport systems: GLUT transporters, Ion channels, Sodium – Potassium pump, Glucose – sodium co-transporter
- 7.4 Hypotonic, Isotonic & hypertonic solutions and their effect on cells

8. Metabolism & Energy generation (4 hrs)

- 8.1 Metabolic pathways harvesting energy stored in molecules: Aerobic glycolysis and its role in energy harvesting; ATP production at substrate level
- 8.2 Anaerobic glycolysis & its significance
- 8.3 TCA & its role in energy harvesting
- 8.4 Fatty acid oxidation & its role in harvesting energy stored in fatty acids

9. Electron Transport & Oxidative phosphorylation(4 hrs)

- 9.1 Electron transport chain (ETC): Introduction, Location, Points of entry of reducing equivalents into ETC
- 9.2 Malate & glycerophosphate shuttles: Shuttles that transport reducing equivalents from cytoplasm into mitochondria
- 9.3 ATP production in ETC, Comparison of substrate level ATP production and oxidative Phosphorylation
- 9.4 Mitchell's chemiosmotic hypothesis
- 9.5 Inhibitors & uncouplers

10. Hormones and their mechanism of action (4 hrs)

- 10.1 Introduction to the endocrine system
- 10.2 Classification of hormones
- 10.3 Endocrine glands and their location
- 10.4 Biological functions of hormones (basics)
- 10.5 Hormone receptors
- 10.6 Basic biochemical mechanisms of hormone signal transduction

11. Separation techniques in Biochemistry (4 hrs)

- 11.1 Methods of disintegration of tissues / cells
- 11.2 Separation of sub-cellular organelles
- 11.3 Solvents and precipitation of salt
- 11.4 Paper & thin layer chromatography
- 11.5 Column chromatography: Molecular sieving, Affinity, Ion exchange, Examples of practical applications
- 11.6 Electrophoresis: Introduction, Practical applications
- 11.7 Ultracentrifugation

Suggested References:

- M. Cooper Geoffrey, "A Molecular Approach, The Cell", 2nd Edition, Boston University, Sunderland (MA): Sinauer Associates 2000. ISBN-10: 0-87893-106-6
- J. M. Berg, J. L. Tymoczko, L. Stryer, "Biochemistry", 5th Edition, New York, W H Freeman, 2002.

Evaluation Criteria: Three hours examination at the end of the semester

C 21073 - Introduction to Management, Economics and Finance

1. Basic Principles of Management (19 hrs)

1.1 Introduction to management (4 hrs)

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 (3 hrs)

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, Standardization, 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 (4 hrs)

Task environment (Key elements), Macro Environment (key elements), Internal Environment (organization culture and its key elements)

1.4 Functions of management (8 hrs)

Planning function, 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, the advantages and disadvantages of the characteristics of different structures) Leading Function, Controlling Function, Types of control (feed back control, feed forward control and concurrent control), Operations management control loops (voice of process and voice, of customer)

2. Operations Management (12 hrs)

2.1 Introduction to concepts of operations management (4 hrs)

Transformation of inputs to useful outputs, Productivity, 2 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 (4 hrs)

Continuous improvement, Fundamental improvement, Innovation & creativity,

5S + 3R concept and how it enhances efficiency, Quality circles

2.3 New Product Development (2 hrs)

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 (2 hrs)

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 hrs)

3.1 Economy and Economics; Scarcity, Choice and opportunity cost; Basic economic problems; Factors of production; Law of diminishing returns: Marginal, Average and total product; and economic systems: Traditional, Command, Market and mixed; Concept of profit

4. Aspects of Finance (8 hrs)

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. (2 hrs)

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 (2 hrs)

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 (4 hrs)

Suggested References:

- 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 Thomson.

Evaluation Criteria: Three hours examination at the end of the semester

LEVEL 3
Core Course Units
26 Credits

C 31003 - Energetics and Kinetics

1. Special Topics in Chemical Thermodynamics (10 hrs)

- 1.1 Extensive review of basic thermodynamic principles dealt with at levels 1 & 2
- 1.2 Open system: Partial molar properties, Gibbs-Duhem equation, Determination of partial molar properties by alternative methods
- 1.3 Chemical potential, Its variation with temperature and pressure, Application of free energy change for a general reaction in terms of standard free energy change and activities of reactants and products
- 1.4 Fugacity with special reference to gaseous system: Determination of fugacity of (i) A real gas (ii) A real gas in a gaseous mixture: Activities and activity coefficients
- 1.5 Experimental and other evidence leading to the third law; The third law of thermodynamics
- 1.6 Determination of the third law entropies; Debye T³ law; Comparison of spectroscopic and colorimetric properties
- 1.7 The molecular basis of entropy; Entropy as a measure of probability and disorder; Boltzmann Plank – Equation (These aspects will be done more completely and correlated under statistical thermodynamics)

2. Statistical Thermodynamics (10 hrs)

- 2.1 Introduction
Scope of statistical thermodynamics
- 2.2 Definition of basic concepts
Quantum mechanical picture of a system of non-interacting particles; Configuration; Weight of a configuration, Distinguishable and indistinguishable particles; Boltzmann, Fermi-Dirac and Bose- Einstein wave functions; Relationship between macroscopic properties of a system and its possible configurations
- 2.3 Derivation of distribution functions
Probability of occurrence of a configuration in an isolated system; Definition of dominating configuration, Stirling's approximation; Identification of the dominating configuration of a system; Derivation of the Boltzmann, Fermi-Dirac and Bose- Einstein distributions, The classical limit (where Fermi-Dirac Bose-Einstein distributions tend to the Boltzmann distribution)
- 2.4 Molecular partition function
Definition of molecular partition function; Physical interpretation of the molecular partition function

- 2.5 Translational and vibrational partition functions
Derivation of the translational partition function of a particle in a one and three dimensional boxes; Derivation of the vibration of a diatomic molecule which behaves as a harmonic oscillator
- 2.6 Isolated systems and molecular partition function
Relationship between the internal energy of an isolated system and the molecular partition function; Statistical entropy of an isolated system
- 2.7 Non –isolated systems
Quantum mechanical picture of a closed system of molecules with interactions; Concept of ensemble; Definitions of micro-canonical and grand – canonical ensembles; Relationship between canonical partition function and canonical ensemble averages of internal energy and entropy
- 2.8 Canonical ensemble with non interacting molecules
Relationship between canonical partition function and molecular partition function for systems of distinguishable and indistinguishable molecules; A monoatomic ideal gas and Sackur-Tetrode equation, Evaluation of the Lagrange multiplier, β ; Relationship between the canonical partition function and thermodynamic parameters other than internal energy and entropy
- 2.9 Evaluation of molecular partition function of realistic systems
High temperature approximation to rotational and vibrational partition functions; Mean energies; Heat capacities
- 2.10 Evaluation of equilibrium constants for reactions of ideal gases

3. Reaction Dynamics (08 hrs)

- 3.1 Introduction, Potential energy surfaces, The kinetic theory of collision, Relationship between critical energy and the activation energy, Probability factor
- 3.2 Activated complex theory, Vibrational mode along the reaction coordinate, Thermodynamic interpretation of the overall rate constant, Application of activated complex theory
- 3.3 Theories of unimolecular reactions, Lindemann theory, The $[M]^{1/2}$ value of the unimolecular reactions, Weaknesses of Lindemann theory, Calculation of k value from Hinshelwood method, The treatment of Rice-Ramsperger and Kassel, Energized complex, Slater's treatment, Rice – Ramsperger-Kassel-Marcus theory
- 3.4 Liquid phase reactions, Theory of diffusion- controlled reactions, The theory of absolute reaction rates, Influence of solvent in liquid phase reactions, Single and double sphere models
- 3.5 Influence of ionic strength of reactions in solutions

4. Selected Topics in Electrochemistry (17 hrs)

- 4.1 Ion-solvent interactions: The non structural treatment of ion solvent interactions, The Born model, enthalpy, Entropy and free energy change of ion-solvent interactions, Ion solvation and solvation number
- 4.2 Ion-Ion interactions: Debye Huckel theory of Ion-Ion interactions, Activity coefficient and ion-ion interaction, Mean activity, Limiting and extended forms of Debye-Huckel equation
- 4.3 Electrode-Electrolyte interface, Electrocapillary equation, Experimental evaluation of surface excesses, Charge density and interfacial capacitance
- 4.4 Structure and theories of electrical double layer, Models for the electrical double layer: The Helmholtz-Perrin Model, The Gouy Chapman theory and the model, The Gouy - Chapman Stern model, The Grahame model, The Bockris-Devanathan -Muller model, The Zeta potential
- 4.5 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 its approximate forms. Charge transfer resistance, Tafel plots

Suggested References:

- Atkins, P.W. and De Paula, Julio “Atkins’ Physical Chemistry” 8th Edition, 2006, Oxford University Press
- Bard, Allen J. and Faulkner, L.R. “Electrochemical Methods” 2004, Wiley and Sons
- Seddon, J.M. and Gale, J.D. “Thermodynamics and Statistical Mechanics” 2004, RSC Publications
- Open University of Sri Lanka “Publication on Advanced Chemical Thermodynamics” CHU 3030, Level 5

Evaluation Criteria: Three hour examination at the end of the semester

C 31012 - Special Topics in Physical Chemistry I

1. Molecular Spectroscopy (10 hrs)

- 1.1 Analysis and assignment of normal modes of vibration; Determination of structure of molecules
- 1.2 Raman spectroscopy; Classical and quantum theory of Raman Effect, Polarization effects, Vibration using IR and Raman data; Rotational Raman Spectroscopy
- 1.3 Electronic spectra of diatomic molecules; Vibrational coarse structure, Rotational fine structure, Franck–Condon principle, Determination of bond dissociation energy, General principles of instrumentation, Fourier transformation method, Spectroscopic determination of structure of molecules

2. Symmetry and Group Theory (05 hrs)

- 2.1 Applications of molecular symmetry, Group multiplication and character tables, Two dimensional irreducible representations, Predict IR/Rahman modes

3. Quantum Chemistry and Quantum Mechanics (15 hrs)

- 3.1 Revision of quantum mechanics 1 (Postulates of quantum mechanics, Functions, Operators, Operator algebra, Linear operators, Eigen functions and Eigenvalues, Linear independence of functions, Dirac notation, Hermitian operators, Eigenvalues of Hermitian operators, Orthonormality of Eigen functions of Hermitian operators, Completeness of set of functions, Commutation theorem, Stationary states)
- 3.2 Simple three dimensional (3D) systems, Stationary states of a particle in a 3D box, Degeneracy of energy levels of a particle in a cubic box, Harmonic oscillator, Energy levels and stationary states of a rigid rotor, Properties of spherical harmonics, Rotational energy levels of a diatomic molecule, Angular momentum in quantum mechanics
- 3.3 Energy levels and stationary states of a hydrogen atom, Radial part and angular part, Angular momentum, Magnetic quantum numbers
- 3.4 Approximate methods; Perturbation theory and variational method
- 3.5 Introduction to quantum chemical calculations on atoms and molecules, Definition of atomic units and status of quantum chemical calculations on helium atom
- 3.6 Applications in chemical bonding, Valance-bond theory, Molecular orbital theory and Huckel approximation

Suggested References:

- Atkins, P.W. and De Paula, Julio "Atkins Physical Chemistry" 9th Edition, Oxford University Press
- Struve, W. S. "Fundamentals of Molecular Spectroscopy" 1989 John Wiley & Sons, Inc.
- Pavia, D.L., Lampman, G.M., Kriz, G.S. and Vyvyan, J.R. "Spectroscopy" 2007, CengageLearning Products
- Ball, D.W., "The Basics of Spectroscopy" 2009, PHI Learning Pvt Ltd
- Engle, Thomas "Quantum Chemistry and Spectroscopy" 2006, Pearson Education Inc.
- Mcquarrie, D.A. "Quantum Chemistry" 2nd Edition, University Science Books

Evaluation Criteria: Two hours examination at the end of the semester

C 31022 - Special Topics in Physical Chemistry II

1. Special Topics in Surface Chemistry (10 hrs)

- 1.1 Drawbacks and inadequacy of the Langmuir and other simple adsorption models
- 1.2 Variation of enthalpy of adsorption with coverage
- 1.3 Multilayer physical adsorption; Brunauer-Emmett-Teller Adsorption Isotherm; Determination enthalpies of adsorption using isosteric, Calorimetric (film and filament calorimetry) and desorption energy methods, The use of Lennard-Jones potential energy diagram in understanding adsorption and desorption phenomena
- 1.4 Need for a good vacuum in surface work; Measurement of pressure in vacuum systems using Mc-Leod gauge, Piranigauge and Ion gauge and other methods
- 1.5 Measurement of dose size in vacuum system using calibrated volume and calibrated leak method, Molecular flow of the surface area from multilayer adsorption data
- 1.6 Determination of gases through fine capillaries, Knudsen number

2. Experimental Methods in Surface Chemistry (05 hrs)

- 2.1 Surface analytical techniques
Typical surface analytical techniques: Low energy electron diffraction (LEED), Auger Electron Spectroscopy (AES), Photoelectron Spectroscopy (UPS, XPS), Field ion microscopy (FIM), Field Emission Microscopy (FEM), Secondary ion mass spectroscopy (SIMS)

3. Experimental Methods in Chemical Kinetics (07 hrs)

- 3.1 Experimental methods in reaction kinetics, Plug and stirred flow methods, Stopped-flow and continuous flow methods, Contact time, Pressure and temperature jump methods, Shockwave tube, Relaxation techniques, Pulse radiolysis
- 3.2 Kinetics of photochemical phenomena: Estimation k_f , k_p , k_{isc} , k_{ic} , from photochemical quantities, Kinetics of photochemical quenching: simple Stern-Volmer plot to complex quenching patterns

4. Emerging Frontiers in Chemistry (08 hrs)

- 4.1 Sonochemistry
Properties of sound wave & ultra sound waves and their applications such as bubble chemistry, Surface cleaning, Kinetics, Materials technology & biomedical applications

4.2 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, Properties of laser light and their applications, Laser sources: Optically pumped solid lasers, Semiconductor lasers, Atomic and ionic lasers, Molecular gas lasers, dye lasers

4.3 Liquid crystals

Mesophase: An intermediate between liquid and solid phases, Comparative description of smectic, nematic, and cholesteric phases and applications of liquid crystals

Suggested References:

- Bréchnignac, C., Houdy, P., Lahmani, M. “Nanomaterials and Nanochemistry” 2006, (Eds.) Belin, Paris

Evaluation Criteria: Two hours examination at the end of the semester

C 31033 - Advanced Topics in Organic Chemistry

1. Synthetic Organic Chemistry (20 hrs)

- 1.1 Introduction to synthetic organic chemistry- Structure and stability of organic compounds, Bronsted acids and bases, Kinetically controlled and thermodynamically products of organic reactions , Classes of mechanisms in organic synthesis
- 1.2 Cyclization reactions--Baldwin's rules for ring closure reactions
- 1.3 Modern reagents in synthetic organic chemistry – Overview of frequently used organic reagents used for oxidation, Allylic oxidation, Reduction, Dihydroxylation, Hydrogenation, Carbonylation, regio and chemo selective reagents
- 1.4 Review of selected named reactions used in organic synthesis
- 1.5 Protection/deprotection in organic synthesis - Protection/ deprotection of alcohols, Amines, Aldehyde, Ketones and Thiols
- 1.6 Two phase reactions in organic chemistry
- 1.7 Selected examples of total synthesis of natural and pharmaceutical compounds
- 1.8 Disconnection Approach to Organic Synthesis (14 hrs)
Introduction to retro synthetic approach; Concept of synthon, Synthetic equivalent, Functional group inter conversion; Regioselectivity, chemoselectivity, stereospecificity and stereoselectivity; Control, activation and protection; One group disconnections (simple alcohols, compounds derived from alcohols, olefins, aryl ketones); Two group disconnections (beta-hydroxy carbonyl compounds, alpha,betaunsaturated carbonyl compounds, 1,3-dicarbonyl compounds, 1,5-dicarbonyl compounds); Illogical two group disconnections (1,2dioxxygenated pattern, 1,4- dioxxygenated and 1,6-dioxxygenated compounds)

2. Spectroscopic Methods (25 hrs)

- 2.1 Free Induction Decay (FID), Instrumentation, Complex splitting patterns of ¹H NMR and J values, NMR of homotopic, Enantiotopic and diastereotopic protons, ABC, ABX and AMX spin systems, Improving NMR spectra (decoupling, shift reagents, magnetic field etc.), Non- first order spectra, ¹³C NMR ; Solvent peak of ¹³C NMR, Simplification of ¹³C NMR, Double quantum, Single quantum and zero quantum spin relaxations, Different types of ¹³C NMR spectra, NOEDIFF, INEPT, APT, DEPT experiments, 2D NMR; COSY, ROSSY, TOCSY, HECTCOR, HMQC, HSQC, HMBC, NOESY, ROSEY
- 2.2 Mass spectrometry; Ionization methods (CI, EI, APCI(+), APCI(-), ESI, MALDI *etc.*), GCMS, LCMS, HRMS, Fragmentation patterns of some classes of organic compounds

2.3 Problem Solving in structure elucidation of organic compounds

Suggested References:

- McMurry, John “Organic Chemistry” page 440-475, 5th Edition, 1999, Asian Edition.
- March, Jerry, John, Wiley “Advanced Organic Chemistry-Reactions , Mechanisms & Structure” 4th Edition, 2009, New Delhi, India
- Carruthers, W., (1996) Modern Aspects of organic synthesis, Cambridge press
- Firebolin, H., (2004) Basic One – and two – dimensional NMR spectroscopy, VCH
- Silverstein, R.M., Webster, F. X., (1997) Spectrometric identification of organic compounds , John Willey
- Sanders, J. K. M. and Hunter, B. K., (1993) Modern NMR spectroscopy, Oxford University Press
- Williams, D. and Fleming I., (1989) Spectroscopic methods in Organic chemistry, McGraw-Hill International (UK) limited

Evaluation Criteria: Three hours examination at the end of the semester

C 31043 - Physical Organic Chemistry

1. Correlation of Structure with Reactivity (10 hrs)

Quantitative treatments of the effects of structures on reactivity; The use of Hammett equation, Substituent constant σ , σ_0 , Reaction constant ρ and its significance, Applications, Free energy diagrams, Failures and modifications Hammett equation; Yukawa – Tsuno equation and its applications., The use of σ^+ , σ^- values; Taft equation, Steric effects in organic reactions

2. Solvent Effects in Organic Reactivity (03 hrs)

Protic, Aprotic and dipolar aprotic solvents in organic reactivity; Significant and application of m and γ constants; Two phase reactions in organic chemistry

3. Conformational Analyses (07 hrs)

Reactivities of erythro and threo isomers, Curtin Hammett principle, Cram's rule, Conformations of cyclohexanones and dihalocyclohexanone, Neighbouring group participation in organic reactions

4. Pericyclic Reactions (10 hrs)

Introduction to pericyclic reactions, Types of pericyclic reaction: Cycloaddition, Electrocyclic reactions, Sigmatropic reactions. Intercation diagrams: Aromaticity, Antiaromaticity, Huckel systems, Mobius systems, Dewar-Huckel-Zimmerman aromatic transition state concept; Molecular orbitals, Molecular orbitals of conjugated polyenes and allyl systems, Correlation diagrams, Concept of HOMO and LUMO - Fuki frontier orbital approach., Woodward-Hofmann rules, Selection rules and stereochemistry of electrocyclic reactions, Cycloadditions and sigmatropic shifts – applications of frontier molecular orbital approach, Correlation diagram approach, Huckel-Mobius approach; Sommelet-Hauser, Cope and Claisen rearrangements

5. Photochemistry (15 hrs)

Organic photochemistry: Selection rules for electronic excitation, Electronic states, Quantum yield, Excitation sources, Filters, Fluorescence and phosphorescence. Jablanski diagram, Singlet and triplet excited states, Quenching of excited state, Lifetime of excited state, Selective quenching, Triplet quenchers, Energy transfer, Triplet sensitization, Mechanism of photochemical reactions: Excitation, Excited states, Primary photolysis, Reactive intermediates, Secondary reactions, Study of photochemical reactions of carbonyl, Compounds: Norrish type I and II reactions, Photooxidations, Photoreductions, Photocycloadditions and photorearrangements -

di-pi-methane rearrangement, Industrial and biological application of photochemical reactions

Suggested References:

- Isaacs, Neil S “Physical Organic Chemistry” 1987, Longman Group (UK)
- Costa, M D P De “Pericyclic Reactions. Theory and Applications” 2010, Revised Edition, Institute of Chemistry Ceylon, Monograph 22
- Costa, M.D.P. De Handout on Mechanistic Organic Photochemistry, 2006

Evaluation Criteria: Three hours examination at the end of the semester

C 31053 - Special Topics in Inorganic Chemistry I

1. Physical Methods in Inorganic Chemistry (15 hrs)

- 1.1 Applications of UV, Visible & IR spectroscopic techniques in inorganic chemistry
- 1.2 Theory and applications of Nuclear Magnetic Resonance (NMR) spectroscopy (to include ^{19}F , ^{13}C , ^1H , ^{31}P , ^{11}B , and ^{14}N nuclei) in inorganic, organometallic and bioinorganic chemistry
- 1.3 Theory and applications of Electron-Spin Resonance spectroscopy (ESR) including Nuclear Quadrupole Resonance (NQR)
- 1.4 Theory and applications of Mössbauer spectroscopy

2. Electronic Spectra of Coordination Complexes (10 hrs)

- 2.1 Energy levels of atoms, Russell Saunders coupling, Energies and term symbols. Fine structure, Zeeman and Stark effects
- 2.2 Ligand Field Theory: Term symbols and energies for d^n ions. Derivation of ligand field theory from group theoretical considerations. Construction of Orgel diagrams. Molecular Orbital Theory, Complexes with π - bonding ligands
- 2.3 Electronic spectra of transition metal complexes; Number and intensities of bands in electronic spectra from Orgel and Tanabe-Sugano diagrams, Jahn-Teller theorem and its applications, Nephelauxetic effect, Charge-transfer spectra
- 2.4 Structural effects: Application of crystal field stabilization energy to predict structural effects, Spinel and inverse-spinel structures

3. Organotransition Metal Chemistry (20 hrs)

- 3.1 Introduction:
Importance of organotransition metal chemistry, Definition of an organometallic compound, Classification of ligands according to the number of electrons donated (covalent model); The 18 electron rule, Coordinative unsaturation; Oxidation state formalism; Hapticity (η^n), Geometry of organo transition metal complexes vs coordination number and electron configuration (d^n)
- 3.2 Metal-ligand bonding:
Ligands include carbon monoxide; Dinitrogen, Isocyanides thiocarbonyls, olefins; Acetylenes, Nitric oxide, Group VB donors; Carbenes, Carbynes, Allyls, Cyclobutadienes, Cyclopentadienes, Benzene and H_2
- 3.3. Homogeneous catalysis using transition metal complexes. Reaction in catalysis, Oxidative addition, Migratory insertion reactions, Reductive elimination,

Association; Dissociation, Substitution, Elimination and oxidative coupling

3.4 Examples of Homogeneous Catalysis:

Olefin isomerization, Olefin hydrogenation, Hydrosilation and hydrocyanation of unsaturated compounds hydroformylation reaction; Monsanto acetic acid synthesis, Water gas shift reaction, Hydration of alkenes, Polymerization of olefins, Olefin metathesis, Heck reaction

3.5 Reactivity of coordinated ligands: Electrophilic and nucleophilic addition and abstraction

Suggested References:

- Crabtree, Robert H “The Organometallic Chemistry of the Transition metal”
- Perera, K S D “Inorganic NMR Spectroscopy” College of Chemical Sciences, Institute of Chemistry Ceylon, Monograph No 25
- Cotton, F Albert and Wilkinson, Geoffrey “Advanced Inorganic Chemistry” 6th Edition, 2004, Wiley

Evaluation Criteria: Three hours examination at the end of the semester

C 31062 - Special Topics in Inorganic Chemistry II

1. Symmetry and Diffraction Methods (10 hrs)

Point symmetry and determination of point groups, Schoenflies and Hermann-Mauguin notations. Molecular symmetry and space symmetry; glide planes and screw axes. Determination of space groups from X-ray diffraction patterns. Structure determination, phase problem, Fourier and Patterson maps and direct methods, refinement, Electron and Neutron diffraction.

2. Bioinorganic Chemistry (10 hrs)

2.1 Introduction

Role of Metals in biological systems, Metals and human health, Speciation and specificity of metal complexes *in vivo*

2.2 Metalloproteins and metalloenzymes, Representative metalloenzymes, Types and properties of metalloenzymes

2.3 Dioxygen carriers

Dioxygen complexes of transition elements, Haemoglobin, myoglobin, Haemocyanins, haemerythrins, Haemovanadins, nature of haem dioxygen binding, Model systems

2.4 Transition metals in biological redox reactions

General mechanism of electron transfer, Blue copper proteins, Iron Sulphur proteins (rubredoxins & ferredoxins), Cytochromes, Photosynthetic pathway

2.5 Distribution and functions of metals in vivo

Storage & transport of iron, Chemistry & biochemistry of nitrogen fixation, Mechanisms & action of zinc, copper, cobalt & molybdenum containing enzymes, Enzymes containing vanadium, chromium & nickel

3. Inorganic Reaction Mechanisms (10 hrs)

3.1 Introduction to kinetics and mechanism: Stoichiometric mechanisms (Associative (A), Dissociative (D) and Interchange (I)) and Intimate mechanisms (A, D, I_a, I_d) related to square planar and octahedral substitution reactions, Kinetic and thermodynamic aspects of reactivity of complexes (labile; inert stable & unstable), Activation parameters (ΔS^\ddagger , ΔH^\ddagger , ΔV^\ddagger)

3.2 Substitution reactions of octahedral complexes: Water exchange reactions, Acid hydrolysis, Base hydrolysis (CB mechanism), 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 (Bailor and Ray-Dutt twists)

3.3 Substitution reactions of square planar complexes

General rate law, Intimate mechanisms, Factors affecting rates of square planar substitution – nature of entering group, Leaving group, Other ligands (cis and trans), Steric and Solvent effects

3.4 Electron transfer reactions in transition metal complexes: Introduction, Franck-Condon principle, Marcus theory, Exchange reactions and cross reactions, Elementary steps in the outer sphere mechanism. Inner sphere mechanism, Elementary steps and rate expressions for inner sphere mechanism, Factors which affect the rate of inner sphere reactions, Two-electron transfer reactions

Recommended Reading:

- Liyanage, Janitha A “Life and Metals” College of Chemical Sciences, Institute of Chemistry Ceylon, Monograph No
- Miessler, Garry L. and Tarr, Donald A. “Inorganic Chemistry” 4th Edition, 2010, Prentice Hall

Evaluation Criteria: Three hours examination at the end of the semester

C 31072 – Analytical Chemistry

– Instrumental Analysis I

1. Electro-Analytical Chemistry (15hrs)

- 1.1 Electrodes and potentiometry: Reference electrodes: Calomel electrodes, Silver / silver chloride electrodes, 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 Electro-gravimetry 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 Polarography and Voltammetric Methods of Analysis: Classical polarography: Diffusion current, Residual current and limiting current, Half wave potential, Ilkovic –Heyrovskiequation, Oxygen wave, Current maxima, Effect of complex formation; Chemicalanalysis 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 – Sevcikequation;Mechanistic studies using voltammetry; Amperometry: Amperometric titrations and biamperometry; Voltammetry under convection control; Introduction to convective systems; Hydrodynamic voltammetry; Rotating disk electrode voltammetry; Levichequation;Rotating ring disk electrodevoltammetry; Chemical analysis and mechanistic studies using rotating disk electrode voltammetry

2. Thermal analysis (5 hrs)

- 2.1 Thermogravimetry: Thermogravimetry (TG) and derivative thermogravimetry (DTG), Differential thermal analysis (DTA) and differential scanning calorimetry (DSC)

- 2.2 The theoretical aspects of Thermometric titrimetry: Thermometric titration in non-aqueous systems Catalymetric thermometric titrimetry Aqueous system and the application in analysis of colored industrial effluents
- 2.3 Direct injection enthalpimetry: Unfavourable kinetics and the development direct injection enthalpimetry (DIE) Applications of DIE in clinical area

3. Spectroscopic applications of analytical chemistry (10 hrs)

- 3.1 Ultraviolet and visible molecular absorption spectrometry (UV-Vis): Basic principles: Beer's law, Measurement of transmittance and absorbance, Effect of bond conjugation on peak position and absorbance, Quantitative and qualitative applications of UV-Vis spectrometry, Absorbance of mixtures, Deviations from beer's law; 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, Spectrophotometric kinetic methods
- 3.2 Molecular luminescence spectroscopy: Theory of fluorescence and phosphorescence; Instrumentation of luminescence spectroscopy, Applications of photoluminescence methods in analysis, Chemiluminescence and electro generated enhanced chemiluminescence
- 3.3 Infra-red spectrometry: IR instrumentation, IR sources, Transducers and detectors; Fourier transform IR spectrometry; Sample handling in IR spectrometry; Reflectance IR spectrometry: Attenuated total reflectance (ATR), Diffuse reflectance; Fourier-transform interferometry and Michelson Interferometer
- 3.4 Introductory Raman spectrometry: Raman scattering; Raman variants: Surface enhanced Raman spectrometry (SERS), Resonance Raman spectrometry; FT-Raman instrumentation, Raman microprobe laser sources

Suggested References:

- Harris, D. C.; Lucy, C.: Quantitative Chemical Analysis; W. H. Freeman, 2015.
- Skoog, D. A.; Holler, F. J.; Crouch, S. R.: Principles of Instrumental Analysis; Thomson Brooks/Cole, 2007. J. M.: Vogels Textbook Of Quantitative Chemical Analysis; Pearson Education, 2006.
- Peters, D. G, Hayes, J. M. and Heiftje, G.M., "Chemical Separations and Measurements" Saunders Golden Series. W.B. Saunders Company Philadelphia.

Evaluation Criteria: Two hours examination at the end of the semester

C 31082 – Analytical Chemistry: Instrumental methods II

1. Gas chromatography (GC) (6 hrs)

- 1.1 Components and their functions of a GC
- 1.2 Gas-liquid chromatography and gas-solid chromatography
- 1.3 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
- 1.4 Sample injection in GC: Split, Splitless and on-column injection
- 1.5 Carrier gasses in GC and the application of Deemter equation in GC
- 1.6 Retention index
- 1.7 GC detectors: Types of detectors, Applications, and sensitivities: Thermal conductivity, Flame ionization, Flame photometric, Electron capture, Nitrogen-phosphorus, etc.
- 1.8 Method development in GC analysis
- 1.9 GC troubleshooting

2. High performance liquid chromatography (HPLC) (6 hrs)

- 2.1 Components and their functions in a HPLC system
- 2.2 HPLC columns: Packing material for reversed and normal phase HPLC, Particle diameter, Guard columns
- 2.3 HPLC mobile phases: Common mobile phases, Mixed mobile phases, Selecting a mobile phase, Degassing of solvents
- 2.4 HPLC pumping systems: Basic requirements of the pumping system, Types of pumps and advantages and disadvantages: Reciprocation pump, Displacement pump, Pneumatic pump
- 2.5 HPLC sample injection: Six port injection valve and its mechanism
- 2.6 Extra column dispersion
- 2.7 HPLC detectors: UV-Vis detectors: Fixed wavelength and multi wavelength detectors; Fluorescence detectors; Refractive index detectors; Evaporative light scattering detectors
- 2.8 HPLC troubleshooting

3. Mass Spectrometry(6 hours)

- 3.1 Components of a mass spectrometer
- 3.2 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
- 3.3 Mass analyzers: Quadrupole, time of flight, Ion trap, Magnetic sector and Fourier transform ion cyclotron resonance
- 3.4 Scan, Selected ion monitoring and multiple reaction monitoring mass spectrometry
- 3.5 Tandem mass spectrometry: Triple quadrupole, quadrupole – time of flight mass spectrometers
- 3.6 Chromatography hyphenated with mass spectrometry: GC/MS, LC/MS, GC/MS/MS, LC/MS/MS

4. Preparative chemical separation (8 hours)

- 4.1 Benefits of sample preparation: Making the sample suitable for analysis, Trace enrichment, Elimination of matrix interferences and sensitivity enhancement
- 4.2 Overview of sample pretreatment process: Sample collection, Storage and preservation, Transport, preliminary sample processing, Extraction and derivatization
- 4.3 Preliminary sample processing
- 4.4 Method validation: Extraction efficiency, Matrix effect and method detection limit
- 4.5 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
- 4.6 Extraction of non-volatiles and semi-volatiles in solid samples: Solid-liquid extraction, Soxhlet extraction, Super critical fluid extraction and pressurized liquid extraction
- 4.7 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. Other chromatographic methods (4 hours)

- 5.1 Ion chromatography: Ion pair chromatography, Ion exclusion chromatography,

Ion exchange chromatography, Detectors in ion exchange chromatography, The role of ion suppressors in ion exchange chromatography

- 5.2 Introduction to novel trends in chromatography: Ultra performance liquid chromatography (UPLC), Hydrophilicinteraction chromatography (HILIC), Ultra-performance convergence chromatography (UPC2), Multidimensional gas chromatography

Suggested References:

- Harris, D. C.; Lucy, C.: Quantitative Chemical Analysis; W. H. Freeman, 2015.
- Skoog, D. A.; Holler, F. J.; Crouch, S. R.: Principles of Instrumental Analysis; Thomson Brooks/Cole, 2007.
- Meloan, C. E.: Chemical Separations: Principles, Techniques and Experiments; Wiley, 1999.
- Majors, R., Sample Preparation Fundamentals for Chromatography. Agilent Technologies, Mississauga, ON, Canada: 2013.
- Arsenault, J. C., Beginner's Guide to SPE: Solid-phase Extraction. Waters Corporation: 2012.

Evaluation Criteria: Two hours examination at the end of the semester

C 31092 – Environmental Chemistry

1. Environmental Atmospheric Chemistry (12hrs)

- 1.1 Introduction: Composition of earth's atmosphere, Major layers in the earth's atmosphere; Natural cycles: Oxygen, Phosphorus, Sulfur, Nitrogen and carbon dioxide
- 1.2 Chemistry of the troposphere: Chemical reaction in the troposphere: Carbon monoxide, Nitrogen oxides, Volatile organic compounds and sulfur dioxide; Acid rain; Smog: Industrial and photochemical smog, Key reactions in smog formation; Interaction of air with water: Henry's law and its uses in environmental chemistry, Applying Henry's law for groundwater treatment; Indoor air pollution: Volatile organic compounds, Environmental tobacco smoke
- 1.3 Chemistry of the stratosphere: Atmospheric ozone: Dobson units, Tropospheric ozone (bad ozone), Stratospheric ozone (good ozone), Steady state concentration of ozone, Chapman cycle; Catalytic destruction of ozone: Destruction with hydroxyl and hydroperoxyl radicals, Nitrite oxide radicals, Freons, Chlorine cycle, Effects of ozone depletion on human health and the environment
- 1.4 Analysis of air and air pollutants: Sampling and analytical techniques for air; Particulate emissions: High volume sampling/ separation of particles by size, Air monitoring system of the earth
- 1.5 Global warming and climate change: Evidence for global warming, Effects of global warming, Slowing global warming; Role of atmosphere in weather changes; Residence time of atmospheric gasses, Atmospheric carbon dioxide, Water vapor, Methane and their sinks; Radioactive forcing; Particles in the atmosphere: Suspended particulate matter, Anthropogenic sources of particulate matter, Residence times of particles; Ocean acidification; Montreal protocol

2. Environmental Aquatic Chemistry (12 hrs)

- 2.1 Introduction: Unique properties of water and their role in the environment; Hydrological cycle; Composition of natural waters
- 2.2 Water resources: Distribution of water on the earth, Ground water, Surface water resources (wewa / wari), Water as a limiting resource for economic growth, Water use and water shortages
- 2.3 Environment aquatic chemistry: Redox reactions in aquatic environment: Electron activity, Eh – pH predominance area diagrams; Distribution of multiprotic acid species as a function of pH; Solubility and predominance: Stability (solubility) diagrams for metal hydroxide species; Interaction of water with soil; Agricultural soil pollution and eutrophication

- 2.4 Pollution of water: Types of water pollutants: Point and non-point sources of water pollutants, Disease causing agents, Oxygen consuming wastes and plant nutrients; Suspended solids and sediments; Dissolved solids; Thermal pollution of water; Pollution of ground water; Measurements in water pollution: Biochemical oxygen demand, Chemical oxygen demand, Total suspended solids, Electrical conductivity etc.; Health aspects of pollution of water: Bioaccumulation, Bio concentration factor, Bio magnification, Toxic substances control act; Discharge of synthetic detergents into water bodies; Water treatment: Sewage treatment, Regulation of water quality, Importance of the treatment of municipal, Industrial and CAFO (concentrated animal field operation) waste water
- 2.5 Irrigation water quality: Salinity/electrical conductivity, Sodium absorption ratio (SAR), Effect of adjusted sodium absorption ratio, Adjusted OP and the permeability of soil; Levels of chlorides, Carbonates, Nitrates/nitrogen, Sulphates, Borates, Phosphates
- 2.6 Analytical techniques for the determination of water quality parameters: Sampling methods; Analytical techniques for water quality

3. Environmental soil chemistry (6 hrs)

- 3.1 The rock cycle on earth: Sedimentary, Metamorphic and igneous rocks; Soil formation factors soil minerals and organic fraction
- 3.2 Soil – air – water environment: Key reactions governing fate of chemicals in soil-air-water environment: Sorption, Degradation and volatilization; Soil water content and oxidation reduction potential in soil water environment; pE – pH predominance diagrams, soil sampling methods.

Suggested References:

- Girard, J. E.; Girard, J.: Principles of Environmental Chemistry; Jones & Bartlett Learning, 2014
- Manahan, S. E.: Environmental Chemistry, Ninth Edition; CRC Press, 2009
- Sotheeswaran, S. "Environmental Organic Chemistry" 03rd Edition, 2012, Institute of Chemistry Publications, Monograph No: 11

Evaluation Criteria: Two hours examination at the end of the semester

C 31363 - Fundamentals of Chemical and Process Engineering

- 1. Introduction to Chemical and Process Engineering Fundamentals and Concept of Unit Operations (1 hr)**
- 2. Mass and Energy Balance (4 hrs)**
Application of mass and energy balances for simple systems.
- 3. Mass Transfer (3 hrs)**
Relationship between mass transfer and chemical processes, Introduction to Diffusion, Fick's law, Mass transfer through a stationary phase, equimolecular counter diffusion, mass transfer across a phase boundary
- 4. Heat Ttransfer (6 hrs)**
Introduction, modes of heat transfer, heat transfer coefficients, calculation of heat transfer rates, heat exchangers
- 5. Fluid Flow(6 hrs)**
Rheology, Bernoulli's equation, frictional loss, pipe flow calculations
- 6. Energy (4 hrs)**
Industrial energy sources, theory of combustion, energy management
- 7. Drying(6 hrs)**
Psychrometry, Theory of drying, drying time calculations, different types of industrial dryers
- 8. Mixing(3 hrs)**
Principles of mixing, mixer design
- 9. Adsorption(4 hrs)**
Adsorption isotherms, different types of adsorbents, scaling up of adsorption columns, applications

10. Absorption(4 hrs)

Basic theory, introduction to transfer units, estimation of packed bed height of absorption columns, applications

11. Distillation(04 hrs)

Phase equilibrium, McCabe-Thiele method for binary distillation calculations, introduction to multi-component distillation.

Suggested References:

1. Geankoplis, Christie J. "Transport Processes and Unit Operations" 03rd Edition, 1993, Prentice Hall

Evaluation Criteria: Three hours examination at the end of the semester

C 31102 - Research Methods

1. Introduction to Research Methodology (Scientific Method) (3 hrs)

Identify the problem, Literature review, Building a hypothesis, Design and conduct experiment to test the hypothesis, Analyze data, Interpret data, Draw conclusion, Publish results

2. Literature Survey (3 hrs)

Searching scientific literature from search engines (google scholar), Visit a library and do literature searching (e.g. ITI library), Critical reading, How to read a research article effectively

3. Scientific Writing (4 hrs)

3.1 Components of a research paper (abstract, introduction, methods, results and discussion, conclusion), Referencing

3.2 Guidelines for writing thesis/ literature survey report/ group presentation report

3.3 Abstract writing (half a day workshop)

4. Introduction to Research Proposal Writing and Budgeting (workshop) (4 hrs)

5. Plagiarism and Research Ethics (2 hrs)

What is plagiarism? How to avoid plagiarism in scientific writing, Paraphrasing

6. Data Analysis, Statistics and Graphing, Spreadsheets Analysis (include computer practical) (6 hrs)

7. Research Presentations – Making an Effective PowerPoint Presentation (2 hrs)

8. Chemical Safety and Instrumentation (6 hrs)

Lab safety, Fire training (seminar) Instrumentation

Suggested References:

- The ACS Style Guide: Effective Communication of scientific Information An American Chemical Society Publication
- The ACS Style Guide: Effective Communication of Scientific Information, American Chemical Society
- Anne M. Coghill, Lorrin R. Garson, American Chemical Society, 3, illustrated, American Chemical Society, 2006
-

Evaluation Criteria: Two hours examination at the end of the semester

LEVEL 4

Compulsory Course Units

Either 8 Credits or 5 Credits

C 41152 - Literature Survey

All students should complete either Research/Literature survey or Seminar presentation. It is highly recommended to follow Literature survey during the third year.

1. The time duration

Six/seven months from the day of commencement

2. Field of Survey:

The student can take a topic in one of the following areas; Chemistry- Industry

Chemistry - Agriculture

Chemistry -Medicine

Chemistry - Economics

Chemistry - Management

Chemistry - Education

Chemistry - biology

Chemistry - Physics

Chemistry - Information Technology or

Any other acceptable area other than mentioned above

3. The report should have following major chapters

3.1 Introduction: An introduction to the area or the field of survey, history, the significance of the study and the current knowledge available

3.2 Survey Methodology: This should include the way the survey was conducted, the information sources referred.

3.3 Discussion: The results obtained and how the results are used to draw conclusions should be described.

3.4 Conclusion(s): The outcome of the survey, future directions etc must be included

3.5 References: Should use one of the American Chemical Society (ACS) guidelines

4. The report should have following format

4.1 Title Page: Title of the Project , Student's name, index number, and year of submission

4.2 Declaration page: This should include a statement to certify the that the report is students' own work and all the sources have been acknowledged

4.3 Acknowledgement

4.4 Executive summary

- 4.5 Table of contents
- 4.6 List of Figures
- 4.7 List of tables
- 4.8 Major chapters
- 4.9 Appendix (if needed)

5. Initial submission

Soft bound version to the course coordinator

6. Final submission

Once the presentations and viva are completed on or before the deadline, the corrected version (2 copies) should be submitted to the course coordinator. The report must be a hard bound version with gold lettering in the front cover with red color binding

Guidelines for Literature Survey

1. Students who have signed up for the Literature survey must complete within the given period
2. If a student does not complete the assignment within the period, he/she will be considered as a repeater for the following year and will be eligible maximum of a C-
3. Students must avoid plagiarism and if any report is found plagiarized would be considered as an examination offence
4. It is the student's responsibility to follow the deadlines given by the course coordinator and failing to do will result a 10% deduction of marks as a penalty
5. Student should submit two signed copies (student and supervisor) of the report to the course coordinator on or before the deadline
6. The deadlines you are given will be final and coordinator has full rights to amend it if necessary.

C 41172 - Industrial Placement and Scientific Training

Aims and Objectives

To enable the student to experience the application aspects of their graduateship course in an industrial context.

Learning Outcomes

At the completion of the industrial placement, a student should be able:

- to work in industry as a member of an industrial team with confidence
- to undertake independent projects with much confidence
- to demonstrate presentation and writing skills related to the assigned projects
- to display an appreciation of good practices working in an industrial setting

Method of Selection

The options that a student can choose an industrial setting which he or she prefers can be as follows:

- Student – Student can come up with his or her own choice with the approval of the College of Chemical Sciences (CCS).
- CCS – The CCS will make arrangements to find suitable industrial positions for students' interest.
- Interview – The industrial personnel may visit the CCS and interview candidate to find a better fit for their industrial training.

Syllabus

The time duration of industrial placement lasts for minimum of six weeks. Students are expected to take an active part, in cooperation with the placement coordinator, in securing an appropriate placement in industry in one of the above methods.

The nature of the work undertaken will vary substantially and solely depends upon the industry. However, students will be working with a supervisor from the industry along with co-supervisor assigned from the CCS.

After successful completion of the placement, a report (about 30 pages or 10000 words) will be submitted to the supervisors and a 15 minutes presentation along with question and answer session will be held. The report produced describes the organization in which the student was working, summarizes the various projects in which the student was engaged, and allows the student to reflect on the benefits gained and compare their industrial experience against the theory they have been taught.

It can be mutually agreeable to have the presentation either at the industrial setting (highly recommended) or at the CCS. The report and the presentation will be marked by both

supervisors according to the CCS guidelines.

Evaluation Criteria

Meeting expectations/deadlines, team work, industrial etiquette, professionalism, report, and a 15 minutes presentation.

Pre-requisite

Open to Level 4 students. However, if demand is high, minimum of GPA 2.5 may be required at the time of enroll.

C 41185 - Research Projects

The research project is a very important component in the GIC program and it is offered as a five credit course titled “C 41035 Research Methods in Chemistry”. This is a short term research project in chemistry or in a related area of chemistry that involve field and/or laboratory work. The course consists of a literature review, drafting a research proposal, preparation of a dissertation on the research findings, oral presentation and defending the research finding to an academic audience.

The supervisor for the research project can be from the internal academic staff of the College of Chemical Sciences or from a University or an Institute such as the Institute of Industrial Technology (ITI). The research report/dissertation will be examined by a specialist in this field and the students will be requested to present the research work and also have to appear for an oral examination successfully to complete the project. Beside the above requirements each research student should maintain a well-organized laboratory notebook which has to be submitted along with the final thesis.

Upon successful completion of the course unit the student should be able to

- conduct a literature review to understand the status of the research interest
- demonstrate skills to plan and carryout a research project on chemistry, according to the scientific methods
- interpret accumulated experimental data in a scientific manner after statistical analysis
- present the research results in the form of a dissertation
- defend the findings to the academic audience.

C 41001 - Seminar

Seminars or popular talks on various disciplines in science will be conducted by local and international scientists once a fortnight. Level 4 students should attend at least 12 seminars/ public talks (out of around 16 seminars)

Evaluation Criteria

- Attendance 30%
- Write and submit 5 summaries of talks out of 12 seminars attend (40 %, each summary carries equal marks)
- Quiz based on seminars (30%)

C 41193 - General Chemistry Paper

This paper tests the students' knowledge on principles of chemistry covered during the G.C.E(A/L) Chemistry, level 1, and level 2 of GIC program such as basics of organic chemistry, inorganic chemistry, analytical chemistry, and physical chemistry. Knowledge on applications of chemistry principles and experimental methods will also be tested.

The paper consists of MCQ and short answer type questions. Time duration is 3 hours.

Evaluation Criteria: Three hours examination at the end of the semester

LEVEL 3/4
Optional Course Units

C 31313/41313 – Analytical Industrial Biochemistry

1. Analytical Laboratory Practices (2 hrs)

Analysis, Use and safe handling of radioactive substances, Safe handling of biological samples, Blood borne pathogens

2. Enzyme Assays(4 hrs)

Principles of enzyme assaying, Use of immobilized enzymes, Assays for coenzymes

3. Assay of Serum (6 hrs)

ALT, AST, Acid phosphatase, Alkaline phosphatase, isoenzymes, Troponins, Cholesterol, Lipoproteins (lipid profile), Glucose, Uric acid, Urea, Bilirubin, Urobilinogen, Creatinine, Electrolytes and proteins

4. Assay of Urine(2 hrs)

Glucose, Amino acids, Bilirubin, Urobilinogen

5. Assay of Total Carbohydrates, Dietary fibre and Vitamins (5 hrs)

6. Immunotechnology (4 hrs)

Experimental systems used in basic immunological studies, Immunoassays, Applications of cells and molecules of the immune system

7. Instrumentation in Biochemical Analysis (8 hrs)

Densitometry, HPLC, FPLC, MPLC, Spectrophotometry, Spectrofluorometry, Radioactivity counters

8. DNA based Diagnostics (10 hrs)

Infectious diseases, Genetic diseases, Applications in forensic science, Applications in cancer, biomarkers

9. Fermentation Technology(4 hrs)

Principles of fermentation technology, Aerobic and anaerobic fermentation

Suggested References:

- 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

Evaluation Criteria: Three hours examination at the end of the semester

C 31323/41323 - Biochemistry II

1. Enzymes: mechanism of action of ribonucleas and lysozyme (2 hrs)
2. Bimolecular reaction mechanisms of enzymes (2 hrs)
3. Enzyme kinetics of enzyme inhibition K_i value Eadie – Hofstee and Woolf plots. Examples with applications. (4hrs)
4. Hormones: Insulin, glucagons, thyroid hormones, cortisol Prolactin – Their metabolic effects and mechanism of action (5 hrs)
5. Vitamins – Their role in metabolism & deficiency disorders (04 hrs)
6. Selected microbial carbohydrate metabolic pathways Glyoxalate cycle, enter Duodoroff pathway, Acetone – Butanol Fermentation, Distinguishing pathways of glucose utilization (2 hrs)
7. Metabolism of sulfur containing amino acids. Synthesis of cysteine and methionine in plants and bacteria. Microbial production of glutamate shikimic acid pathway (3 hrs)
8. Metabolism of Glycerophospholipids. Metabolism of sphingolipids and Steroids. Biosynthesis and catabolism of Prostaglandins, Thromboxanes and Leukotrienes (3 hrs)
9. Nucleotide biosynthesis and degradation. (2hrs)
10. Integration metabolism – in starve – feed cycle – Diabetes, Exercise, Pregnancy, Trauma, acidosis, alkalosis (5 hrs)
11. Photosynthesis: Light reactions, Calvin Cycle C – 3 and C- 4 Plants (3 hrs)
12. Mutations: metabolic disorders (2 hrs)
13. Mechanism of action of antibiotics (2 hrs)
14. Molecular physiology – Hemoglobin & Oxygen transport Blood groups, neurotransmission, muscle contraction (6 hrs)

Suggested References:

- Mathews, C.K., Holde, K.G. Van and Ahern K.G. “Biochemistry” 3rd Edition
- Voet, D., Voet, J.G. and Pratt, C. W. “Fundamentals of Biochemistry”
- Devlin, Thomas M. (Editor) “Text Book of Biochemistry with Clinical Correlations” 2011
- Becker, Kleinsmith and Hardin “The World of the Cell” 5th Edition
- Lehninger, Nelson and Cox “Principles of Biochemistry”
- “Harpers Illustrated Biochemistry” 26th Edition
- Mathew, C. Deepal “Enzymes”

Evaluation Criteria: Three hours examination at the end of the semester

C 31333/41333 - Chemical Education

1. Foundations in Education (12 hrs)

Psychological aspects of learning and teaching, Sociological and philosophical aspects of teaching and learning, new trends in education

2. Technological Aspects of Education (10 hrs) Designing curricula, Educational technology

3. Historical & Philosophical Development of Chemistry (08 hrs)

Belief-systems of science, Roots of chemistry, Development of quantitative relationships in Chemistry, Concepts of structure and dissociation, Chemical industry & modern analytical techniques

4. Methodology of Teaching and Learning Science (15 hrs)

Instructional design, Evaluation of achievement, 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

5. Classroom Assessment:

Teaching practice and seminar presentations which carries 20% of the marks for the course. (Additional hours, [approximately 5 hours] which depend on the number of students in the class is necessary to conduct this part of the course)

Suggested References:

- Dieter, H., Gunther, H., Harsch, G., and Schmid, S. "Essentials of Chemical Education" ISBN: 978-3-642-21755-5 (Print) 978-3-642-21756-2 (Online)
- Evaluation Criteria: Combination of an end semester theory paper + continuous and/or other assessments

Weightages: Theory paper 2/3 of the final mark, all the assessments 1/3 of the final mark

C 31353/41353 – Food Chemistry & Technology

1. Food Chemistry (28 hrs)

- 1.1 Introduction (01 hr)
Food components, Moisture & mineral matters
- 1.2 Food Carbohydrates (04 hrs)
Sugars and their derivatives: occurrence in food, structure and properties of glucose, lactose, maltose and sucrose. Starch: occurrence in food, properties of 74e micel and amylopectin, gelatinization of starch, cellulose and 74e micelluloses. Pectins: occurrence in fruits and vegetables, physio-chemical properties, application in food industry. Food gums and their applications in food industry. Determination of carbohydrates
- 1.3 Food proteins (04 hrs)
Classification of proteins, amino acids and peptides. Denaturation of proteins, enzymes, meat proteins, milk proteins, egg proteins, wheat proteins. Functional properties of proteins. Determination of proteins in food
- 1.4 Food lipids (04 hrs)
Classification of lipids, properties of fatty acids, triglycerides. Manufacture of edible oils. Deterioration of oils & fats. Identification and quality parameters of oils & fats. Analysis of food lipids
- 1.5 Sensory properties of foods (02 hrs)
Flavour compounds. Pigments in foods
- 1.6 Micronutrients (02 hrs)
Vitamins. Minerals
- 1.7 Food additives (Including Legislation) (08 hrs)
Introduction and classification of food additives. Preservatives. Antioxidants. Food colouring substances (natural and artificial). Emulsifiers and stabilizers. Flavours and flavor enhacers. Sweeteners. Analysis of food additives
- 1.8 Food adulteration and food contaminants (03 hrs)
Food adulteration and detection of adulterants. Food microscopy. Classification of food contaminants. Detection of food contaminants

2. Food Process Technology (17 hrs)

- 2.1 Food spoilage (03 hrs)
Introduction – Physical, microbial and biochemical spoilage. Water activity. Prevention of food spoilage
- 2.2 Principles of food preservation (04 hrs)
Introduction. Dehydration. Freezing. Heat processing. Curing and smoking.

Food fermentation

2.3 Food packaging (01 hrs)

2.4 Technology of processed food products (05 hrs)

Technology of cereals and bakery technology. Dairy technology. Fruits and vegetables product technology. Nonalcoholic beverage technology. Sugar confectionery

2.5 Technology of spices, essential oils & flavours (04 hrs)

Sri Lankan spices, methods of processing. Chemical & physical characteristics. Unique characteristics, comparison with other products.eg. Cinnamon&cassia. Production of essential oils. Production of oleoresin. Quality assurance, specifications, methods of determinations, ISO, SLS, BP, USP etc

Suggested References:

- Norman, N Potter and Joseph, H. Hotchkiss “Food Science” 5th Edition, Chapman & Hall publishers
- Fellows, P.J. “Food Processing Technology-Principles & Practice” 2000, Woodhead Publishing Ltd, Cambridge, England
- Ihekoronye, R.I. and Ngoddy, P.O. “Integrated Food Science and Technology for the Tropics” 1985, Macmillan Publishers
- Fennema, Owen R. (editor) “Food Chemistry” 3rd edition, 1996, Marcel Dekker Inc, New York
- Davidek, Jiri, Velisek, Jan and Pokorny, Jan “Chemical Changes during Food Processing” 1990, Elsevier Science Publishing
- Wong, Dominic W. S., Reinhold, Van Nostrand “Mechanisms & Theory in Food Chemistry” 1989, New York
- Coultate, Tom P. “Food: The Chemistry of its components” RSC publication
- Ravindran, P. N. (Editor) “Cinnaman and Coffea: The Genus Cinnamomum” C R P Press
- “Spice and Aromatic Plant” Monograph Series, ITI(CISIR)

Evaluation Criteria: Three hours examination at the end of the semester

C 31373 / 41373 - Industrial Chemistry & Technology

1. Metal Industry (7 hrs)

1.1 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

1.2 Light metal properties and their applications Beryllium, Magnesium, and Titanium

1.3 Nonferrous metals, alloys and their application Copper and its alloys, Aluminum and its alloys

2. Cement (4 hrs)

2.1 Classification of cement (natural cement, Puzzolana cement, slag cement, Portland cement, special cements, masonry cement)

2.2 Manufacture of Portland cement

2.3 Chemical composition of cement

2.4 Setting & hardening of Portland cement (sequence of chemical reactions during hardening of cement, including heat of hydration of cement)

3. Ceramics & Glass (4 hrs)

3.1 Types of glass (soft glass, potash lime, Flint, Pyrex, safety, insulating glass, wired glass, laminated glass, glass wool)

3.2 Manufacturing techniques of glass

3.3 Classification of clay products

3.4 Properties of clay

3.5 Glazing – purpose of glazing, methods of glazing

4. Paint Industry (8 hrs)

4.1 Definitions of a paint and introduction of materials used

4.2 Definitions of types of paints (varnish, lacquer, enamel paints, top coat , undercoat, filler paints, Primers, surfaces or undercoats, sealers, etc)

4.3 Compositions of emulsion & enamel paints and formulation principles

4.4 Manufacture of alkyd Resins and binders for water born emulsion paints

- 4.5 Various drying / film formation mechanisms of Paints
- 4.6 Different paint formulations (water based & solvent based)
- 4.7 Details of some important Raw materials used
- 4.8 Colour & colour chemistry
- 4.9 Chemistry of rheology modifiers
- 4.10 Self-Healing coatings

5. Leather Industry (8 hrs)

- 5.1 Raw materials
- 5.2 Process technology
- 5.3 Preservation of skins, soaking, liming, unhairing, scudding, de-liming, bathing, pickling, degreasing, tanning (vegetable & chrome)
- 5.4 Environmental issues

6. Latex based polymer industry (10 hrs)

- 6.1 Definition of a latex and the physico-chemical composition of natural rubber field latex
- 6.2 Concentration of field latex by creaming and centrifuging methods, and stabilization and maturation of concentrated latex
- 6.3 Important differences between concentrated natural rubber latex and synthetic latices (Nitrile and Neoprene types)
- 6.4 Characterization of Latex
- 6.5 Latex Compounding
Materials and chemicals used in the latex based product manufacturing industry and their functions. Preparation of materials to be added and mixed with latex, as solutions, emulsions and dispersions. Mixing and maturation of a latex compound
- 6.6 Types of latex based product manufacture (Dipping, Foaming and Extrusion)
Dipped product manufacture - Gloves, balloons and condoms - Formulations of ingredients, formers used, gelling methods, leaching method, chlorination, drying and vulcanization, desired technical properties and product usage safety issues. Foam rubber manufacture - Foam rubber cushions, mattresses, sheets and carpet underlay. Formulations, methods of foaming and gelling, vulcanization and drying, and desired properties. Latex thread extrusion - Formulation, method of extrusion, gelling, vulcanization, dusting and ribboning and desired technical properties

- 6.7 Waste water disposal in latex based product manufacturing factories. Quality of waste water and method of waste water treatment and possible adverse effects on environment (Case Study)

7. Textile chemistry & technology (4 hrs)

- 7.1 Introduction to textiles (definition of a textile, terminology such as, staple, yarn, spinning, and physical construction of different types of textiles)
- 7.2 Chemical and physical structures of textile fibres (natural, artificial & synthetic types), cotton, wool, silk, nylon, polyesters, acrylics, polyethylene, polypropylene and polyaramids
- 7.3 Textile reactive dyes - Different reaction mechanisms, examples and chemical structures of some important reactive dyes, the reactive dyeing process

Suggested References:

- 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 Lattices" Vol 3, 02nd edition, 1997
- Lakhtin, Y. "Engineering Physical Metallurgy" 5th edition, 2000
- Allen, D. K. "Interaction to Engineering Materials" 05th edition, 1998
- Higgins, R. A. "Engineering Materials" 05th edition, 1992
- Dustavson, K. H. "Chemistry of Tanning Processes" 1966
- Bentley, J. and Turner, G. P. A. "Introduction to Paint Chemistry" 04th 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

Evaluation Criteria: Three hours examination at the end of the semester

C 31383/C 41383 – Natural Products

1. Alkaloids (6 hrs)

Biosynthesis, Chemical synthesis, Chemistry and biological activities of some selected alkaloids

2. Terpenoids (8 hrs)

Terpenes and their characteristics, Mechanisms of biosynthesis of acyclic, monocyclic and bicyclic monoterpenes, sesquiterpenes, diterpenes etc. Chemistry and synthesis of selected acyclic, monocyclic and bicyclic monoterpenes and sesquiterpenes, Uses of commercially important monoterpenes, important sesquiterpenes, dipetepenoids, triperpenoids, Biological function of triterpenoid and steroids, Modern methodologies in isolation of natural products; oleoresins & supercritical extractions etc

3. Steroids (7 hrs)

Steroids; Nomenclature and medicinal uses of bile acids, plant steroids, cholesterol, vitamins, steroid hormones, chemistry and interconnectivity of biosynthetic pathways of key intermediates, monoterpenes via mevalonic acid pathway, synthesis of commercially important steroids.

4. Phenyl Propanoids and polyketides (4 hrs)

Phenyl propanoids and polyketides; production, biosynthesis precursors, biosynthesis (shikimic acid pathway and polyketide pathway), mechanism of biosynthesis of selected polyketides, detail mechanisms of biosynthesis of macrolides, biosynthesis of coumarins, flavonoids, tannins.

5. Chemistry and Biological activity of natural Phenols (5 hrs)

Overall biological activity and chemistry of flavonoids, anthocyanins, and xanthones.

6. Plant glycosides (3 hrs)

Cyanogenic glycosides, plant saponins.

7. Organosulfur compounds in nature (3 hrs)

Chemistry and biochemistry of onion, garlic, organosulfur compounds in the environment such as methyl sulfonyl methane.

8. Marine Natural Products (4 hrs)

Marine toxins, and medicinally useful natural products from marine organisms.

9. Natural Products from selected Commercially useful plants of Sri Lanka (5 hrs)

e.g Gotukola, Karawila, Cinnamon, uluhal, etc.

Suggested References:

- Alkaloids: Chemical and Biological Perspectives, S.W. Pelletier
- Drugs of Natural Origin, Gunner Samuelson
- Mann J., Davidson R S, Hobbs J.B., Banthorpe DV and Harbone J.B., (1996) Natural Products: Their chemistry and biological significance, Longman
- Dewick, P. M., (2000) Medicinal Natural Products: A Biosynthetic Approach, John Wiley.
- Mann J, (1995) Chemical Aspects of Biosynthesis, Oxford Chemistry Primers
- Bohl, M. and Duax, W. L., (2000) Molecular structure and biological activity of steroids, CRC press
- Organosulfur compounds in Nature, S. Sotheeswaran, 2014, ICHEMC Monograph No: 33.
- Marine Organic Chemistry, S. Sotheeswaran, ICHEMC Monograph, in press, 2015.

Evaluation Criteria: Three hours examination at the end of the semester

C 31393/41393 – Pharmaceutical & Medicinal Chemistry

1. General Principles (6 hrs)

- 1.1 Introduction
- 1.2 How do Drugs work – Enzyme inhibition, Interaction at receptors, Interaction with Nucleic acids, Physicochemical properties of Drugs
- 1.3 Drug metabolism

2. Drug Discovery and Development (9 hrs)

- 2.1 Screening of Natural products and discovery of lead compounds
- 2.2 Synthetic analogs of the lead compounds
- 2.3 Structure Activity Relationships (including a case study such as taxol)
- 2.4 Role of biotechnology in drug discovery
- 2.5 Pharmacodynamics and quantitative structure activity relationships
Pharmacokinetics

3. Mode of Action of the Following Topics (30 hrs)

- 3.1 Antibiotics - antibacterials, antifungals
- 3.2 Anti Cancer Drugs
- 3.3 Antivirals

4. Steroids

Non-steroidal anti-inflammatory drugs

5. Drugs Acting on the central Nervous system

Suggested References:

- 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

Evaluation Criteria: Three hours examination at the end of the semester

C 31403/41403 - Polymer Chemistry & Technology

1. Characterization and Physical Chemistry of Polymers(15 hrs)

- 1.1 Determination of molar masses
- 1.2 End – group analysis
- 1.3 Direct measurements of average molar masses
- 1.4 Virial equations
- 1.5 Membrane osmometry
- 1.6 Vapour Phase osmometry
- 1.7 Light scattering
Scattering from large particles, Zimm method, Low angle laser light scattering
- 1.8 Viscosity measurements
- 1.9 Mark – Houwink – Sakurada relationship
- 1.10 Huggins and Kramer equations
- 1.11 Gel permeation chromatography
- 1.12 Instrumentation and experimental methods
- 1.13 Universal calibration
- 1.14 Polymer solutions
- 1.15 Concept of solubility parameters
- 1.16 Flory – Huggins Theory
- 1.17 Compatibility of polymer blends and polymer solutions
- 1.18 Theta conditions and temperature
- 1.19 Amorphous and crystalline states of polymers
- 1.20 Determination of crystallinity
- 1.21 Determinations of thermal transitions
- 1.22 Dilatometry
- 1.23 Differential Thermal Analysis (DTA)
- 1.24 Differential Scanning Calorimetry (DSC)
- 1.25 Dynamic Mechanical Analysis (DMA)

2. Polymer Chemistry (15 hrs)

- 2.1 Introduction (02 hrs)
Different types of polymers (homopolymer, copolymers, linear and branched

polymers, saturated and unsaturated polymers, amorphous and semi-crystalline polymers). Average molar masses of polymers. Different aggregated states of polymers (viscous melt, glassy, rubbery, hard crystalline), as a function of molecular weight and temperature. Glass transition temperature, crystalline melting point, and thermal decomposition temperature of polymers. Rubbers (elastomers) and plastics (some examples of rubbers and plastics, poly isoprene, polybutadiene, styrene butadiene)

2.2 Step- growth polymerization (03 hrs)

Introduction to step growth polymerization; Kinetics of step growth polymerization (acid catalysed and self catalysed step growth polymerization); Molecular weights in step growth polymerization and Carother's equation; Polydispersity Index; Polymerization with a stoichiometric imbalance of reacting groups; Use of mono-functional reagents to control molecular weight

2.3 Chain growth polymerization (03 hrs)

Steps in chain growth polymerization (initiation, propagation and termination) and kinetics of chain growth polymerization; Kinetic chain length of a polymer; Radical life time; Chain transfer reactions.

2.4 Ionic polymerizations (04 hrs)

Anionic polymerization (initiation, propagation and termination, kinetics); Cationic polymerization (initiation, propagation, termination, kinetics)

2.5 Polymerization reactions based on the use of metal catalysts (03 hrs)

Nature of the catalyst and active centre (Ziegler catalysts); Examples of stereo regular polymerizations.

3. Polymer Technology (15 hrs)

3.1 Structure – property relationships of Plastics (02 hrs)

Polyethylene, polypropylene, polystyrene, polyvinyl chloride, polymethyl methacrylate, nylons, polyesters, polycarbonates, and polytetrafluoro ethylene

3.2 Structure – property relationships of rubbers(02 hrs)

Polyisoprene, polybutadiene, polychloroprene, styrene butadiene copolymer, acrylonitrile-butadiene copolymer, ethylene-propylene diene monomer terpolymers, and silicone rubbers

3.3 Introduction to plastics based product manufacture(04 hrs)

Melt processing of plastics, extrusion, injection moulding, and blow moulding; Elastomer state processing – vacuum forming; Compression moulding; Blown film manufacture.

3.4 Introduction to dry rubber based product manufacture (04 hrs)

Mastication of rubber (mechano- chemical process); Materials used in rubber product manufacture and compounding of dry rubber; Vulcanization

(crosslinking) of rubbers (vulcanizing agents and systems, effect of temperature and time on cross-linking, types of crosslinks and relevance to properties; measurement of cure characteristics; vulcanizate properties; A brief introduction to product manufacture with rubber compounds (extruded, moulded and calendered rubber products

3.5 Polyurethanes (03 hrs)

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

Suggested References:

- 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

Evaluation Criteria: Three hours examination at the end of the semester

C 31413/41413 – Further Management, Economics & Finance

1. Management (10 hrs)

- 1.1 Emotional intelligence in management (02 hrs)
- 1.2 Team work and team management (02 hrs)
- 1.3 Features of excellent organizations (02 hrs)
- 1.4 Time management (02 hrs)
- 1.5 Change management (02 hrs)

2. Managerial Economics (8 hrs)

- 2.1 Demand and supply analysis (02 hrs)
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 & applications (02 hrs)
Definition of elasticity, different types of elasticity, elasticity coefficients, practical applications in business, inflation and its impact on business
- 2.3 Market structures (02 hrs)
Perfect competition, monopolistic competition, oligopoly and monopoly. Strategies for business success
- 2.4 Pricing decisions (02 hrs)
Economist's model & its limitations, full – cost pricing, target return on investment (ROI) pricing, marginal cost pricing, pricing under different market structures and pricing strategies

3. Accountancy & Finance (12 hrs)

- 3.1 Interpretation of financial statements (04 hrs)
Accounting equation, assets, liabilities and equity. Accounting process, understanding and interpreting financial statements. Manufacturing – profit & loss account & balance sheet
- 3.2 Costing methods (04 hrs)
Prime cost, production overheads, total production cost, job and batch costing, characteristics of process industries, losses in processes (normal & abnormal losses) and process costing
- 3.3 Budgeting & budgetary control (02 hrs)
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 (02 hrs)

Capital markets vs money markets; primary vs secondary markets: working capital management

4. Marketing(15 hrs)

4.1 Scope and concepts of marketing, marketing mix (02 hrs)

4.2 Orientation towards the market place, production concept, product concept, selling concept, marketing concept, customer concept, societal marketing concept. (03 hrs)

4.3 Building customer value & satisfaction: customer perceived value, total customer satisfaction, value chain. (02 hrs)

4.4 The marketing process (02 hrs)

Value delivery sequence, planning process, nature and contents of a marketing plan.

4.5 Market segments (01 hr)

Methods used to segment, segment marketing, niche marketing (01 hrs)

4.6 Positioning and differentiating the market and product life cycle. (02 hrs)

4.7 Products and branding strategy (02 hrs)

Product levels, hierarchy and classification: product mix, product line, brands.

4.8 Marketing channels (01 hr)

Levels of marketing channels and its selection

Suggested References:

- Management of organizational behavior, Paul Hersey, Kenneth Blanchard, 8th edn, 2005
- Emotional Intelligence, Daniel Goleman, 1995
- Team work is an individual skill, Christopher M Avery, 2003
- Personal Time Management, 3rd edn, Marion Hatnes, 2005
- In search of Excellence, Thomas J Peters & Robert H Watermann, 1993
- How to manage Organizational Change, 2nd edn, D E Hussey, 2000
- Costing an introduction, c Drury, 2000
- Financial accounting, an introductory course of study, 2004
- Economics, Lipsey A & Chrystal A, 12th edn. 2011
- Financial Decision making, JJ Hampton, 9th edn, 2009
- Marketing Management, 11th edition, Philip Kotler, 2003

Evaluation Criteria: Three hours examination at the end of the semester

C 31342/ 41342 - Further Topics in Environmental and Green Chemistry

1. Environmental impact of nuclear power: (4 hrs)

- 1.1 Harmful effects of radiation on humans: Factors influencing radiation damage; units of radiation; harmful limits of radiation
- 1.2 Everyday exposure to radiation: natural sources of radiation, radiation from human activities
- 1.3 Nuclear energy: Problems with nuclear energy: effects of chain reactions, nuclear accidents; Fukushima Daiichi Nuclear disaster; the atom bomb; peaceful uses of nuclear fission; nuclear fusion as an energy source

2. Chemical Aspects of Solid Waste Management (04 hrs)

- 2.1 Types of solid waste: industrial, municipal, hazardous, radioactive & clinical
- 2.2 Treatment (processing) of solid waste: composting, biogas production
- 2.3 Monitoring environmental impacts and quality assurance

3. Toxicology and Pollutants in the Environment (8 hrs)

- 3.1 Organic pollutants in the environment: Pesticides in the environment: organophosphates and dumping of banned chemical weapons of mass destruction; pharmaceutical pollutants; endocrine disruptors; bioaccumulation of organochlorines: banned organochlorines such as DDT, PCBs & dioxins; biogenic and anthropogenic organic chemicals in the atmosphere, origin and fate: methane and non-methane hydrocarbons (organohalogens produced by terrestrial and marine organisms, halons); weedicides: glyphosate and paraquat; atmospheric benzene and toluene; petrochemicals in the atmosphere
- 3.2 Heavy metal pollutants: The big four: cadmium, lead, mercury and arsenic
- 3.3 Industrial explosions and other the releases of chemicals to the environment: Bhopal disaster; dioxin release (Sevesco, Italy); minamata disease (methyl mercury); Asbestos diseases
- 3.4 Toxicology: Types of routes and exposure; dose and response; Excretion of chemicals from the body; Teratogens, mutagens and carcinogens; Nucleic acids; Protein synthesis, the genetic code

4. Introduction to Sustainable Technology (6 hours)

- 4.1 Sustainable consumption and production

- 4.2 Five axioms of sustainability: 1. Any society that continues to use critical resources unsustainably will collapse; 2. Population growth and/or growth in the rates of consumption of resources cannot be sustained; 3. To be sustainable, the use of renewable resources must proceed at a rate that is less than or equal to the rate of natural replenishment; 4. To be sustainable, the use of non-renewable resources must proceed at a rate that is declining, and the rate of decline must be greater than or equal to the rate of depletion; 5. Sustainability requires that substances introduced into the environment from human activities be minimized and rendered harmless to biosphere functions
- 4.3 Putting sustainability into practice

5. Fundamentals of Green Chemistry (8 hours)

- 5.1 Fundamentals: Concept of green chemistry; Green chemistry examples: Green solvents, earth-friendly plastics, replacing chlorine, replacing toxic materials, environmentally benign pesticides, Carbon foot print and carbon neutrality
- 5.2 Renewable Energy: Importance of renewable energy; Biofuels and green fuels

Suggested References:

- 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

Evaluation Criteria: Three hours examination at the end of the semester

C 31422/41422 - Agrochemicals

1. Introduction (2 hrs)

Definition, classification, need for use of pesticides, use and misuse of pesticides, world market of pesticides, use of pesticides in Sri Lanka, positive and negative impact of pesticides, legislations on the use of pesticides in Sri Lanka, development & registration of new pesticides, selectivity and resistance to insecticides.

2. Formulation & Application of Pesticides (2 hrs)

Formulations, additives, spraying equipment, packaging & labeling

3. Toxicology of Pesticides (2 hrs)

Types of exposure, terminology used in toxicology studies, measurement of toxicity levels, classifications of pesticides according to toxicity levels

4. Chemistry of Synthetic Pesticides (12 hrs)

4.1 Synthetic Insecticides (08 hrs)

Inorganic insecticides, synthesis, metabolism & mode of action of organochlorines, organophosphates, carbamates, pyrethroids, formidines, synthetic pheromones & growth regulation, chloronicotonyl & modern synthetic insecticides, development of resistivity.

4.2 Synthetic Herbicides (06 hrs)

Introduction, classification according to mode of action & uptake of herbicides, application, synthesis, mode of action and metabolism of herbicides and metabolism of herbicides

4.3 Fungicides (02 hrs)

Classification synthesis, mode of action and metabolism of fungicides

4.4 Rodenticides, Nematocides, Acracides, Molluscicides(02 hrs)

Synthesis and mode of chemicals used as rodenticides, nematocides, acracides and molluscicides.

5. Bio -pesticides (3 hrs)

Mode of action of pesticides from plants, animals & microorganisms, living system as insecticides.

6. Chemistry of synthetic and biofertilizers (6 hrs)

7. Degradation of Pesticides and Pesticide Residue Analysis (3 hrs)

Degradation of pesticides and the environment, methods used in pesticide residue analysis

Suggested References:

- 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

Evaluation Criteria: Two hours examination at the end of the semester

C 31432/41432 - Atomic Spectroscopic Methods of Analysis

1. Atomic Absorption Spectroscopy (AAS) (08 hrs)

1.1 Principles of AAS

Atomic energy levels and Boltzmann distribution law. Electronic transitions; transition probabilities, selection rules and electronic transitions. Absorption, emission and fluorescence processes. Collisional excitation and collisional de-excitations. Spontaneous emission. Doppler broadening and collisional broadening. Spectral line widths. Emission spectral profile and absorption coefficient profile.

1.2. Instrumentation for AAS

Radiation sources. Line sources : hollow cathode lamps, electrodeless discharge lamps. Continuum sources; quartz halogen lamp, deuterium lamp. Atom generating devices; Flames and burner nebulizer systems. Furnaces Massman and Lvov designs. Graphite tube platforms. Wavelength selection devices: Monochromators; Prism and grating based monochromators. Figures of merit of monochromators; angular dispersion, linear dispersion, reciprocal linear dispersion. Resolving power, resolution and spectral band pass of monochromators. Radiation detectors: Photoelectric effect and photomultiplier tube.

1.3 Applications of AAS: Sampling

Liquid and solid sampling. Sample preparation techniques for total metals, dissolved metals and suspended metals. Metal speciation. Sample digestion techniques; acid digestion and microwave digestion. Solvent extraction as a mean of pre-concentration and minimization of interferences. Optimization of instrumental parameters.

2. Atomic Emission Spectroscopy (AES) (14 hrs)

2.1 Principles and application in microwave plasma atomic emission spectrometry Fundamentals, Instrumentation and applications related to Microwave Plasma Atomic Emission Spectrometry (MP-AES)

2.2 Inductively coupled plasma optical emission spectrometry (ICP-OES)

Principles and method description of ICP-OES. Component of an ICP-OES. Schematics of and ICP-OES spectrometers. Stability of the ICP as an emission source. Sample preparation methods for ICP spectrometry; Aqueous samples: Liquid-liquid extraction, ion exchange, co-precipitation. Solid samples: Decomposition techniques, Microwave digestion, Dry ashing, Fusion. Sample introduction procedures for ICP analysis; Continuous sampling using

pneumatic nebulizer or Frit nebulizer, Discrete sample introduction. Plasma appearance and spectra. Plasma viewing options (radial versus axial). Sequential elemental analysis with scanning monochromators. Simultaneous multi-element analysis with polychromators. Rowland circle. Array spectrometers. Echelle monochromator, Detectors ICP-OES. Interferences in ICP-OES; Transport interferences and background emission. Chemical and Ionization interferences, Spectral Interferences. Types of spectral interferences. Correction for spectral interference. Internal standardization, Standard Addition, Matrix matching, Analytical performance characteristics. Current trends in ICP-OES. Application in environmental analysis; Agriculture and foods, Biological and clinical, Geological, Metals, Organics etc.,

2.3 Inductively Coupled Mass Spectrometry (ICP-MS)

Fundamentals of mass spectrometry, Inorganic mass spectrometry. The role of mass spectrometer, Quadrupole mass spectrometer, sector field mass spectrometer, Ion trap mass spectrometer, time of flight mass spectrometer. Fundamentals of ICP MS. Non collision type and Collision reaction Cell type. Schematic diagram of an ICP MS system. Interface between ICP and MS. Interferences; Isobaric interferences, Molecular Interferences: Polyatomic interferences, Doubly charged polyatomic interferences, Remedies for interferences. Applications: Analysis of environmental samples; soil and water, Industrial analysis, food and pharmaceuticals.

3. X-Ray Spectroscopy (08 hrs)

Properties of X radiation. Generation of X Radiations. 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. : (XPS, ED XRF and WD XRF) Energy dispersive and wavelength dispersive X ray fluorescence spectrometry. Instrumentations and application of X ray fluorescence spectroscopy.

Suggested References:

- Willard H.H., Merritt L.L. and Dean J.A. "Instrumental Methods of Analysis." 04th Edition, 1965, Van Nostrand Reinhold Company, New York
- Weltz Bernhard "Atomic Absorption Spectrometry", 02nd Edition, 1985, VCH Germany

Evaluation Criteria: Two hours examination at the end of the semester

C 31442/C 41442 – Chemical & Molecular Toxicology

1. Fundamentals of Toxicology (08 hrs)

- 1.1 Definition and basic concepts, description and terminology of toxic effects
- 1.2 Concepts in toxicodynamics and kinetic parameters (toxicokinetics), toxicokinetic processes, toxicokinetic methods, rate laws
- 1.3 Disposition of toxic compounds, ADME studies, clearance of toxicological materials, apparent volume of distribution, factors influencing toxicity, transport across the cell membrane
- 1.4 Dose-response relationship, effective dose, margin-of-safety and the relationship of effective dose (ED) vs. toxic dose (TD), therapeutic index (TI)

2. Analytical Applications in Toxicological Studies (04 hrs)

- 2.1 Spectroscopic methods in analytical toxicology
- 2.2 Chromatographic techniques
- 2.3 Electro-analytical methods

3. Role of Cytochrome P-450 Monooxygenases in Biotransformation (04 hrs)

- 3.1 Biotransformation of xenobiotics
- 3.2 Phase I and Phase II biotransformation reactions
- 3.3 Role of monooxygenases in biotransformation reactions

4. Molecular Toxicology (08 hrs)

- 4.1 Oxidative stress, DNA Damage, DNA Repair, DNA methylation
- 4.2 Chemical carcinogenesis, molecular carcinogenesis, role of drug metabolizing enzymes in carcinogenesis
- 4.3 Genetic polymorphism and carcinogenesis, cell cycle delay, perturbations to the cell cycle, cell signaling & sensing toxicant stress
- 4.4 Perturbations to intra- and intercellular signaling, apoptosis
- 4.5 Toxicogenomics and toxicoproteomics

5. Environmental Toxicology (06 hrs)

- 5.1 Air, aquatic and soil toxicology
- 5.2 Environmental hazards, pesticides, hazard evaluation and risk assessment

5.3 Toxic substances of plant and animal origin

5.4 Heavy metal toxicity

Suggested References:

- Timbrell, John A. "Principles of Biochemical Toxicology"
- Klaassen, Curtis and Watkins, John B. "Casarett & Doull's Essentials of Toxicology" 02nd Edition
- Hayes, A. Wallace "Principles and Methods of Toxicology" 05th Edition
- Timbrell, John A. "Introduction to Toxicology" 03rd Edition
- Wright, David A. and Welbourn, Pamela "Environmental Toxicology" Cambridge Environmental Chemistry Series
- Boelsterli, Urs A. "Mechanistic Toxicology: The Molecular Basis of How Chemicals Disrupt Biological Targets" 02nd Edition

Evaluation Criteria: Two hours examination at the end of the semester

C 31452/41452 - Computational Chemistry

1. Molecular Mechanics (06 hrs)

- 1.1 Potential energy functional forms
- 1.2 Molecular mechanics force field of a molecular system
- 1.3 Optimization: Simplex, Steepest decent, and conjugate gradient methods
- 1.4 Use of optimization in molecular system

2. Molecular Simulation (12 hrs)

- 2.1 Introduction to molecular simulation
- 2.2 Monte Carlo simulation and determining chemical and physical properties
- 2.3 Molecular dynamics simulation and determining chemical and physical properties
- 2.4 Introduction to Coarse grain and multiscale simulations

3. Introduction to electronic structure theory calculations (6 hrs)

- 3.1 *ab initio*, semi empirical and density functional theory calculations
- 3.2 Potential energy surfaces, normal modes, and finding transition states
- 3.3 Calculate physical and chemical properties of small molecules

4. Molecular Modelling in drug discovery (6 hrs)

- 4.1 Introduction to cheminformatics
- 4.2 Visualizing biomolecules and explore pdb structure database
- 4.3 Molecular docking

Suggested References:

- Leach, A.R. "Molecular Modeling: Principles and Applications" 02nd Edition, 2001

Evaluation Criteria: Two hours examination at the end of the semester

C 31462/41462 - Electrochemical Technology

1. Corrosion and the Stability of Metals

Mechanisms of corrosion, Thermodynamics of corrosion and the stability of metals, pourbaix diagrams; limitations of pourbaix diagrams. Kinetics of corrosion, corrosion current and corrosion potentials. Mixed potential theory of corrosion. Uses of Evans's diagrams for understanding of corrosion: Corrosion reaction under cathodic control, corrosion reaction under anodic control, corrosion reaction under diffusion control, corrosion control by flowing solution, corrosion control by passivation, determination of rate of corrosion by corrosion current. Corrosion of different forms: Galvanic corrosion, Crevice corrosion, Pitting corrosion, intergranular corrosion, selective corrosion, erosion corrosion, stress corrosion, hydrogen damage, corrosion control methods. Inhibitors: 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

Terminology related to energy conversion and storage: Primary, secondary and fuel cells. Primary batteries: examples for them, secondary batteries: lead acid battery etc, reserve batteries: Lithium batteries, nickel cadmium batteries, fuel cells: hydrogen oxygen cell, Hydrogen air cell, natural gas Co-Air cells, etc.,

3. Electrochemistry in Industry

Electrochemical reactors, examples for Industrial electrolysis and electrosynthesis: Chloroalkali process, metal extraction, metal finishing, electro dialysis and its applications, metal recovery by Ion exchange, electrochemical ion exchange, electrowinning, electro catalysts and electro synthesis. Metal extraction & refining: aluminium extraction, Silicon magnesium and lithium, manufacturing process metal finishing. Electroplating: requirements for electroplating, mechanism of electroplating plating bath. Macro throwing power, micro throwing power, Plating from non-aqueous solutions, Metal processing: electroforming, electrochemical machining, electrochemical etching

4. Electrochemical Impedance Spectroscopy

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

6. Solar Energy

Photo electrochemical (PEC) and photogalvanic (PG) conversion. PEC cells, PG Cells, Photovoltaic cell of first, second, third and fourth generation, hybrid solar cell

7. Bioelectrochemistry

The electrochemical interface between biomolecules, Nerve impulses and cardiovascular electrochemistry, oxidative phosphorylation, Bioenergetics, Bio electrocatalysis. Bioelectroanalysis

Suggested References:

- Bockris J. O. M. & Reddy A. K. N. "Elementary Electrochemistry" A Plenum / Rosetta Edition
- Perez Nestor "Electrochemistry & Corrosion Science" 2004, Kluwer Academic Publishers
- Kelly R.G., Scully J.R., Shoesmith D.W., Buchheit R.G. "Electrochemical Techniques in Corrosion Science & Engineering" Marcel Decker Inc., New York
- Pletcher Derek "A First Course in Electrode Processes" Electrochemical Consultancy, Alresford Press, UK
- Pletcher Derek "Industrial Electrochemistry"

Evaluation Criteria: Two hours examination at the end of the semester

C 31472/41472 - Industrial Safety and Environmental Technology

1. Introduction, Industrial Hazards and Risks (2 hrs)

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 hrs)

Hazards and Operability (HAZOP) analysis, What if Analysis, Fault Tree Method, Event Tree Diagram, Tie and Bow Analysis

3. Laws and Regulations (2 hrs)

Introduction to Sri Lankan Laws and regulation pertaining to occupational health and safety

4. Environmental Impacts of Industry and the Concept of Sustainability (2 hrs)

Introduction to the environmental impacts from industry, resource depletion and concept of sustainability

5. Industrial Pollution Control Techniques (5 hrs)

Wastewater treatment techniques, Solid waste management, Air Pollution Control techniques

6. Pollution Prevention and Cleaner Production (4 hrs)

Introduction to cleaner production as an industrial pollution prevention/reduction strategy

7. Environmental Management Systems (4 hrs)

Introduction to ISO 14001:2004 and ISO 14001:2015

8. Laws and Regulations (2 hrs)

Introduction to environmental laws and regulations

9. Occupational Health and Safety Management System (4 hrs)

Introduction to OSHAS 18000, OSHAS 18001, OSHAS 18002, and Safety culture

10. Global Social Compliance Program (2 hrs)

GSCP Introduction

Suggested References:

- 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

Evaluation Criteria: Two hours examination at the end of the semester

C31482/41482 - Information Technology for Chemistry

(15 Hours Lectures and 30 Hours Practical Sessions)

1. Spreadsheet Applications for Chemistry Students

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.

2. Computer programming

Introduction to Linux/Unix operating system and basic commands, vi editor, gnuplot, python basics (Python to be taught as a programming and scripting language for this course)

3. Solving Equations

Method of successive approximations: Newton's method, bisection method; Applications: weak acid and weak base dissociation, acid-base titrations, complex equilibrium.

4. Numerical Differentiation and Integration Methods

Use of numerical differentiation methods in chemical kinetics; Application of numerical integration methods such as trapezoidal rule, Simpson rule in solving chemical problems. These methods will be presented with computer programming (Eg. Python, Mathematica, Math-lab)

5. Use of Computer Packages

Computational chemistry software packages such as ChemDraw, Gaussian, Gamess, and perform molecular structure optimization, electronic structure calculation etc., Molecular mechanics and quantum mechanics methods will be introduced in predicting IR spectra of organic molecules

6. Biochemical Applications

Freely available WEB based databases (chemical information systems such as PDB databank) of proteins, peptides and small drug molecules etc. will be used to obtain structural and chemical information of interested molecular systems. Visualizing PDB structures (proteins) using VMD or Pymol programs. Introduction to molecular docking software (Eg. Autodock vina)

Suggested References:

- Barrante, James R. "Applied Mathematics for Physical Chemistry" 03rd Edition, 1974, Presntice-Hall, Inc
- Cramer, Christopher J. "Essentials of Computational Chemistry: Theories and Models" 02nd Edition, John Wiley & Sons, Ltd
- Web links and other reference pdf documents will be given in the class.

Evaluation Criteria: Two hours examination at the end of the semester

C 31492/ 41492 - Molecular Biology & Biotechnology

1. Basic Principles and Techniques in Molecular Biology (19 hrs)

- 1.1 Recall of basic principles
- 1.2 DNA isolation techniques (bacterial, plasmid & genomic)
- 1.3 Agarose & polyacrylamide gel electrophoreses and visualization of DNA
- 1.4 Enzymes in molecular biology
- 1.5 Mitochondrial DNA
- 1.6 Theory of nucleic acid hybridization
- 1.7 DNA labeling
- 1.8 DNA probes and their use
- 1.9 Splicing of DNA from different sources
- 1.10 Vectors used in cloning of DNA
- 1.11 Transformation techniques
- 1.12 DNA cloning
- 1.13 c DNA synthesis and its uses
- 1.14 DNA libraries
- 1.15 DNA sequencing
- 1.16 PCR techniques and their uses
- 1.17 Short interfering RNA

2. Basic Immunology and Vaccines (3 hrs)

- 2.1 Innate and adaptive immunity
- 2.2 Immunoglobulins
- 2.3 Preparation of vaccines, vaccinology

3. Useful applications of Gene Technology (8 hrs)

- 3.1 Transgenic animals and plants
- 3.2 Gene therapy
- 3.3 Preparation of vaccines
- 3.4 Genetically engineered proteins, eg: Insulin, growth hormone etc

Suggested References:

- 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

Evaluation Criteria: Two hours examination at the end of the semester

C 31502/41502 - Particle Physics

1. Introduction to particle physics; Nomenclature and Catalogue of particles; Conservation laws;
2. Introduction to quarks and basic interactions in nature; Leptons and the electromagnetic and weak interactions;
3. The quarks Mass; Lifetime and other particle properties; The instability of the heavy leptons;
4. Muon decay; Parity violation; Nucleon and the strong interactions; Properties of the proton and the neutron;
5. The quark model of nucleons; pions and other bosons and their decay modes; Feynmann diagrams; Spin and intrinsic parity;
6. Classification of Hadrons and Quarks; Particle accelerators;
7. The Cyclotron, Betatron and the Synchrotron; Colliding beams.

Suggested References:

- Thorndike "Elementary Particles"
- Swartz "The Fundamental Particles"
- Segre E "Nuclei & Particles"
- Lavelle Martin "Particles & Nuclei"
- Khanna "Particle Physics"

Evaluation Criteria: Two hours examination at the end of the semester

C 31512/41512 - Photochemistry

1. Molecular photophysics: Deactivation paths of excited states, Kinetics of photophysical processes, Excimers and exciplexes, Energy transfer and sensitization
2. Photochemical reactions: Photodissociation, Light-induced electron transfer, Photo-Pericyclic reactions
3. Polymer photochemistry: Photo-polymerization and cross-linking, Photo-degradation and stabilization of polymers
4. Natural photochemical processes: Atmospheric reactions, Photochemistry of waters and soils, Photosynthesis, Mechanisms of vision
5. Principles of photo-induced electron transfer: Redox properties of excited states, Thermodynamics of photoredox reactions, Dynamics of electron transfer processes, Examples of homogeneous and micro-heterogeneous systems
6. Photo-electrochemistry of semiconductors: Contact phenomena at interfaces, Specific adsorption and surface states, Charge carriers dynamics, Spectral sensitization of wide band-gap solids
7. Photo-electrochemical conversion of solar energy: Thermodynamic limitations of energy conversion, Hydrogen production from water photolysis, Photovoltaic solar cells
8. Semiconductor-assisted photocatalysis: Advanced oxidation processes, Air pollution remediation and surface modifications, Waste water remediation
9. Photographic and xerographic processes: Color theory, Molecular photographic systems, Silver photography, Electrostatic photography, Offset printing.
10. Fluorescence Sensors: Different type of fluorescence sensors, Sensitivity and selectivity Mechanism of fluorescence sensors, Sensing by Collisional Quenching, Energy-Transfer Sensing Photoinduced Electron Transfer (PET) Probes for Metal Ions and Anion Sensors, Probes of Analyte Recognition, Glucose-Sensitive Fluorophores, Protein Sensors

Suggested References:

- Turro, Nicholas J. "Modern Molecular Photochemistry" 01st Edition, 1991, University Science Books
- Lakowicz, Joseph R. "Principles of Fluorescence Spectroscopy" 03rd Edition, 2006, Springer

Evaluation Criteria: Two hours examination at the end of the semester

C 31522/41522 – Advanced Quantum Mechanics

1. Revision of quantum mechanics principles: quantum mechanics postulates, Harmonic oscillator, Hermite polynomials, Rigid rotor, Hydrogen Atom, Dirac notation
2. Many electron atoms, Electronic Hamiltonian, Difficulty in solving the Schrödinger equation, Independent particle model, Hartree product wave function, Spin orbitals, Symmetry requirements on the wave function, Pauli exclusion (antisymmetry) principle, Slater determinant
3. Born Oppenheimer approximation and potential energy Surfaces
4. Revision of variational method and perturbation theory, Second order perturbation theory
5. Hartree-Fock (HF) approximation, Electron correlation. Failures in HF method, Koopman's theorem
6. Basis sets
7. Semi-empirical methods
8. Post HF methods
9. Introduction to density functional theory
10. Geometry optimization and transition state calculations
11. Vibrational frequency calculations
12. Computing thermodynamic quantities
13. Practical applications of electronic structure theory
14. Practical: Run a simple computational chemistry program

Suggested References:

- N. Levine, Quantum Chemistry, 6 ed. 2009.
- C. J. Cramer, Essentials of Computational Chemistry: Theories and Models, 2 ed. 2004.

Evaluation Criteria: Two hours examination at the end of the semester

C 31542/41542 – Petroleum & Petrochemicals

- 1. Definition of crude oil, origin and classification of crude oils (02 hrs)**
- 2. Grease and lubricants including transformer oil and transmission oils (12 hrs)**
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 (06 hrs)**
- 4. Natural gas (LNG/CNG) and its uses in power generation, automobiles and petrochemical industries (06 hrs)**
- 5. LPG, Chemical Naphtha and LNG/CNG as petrochemical feed stock. World Oil depletion and alternative fuels (04 hrs)**

Suggested References:

- Speight James G “Petroleum Chemistry and Refining” 1998, Taylor and Francis Publishers

Evaluation Criteria: Two hours examination at the end of the semester

C 31552/41552 - Quality Management

1. Quality of Substances and Quality of Services (15 hrs)

- 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: The Plan – Do – Check – Act (PDCA) cycle is the operating principle of ISO's management system standards
- 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 (08) Principles of the ISO 9001:2000, 2008 Standard :System approach to management, Process approach to management, Involvement of people, Customer focus, Leadership, Mutual beneficial supplier 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 hrs)

- 2.1 Sri Lanka Accreditation Board for conformity assessment (SLAB) (12 hrs)
Introduction: Sri Lanka Accreditation Board for conformity assessment (SLAB) was established by an Act of Parliament No. 32 of 2005. It is accredited by the International Organization for Standardization (ISO); the International Electrotechnical Commission (IEC); Asia Pacific Laboratory Accreditation Co-operation

(APLAC); International Laboratory Accreditation Cooperation (ILAC). The general requirements for accreditation bodies accrediting conformity assessment bodies are stated in the International Standard ISO/IEC 17011 ISO/IEC 17025-Laboratory Accreditation; ISO 15189-Medical Laboratory Accreditation. Chemical, microbiological and calibration laboratories are 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. It is required for accreditation under ISO/IEC 17025. It is established that accredited laboratories produce accurate analytical results

2.2 ISO/IEC 17025:

Five clauses are, 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

Suggested References:

- Evans, J.R. "Total Quality" 04th Edition, 2007, Thomson – South-Western
- Evan, J.R. and Lidsay "The Management of the Control of Quality" 06th Edition, 2005, Cincinnati 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

Evaluation Criteria: Two hours examination at the end of the semester

C 31562/41562 - Cosmetic Science

1. **Introduction to cosmetics industry- myths and trends (2 hrs)**
2. **Colloidal chemistry: emulsion and surfactant science (6 hrs)**
 - 2.1 Oil, fats and waxes
 - 2.2 Surfactants
 - 2.3 Thickeners, emulsions, gums and resins
 - 2.4 Aerosols
3. **Formulation science and process technology (10 hrs)**
 - 3.1 hair products – raw materials, preparation, stability studies
 - 3.2 Oral care products- raw materials, preparation, stability studies
 - 3.3 skin products – raw materials, preparation, testing and evaluation methods
 - 3.4 cleansing agents – raw materials, formulation techniques
 - 3.5 perfumery- raw materials, formulation techniques, matching fragrances
 - 3.6 decorative cosmetics
4. **Biochemistry and toxicology (8 hrs)**
 - 4.1 Skin biology and hair structure
 - 4.2 Histology of the skin and hair
 - 4.3 Hypersensitivity and immunological skin reactions
 - 4.4 Applied microbiology and pharmacology, Toxicology, cosmetic safety
 - 4.5 Controlling microorganism in order to avoid contamination during manufacturing
 - 4.6 Dosage
 - 4.7 Biochemical changes due to cosmetics products
 - 4.8 Toxicology
5. **Marketing and legal requirements (4 hrs)**
 - 5.1 Product development, packaging, marketing and quality assurance
 - 5.2 Legislation, licensing requirements

Suggested References:

- 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

Evaluation Criteria: Two hours examination at the end of the semester

C 31572/41572 - Nanotechnology

1. Introduction (6hrs)

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 hrs)

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 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

3. Characterization Techniques for Nanomaterials (8 hrs)

Characterization Techniques Related to Nanoscience and Nanotechnology: 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: Voltammetric techniques, AC Impedance Analysis

4. Applications of Nanomaterials in Local Industries (8 hrs)

Applications of nanoscience and nanotechnology in Sri Lankan industries: 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

Suggested References:

- 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

Evaluation Criteria: Two hours examination at the end of the semester

C 31582/41582 - Clinical Herbal Product Development

1. Introduction (5 hrs)

Recognize the concept needs of PRD in medical and global view of health overview of product research and development and stakeholders; Role of chemistry in extraction and preservation of herbal products; Use of computational chemistry in drug development; synthetic analogs of bioactive herbal products

2. Drug discovery and development process (4 hrs)

Describe the pharmacological process for drug discovery (nutraceuticals and herbal drugs/products); Chemical and biochemical basis of drug discovery and development; identify the process to protect intellectual property

3. Pre-clinical Development (4 hrs)

The process of Pharmacological development; chemical aspects of drug protein interactions

4. Clinical Development (2 hrs)

Process of clinical development; Cross reactivity

5. Registration activities, post registration activities (1 hr)

Process of registration activities, post registration activities

6. Theory and practical printed – Develop nutraceuticals/Pharmaceuticals from natural herbal materials and their standardization and quality control (Tablets, Capsules etc) (14 Hrs)

Development and analysis of clinical products; Role of Chemistry in standardization and quality control of pharmaceutical products

Suggested References:

- 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)

Evaluation Criteria: Two hours examination at the end of the semester

C 31592/41592 - Materials Chemistry

1. Chemistry of Clusters (10 hrs)

- 1.1 Boron hydrides – neutral boron hydrides, hydro borate anions and carboranes
- 1.2 Metal Clusters
- 1.3 Isolobal analogy
Silicates, Borones, Metal clusters, Intercalates and clathrates

2. Solid State Chemistry (10 hrs)

Solid state synthesis, high temperature methods, hydrothermal and high pressure methods, solid solutions and alloy systems, thermal analytical methods for characterisation. Perovskites and Metal Organic Frameworks with their synthesis properties and applications Crystalline state, isotropy and anisotropy, piezo and pyro electricity Laue symmetry, optical properties, refractive index, crystals under the polarizing microscope, dispersion, pleochroism, twinning.

3. Inorganic Materials (10 hrs)

- 3.1 Comparison with organic polymers, chains, rings, cross linking
- 3.2 Silicon based chemistry, preparation and applications of : silicates, aluminosilicates, silicones
- 3.3 Host and guest chemistry ; special reference to intercalation compounds
- 3.4 Boron nitrides, sulphur nitrides, phosphor nitrides
- 3.5 Degradation of inorganic materials
Inorganic polymers, advanced ceramics conducting polymers and their applications, solid state balleries, nanomaterial.

Suggested References:

- Anthony R. West, Solid State Chemistry and its Applications, 2nd Edition, Student Edition
- Harry R. Allcock, Introduction to Materials Chemistry
- Leonard R. Mac Gillivray (Editor), Charles M. Lukehart (Editor), Metal-Organic Framework Materials

Evaluation Criteria: Two hours examination at the end of the semester

C 31602/41602 – Chemistry of Gem Minerals & Synthetic Gem Materials

1. Chemical Properties of Gem Minerals (2 hrs)

Chemistry of main mineral classes, Isomorphism, Isomorphous substitution, Polymorphism

2. Crystallography Related to Gem Minerals (4 hrs)

Crystals and polycrystalline (including microcrystalline) materials, Amorphous and metamict materials, The seven crystal systems: the reference (crystallographic) axes, Elements of symmetry, Common and typical crystal forms for each of the systems, The relationship of crystal structure and symmetry to crystal faces, forms, habits, cleavage, internal growth phenomena and crystal surface markings

3. Physical and Optical Properties of Gem Minerals (2 hrs)

Physical properties (hardness, specific gravity), Optical properties of crystalline and non-crystalline gem materials

4. Polarized Light; the Polariscope (1 hr)

The nature of polarized light. Polarization and vibration direction, The production of polarized light; the polarizing filter; 'crossed' polarizing filters, The polariscope: construction and use, Isotropic and anisotropic behaviour; optic axes

5. Refraction (2 hrs)

Refraction; refractive index (RI), definition and description, Singly refractive materials, Doubly refractive materials: directional properties; double refraction, Refractometer, construction; the principle of total internal reflection, Birefringence and optic sign: their measurement by refractometer.

6. Colour (2 hrs)

Light and body colour in gemstones. Dispersion, 'fire' and diffraction., The electromagnetic spectrum, Body colour and selective absorption of light, Colouring elements; allochromatic and idiochromatic materials, Colour and its causes in gem materials, Pleochroism; Dichroscope, construction and use, Luminescence: fluorescence and phosphorescence, Use of the ultra-violet lamp (short wave and long wave)

7. The Absorption Spectrum and the Spectroscope (4 hrs)

Construction and function of the two types of spectroscope. The absorption spectra of the following materials:

Apatite,	almandine garnet,	chrysoberyl,
alexandrite,	emerald,	enstatite
peridot,	Sinhalite,	ruby,
blue sapphire,	Cobalt spinel,	
red glass (selenium),	red glass (gold),	blue glass (cobalt),
blue Verneuil synth.	spinel (Co)	
zircon,		

Use of colour filters; the Chelsea colour filter. Colour change effect ('alexandrite effect').

8. Advanced Analytical Methods in Gem Testing (4 hrs)

Knowledge of the gem testing techniques employed in gemmological laboratories; Use of advance instruments related to the functions of infrared, ultraviolet and X-rays.

XRD

XRF

FTIR

LIBS

LA-ICP-MS

UV Visible spectrometer

Raman Spectrometer

9. Thermal Conductance and Electrical Conductivity (1 hr)

Thermal properties and the uses of thermal conductance meters (thermal probes) in gem identification, Electrical properties of gem materials, Basics of Diamond Tester & Moissanite Tester

10. Artificial Gem Materials (4 hrs)

Artificial and synthetic gems, Single-crystal growth of artificial materials; nucleation; An outline of methods of production and identification of materials produced by the Verneuil flame-fusion method, flux melt method hydrothermal method, skull melting method, czochralski 'crystal pulling' method, floating zone (zone melting) method,

High pressure high temperature (HPHT) synthesis of diamond, Production for Y.A.G., synthetic rutile, strontium titanite and synthetic moissanite and cubic zirconia

11. Treatments of Gemstones (2 hrs)

Methods of treatment (enhancement) and their detection, Dyeing, bleaching, impregnation, coating, irradiation and annealing, heat treatment, laser treatment, fracture filling and diffusion treatment, Special description on heat treatment and diffusion methods, Treatment of diamonds

12. Chemistry of Precious Metals in Jewellery (2 hrs)

Chemistry of platinum, Gold and Silver, Chemistry of alloys in jewellery

Suggested references:

- Nassau, K. "Gemstone Enhancement" 1984, Butterworth & Co., London
- Nassau, K. "The Physics and Chemistry of Color" 2nd Edition, 2001, John Wiley & Sons, New York
- Smart, L. and Moore, E. "Solid state Chemistry: An Introduction" 02nd Edition, 1996, Chapman & Hall, London
- Dissanayake, C.B., Rupasinghe, M.S. and Perera D.G.A. (Editor) "The Sri Lanka Geuda: Proceedings of the National symposium of Geuda Heat Treatment" 1993, IFS, Kandy
- Fernando, P. R. K. "Glossary in Geology, Gemmology & Jewellery" 3rd Edition, 2015, Ceylon Mineral Research Laboratory, Wattala

Evaluation Criteria: Two hour examination at the end of the semester

C31611/41611 - Agro Industries

1. Spices & Essential Oils (6 hrs)

- 1.1 Methods of extraction of essential oils and isolation of economically important compounds
- 1.2 Processing of spices and production of oleoresins
- 1.3 Major constituents in local essential oils and spices
- 1.4 Quality evaluation of essential oils and spices
- 1.5 Industrial applications

2. Medicinal Plants (3 hrs)

- 2.1 Processing technologies of medicinal plants
- 2.2 Production of Herbal medicines and other products
- 2.3 Quality control of MPs and their products.
- 2.4 Regulations for herbal products

3. Tea (2 hrs)

Primary processing, production of black, green, CTC, instant, scented and bottled teas.

4. Rubber (2 hrs)

Primary processing, vulcanization and rubber product manufacture.

5. Coconut Industry (1 hr)

Chemistry and technology of processing coconut oil Manufacture of copra Husk and shell products, Coconut sap products, Non traditional kernel products

6. Coffee & Cocoa (1 hr)

Primary processing of coffee & cocoa, production of instant & decaffeinated coffee, chocolate and cocoa beverage

Suggested References:

- Silva, K. Tuley de (Editor) "A Manual on the Essential Oil Industry"
- CISIR (ITI) monographs on Spice oleoresins, Spice processing, Cinnamon, Pepper, Nutmeg, Ginger & Cocoa
- "Crop Processing (Industrial Products, Food Products)" Diploma in Agricultural

Engineering , Open University of Sri Lanka

- Engelhardt, Ulrich H. Mander L. (Editor), and Hung-Wen B. Liu (Editor) “Chemistry of Tea” 2010, In: Comprehensive Natural Products II, Elsevier
- A.K.N. Zoysa (Editor) “Handbook on Tea” 2008, Tea Research Institute of Sri Lanka
- Wickremasinghe, R. L. “Facets of Tea Research in Practice” 1978, Tea Research Institute of Sri Lanka, Monograph No 7

Evaluation Criteria: One hour examination at the end of the semester

C 31622/41622 - Mini Project

A mini project is a short term group/individual assignment which applies the scientific methodology and problem solving techniques. The topics will be decided by the lecturers during the semester. Maximum of 3 students per group will be allowed for the project and the duration of a project is approximately one month. Three or four days of laboratory work would be sufficient for the successful completion of the course. Apart from the laboratory work students may be required to do field visits, statistical analysis, surveys depending on the project description.

Evaluation Criteria

- Project report (form of a mini paper) (60%)
- Group presentation (10 minutes) + Q&A session (40%)

COMPULSORY

PRACTICAL COURSE UNITS

C 11201 - GENERAL CHEMISTRY PRACTICAL COURSE

1. Neutralization titrations: Calibration of volumetric glassware. Strong acid strong base titrations with different indicators. Titrations of weak acids and polyprotic acids, titration of carbonate/ bicarbonate and carbonate / hydroxide mixtures
2. Chemistry of 's', 'p' and 'd' block elements: Solubility of 's' and 'p' block elements, solubility of 'd' block elements, semi micro qualitative analysis of anions and cations
3. Tests for functional groups in organic compounds

C 21202/31202 ANALYTICAL CHEMISTRY (SECTION A 60 Hrs)

Buffer preparation: Preparation of buffers for a given pH and a given buffer capacity.

1. Redox titrations: Titrations with potassium permanganate and potassium dichromate, iodometric titrations
2. Complexometric Titrations: Differentiation of magnesium and calcium ions in a mixture, elimination of interferences in EDTA titrations
3. Gravimetry: Homogeneous precipitations, weight measurement techniques: gravimetry using sintered glass crucibles, gravimetry using sample ignition techniques
4. Colorimetry: Direct and indirect colorimetry, external calibration curves and standard addition curves in analysis
5. Semi micro qualitative analysis

C 31233/41233 ADVANCED ANALYTICAL AND INORGANIC CHEMISTRY (SECTION B 75 Hrs)

1. Analysis of water samples: Cations using strong cation exchanger. Carbon Oxygen Demand (COD), Biological Organic Demand (BOD) and Dissolved Oxygen (DO). Sodium adsorption ratio in irrigation water
2. Determination of composition (NPK value) of fertilizer samples
3. Inorganic complexes: Synthesis of inorganic complexes of metal ions including photoinduced reactions. Deducing the composition of complexes and electrical conduction
4. Colourimetric and Visible Spectroscopy: Determination of metal ions and adulterants in food
5. FTIR: Determination of product tampering.
6. Atomic Absorption Spectroscopy: Determination of metal ions in industrial samples and vitamin tablets
7. Gas Chromatography: Deducing Henry's law constant and volatile organics
8. Extracting oil from lemon peel using super critical carbon dioxide
9. Electro analytical determinations of analytes.

C 21222/31222 ORGANIC CHEMISTRY PRACTICAL COURSE (SECTION A 60 hrs)

1. Purification of solid organic compound by recrystallization and melting point determination
 - 1.1 Use of single solvent systems
 - 1.2 Use of mixed solvent systems
 - 1.3 Melting point determination
 - 1.4 Mixed melting points
2. Purification of a liquid
 - 2.1 Distillation

3. Boiling point determination (micro scale)
4. Separation of mixtures of Organic compounds
5. Tests for carbohydrates and amino acids by paper chromatography
6. Identification of organic compounds by preparation of derivatives
7. One step syntheses of organic compounds
8. Monitor the progress of an organic reaction using thin layer chromatography

C 31253/41253 ORGANIC CHEMISTRY
PRACTICAL COURSE
(SECTION B 75 hrs)

1. Advanced techniques in organic synthesis separation and structure elucidation
 - 1.1 Synthesis of a heterocyclic compound
 - 1.2 Multi step synthesis (use of a protecting group)
 - 1.3 Oxidation reaction
 - 1.4 Photochemical reaction
 - 1.5 A rearrangement reaction
 - 1.6 Grignard synthesis
 - 1.7 Separation of reaction products by chromatography
2. Extraction of Natural products
 - 2.1 Isolation of caffeine and purification
 - 2.2 Isolation of piperine from black pepper- Soxhlet Extractor
 - 2.3 Isolation by steam distillation: volatile constituents Cumin, identification of major and preparation of derivatives
 - 2.4 Isolations of trimyristin from nutmeg and saponification to myristic acid
 - 2.5 Preparative TLC and fractional distillation to purify organic compounds
3. Biochemistry
 - 3.1 Determination of K_M and V_{max} of an enzyme
 - 3.2 Effect of Temperature and pH on enzyme activity.
 - 3.3 Isolation of DNA from yeast and determination of T_m value

- 3.4 Determination of Cholesterol content in egg yoke
4. Use of GC to analyse essential oils
 5. Phytochemical screening of Ayurvedic herbs

C 21212/31212 PHYSICAL CHEMISTRY

PRACTICAL COURSE

(SECTION A 60 Hrs)

Section A of Physical chemistry covers following areas.

Introductory theoretical exercises

- Calculations based on concepts in statistics and chemometrics: errors and propagation of errors, error analysis (calculus based method and graphical method), concept of accuracy and precision, standard deviation (sample and population)
- Calculations based on concept of significant figures
- Calculations based on advanced statistical concepts: correlation coefficient, tests of significance (Q, F and paired F tests)

Mainly focused to determination of physical constants and parameters in following areas

Thermodynamics

Solubility Product, Partition Coefficient, Phase diagrams (2 component), Enthalpy and Entropy of chemical reaction, Eutectic Point, Colligative property

Chemical Kinetics

Rate law: First order reactions/second order reactions, Order of a chemical reaction, Rate of a chemical reaction, Rate constant of a chemical reaction, Activation energy of a chemical reaction.

Electrochemistry

Potentiometry

Surface Chemistry

Langmuir and Freundlich Adsorption Isotherms

Buffer solutions

Calculations, Preparation of Buffers, use of pH meter

Colorimetry

Absorbance measurements, Kinetic studies

C 31243/41243 ADVANCED PHYSICAL CHEMISTRY

PRACTICAL COURSE

(SECTION B 75 Hrs)

Section B of Physical chemistry covers following areas.

- Calculations based on computer software packages (symmetry and group theory calculations, quantum mechanical calculations, use of software in quantitative chemical analysis)

Thermodynamics

Equilibrium constant, Free energy, enthalpy and entropy, Solubility and Solubility product, Phase diagrams (3 component), Colligative property

Chemical Kinetics

Rate law: First order reactions/second order reactions, Comparison results with different analytical method(s)

Electrochemistry

Coulometry, Potentiometry, Conductometry, Cyclic Voltammetry, Transport numbers

Spectroscopy

Absorbance measurements, Fluorescence studies, Dissociation constant, Comparison with other methods

Computational chemistry

Graduateship Examination

Regulations

LEVELS 1 & 2

(With effect from the 2015 Examination for Level 1 & 2016 examination for Level 2)

1. Papers

- 1.1. The Levels 1 & 2 Examinations will comprise of eighteen written papers divided into nine at Level 1 & nine at Level 2. A given student will be required to sit for **eight** papers at Level 1 (21 credits) and **nine** at Level 2 (21 credits). These theory papers will be as follows:

Level 1 (21 Credits)

- C 11003 - Basic Concepts
- C 11013 - General and Inorganic Chemistry
- C 11023 - Principles of Physical Chemistry
- C 11033 - Principles of Organic Chemistry
- C 11042 - Mathematics for Biological Science Students OR
- C 11052 - Biology for Physical Science Students
- C 11063 - Mathematical Applications for Chemists
- C 11072 - Fundamentals of Physics for Chemists
- C 11082 - Analog and Digital Electronics for Chemists

(Note: Where a student has secured A/L passes in Biology as well as Mathematics, the Dean will, in consultation with the student, make the decision regarding the paper to be sat by the students.)

Level 2 (21 Credits)

- C 21012 - Physical Chemistry
- C 21022 - Principles of Quantum Chemistry and Molecular Spectroscopy
- C 21023 - Inorganic Chemistry
- C 21032 - Organic Chemistry I
- C 21062 - Organic Chemistry II
- C 21042 - Titrimetric and Gravimetric Methods in Analysis
- C 21082 - Separation Methods and Spectroscopic Applications
- C 21053 - Biochemistry
- C 21073 - Introduction to Management, Economics and Finance

The eight (three credit) papers would be of 3 hours duration (+ 15 minutes reading time) and each would have 4-6 questions all of **which will be compulsory**. The remaining ten (two credit) papers would be of 2 hours duration (+ 10 minutes reading time) and would have 3-5 questions, all of **which will be compulsory**. Each question may however have internal choice.

1.2 Chemistry based papers

The papers C 11003, 11013, C 11023, C 11033, C 21012, C 21022, C 21023, C 21032, C 21062, C 21042, C 21082, C 21053 will be referred to in these regulations as the “Chemistry based papers”.

2. Weightage

Total per student will comprise $(8 \times 3) + (9 \times 2) = 42$ credits

The total weightage of the seventeen papers sat by each student will therefore be 42 credits.

3. Grades will be assigned for each of the papers as follows:

	Grades	GPV
A+	85-100%	4.00
A	70-84%	4.00
A-	65-69%	3.70
B+	60-64%	3.30
B	55-59%	3.00
B-	50-54%	2.70
C+	45-49%	2.30
C	40-44%	2.00
C-	35-39%	1.70
D+	30-34%	1.30
D	20-29%	1.00
E	0-19%	0.00

(GPV = Grade Point Value)

4. Pass in a Paper

A candidate obtaining at least a C grade in a given paper shall be deemed to have passed in that paper.

5. Sitting the Examination

5.1 A candidate will be required to sit **all EIGHT** papers (comprising of 21 credits) at Level 1 at the first attempt at one sitting.

5.2 A candidate who obtains a GPA (Grade Point Average) of 1.1 or above with at least one C in C 11013, C 11023 or C 11033 will be **eligible** to sit Level 2 papers in a subsequent year.

- 5.3 A candidate eligible to sit Level 2 papers as per regulation 5.2 above will be required to sit **all NINE** papers (comprising 21 credits) when he sits for Level 2 at his first attempt.
- 5.4 If a candidate is sitting for any papers at Level 2, he/she is strongly recommended to sit for **all** failed papers at Level 1.
- 5.5 Any candidate could repeat any paper at Level 1 and/or 2 for the purpose of improving on the grade obtained at the previous attempt/s. However the maximum grade that will be considered for the overall GPA calculation for the purpose of a class (Honours pass as per regulation 21) in the overall final evaluation for a paper which is thus repeated will be a **maximum of C (GPV of 2.00)** unless he had obtained a better mark and grade at the first attempt.

6. **Noncredit Course - PASS/FAIL Option**

Every student should offer C 11000 – Language Course and obtain a PASS grade. Sinhala Language for students not having an O/L pass in Sinhalese and Tamil Language for students not having an O/L pass in Tamil.

Course Evaluation

The competence and performance of students will be assessed throughout through oral/written assignments/tests etc. and at the end of the course through a final examination.

At the end of such assessment, a PASS/FAIL grade will be assigned by the relevant panel of examiners and confirmed by the Academic Board.

Those who obtain a FAIL grade will be required to repeat the assessment in a subsequent year.

7. **PASS in Level 1 & 2 of the Graduateship Examination (solely for the purpose of award of Advanced Diploma as per regulation 10)**

A Candidate shall be deemed to have passed the Level 1 & 2 examination if he obtains

- 7.1. PASS grades in the relevant zero credit course as per regulation 6
AND
- 7.2. obtains an overall GPA of 2.0 amongst the seventeen (17) written papers at Levels 1 & 2
AND
- 7.3. passes in at least twelve (12) papers (including nine (9) Chemistry based papers) as given in 1.2

8. Failure

A candidate who does not qualify for a pass under rule 7 above shall be deemed to have failed the Level 1 & 2 examination

9. Completing the Examination

A candidate who fails the examination under regulation 7 will be deemed to have passed the examination if he obtains the necessary requirements to satisfy rule 7 by re-sitting one or more of the failed papers at a subsequent attempt in such papers.

10. ADVANCED DIPLOMA IN CHEMISTRY

10.1 Award of an “ADVANCED DIPLOMA IN CHEMISTRY” for students exiting the Graduateship Programme at level 2 or thereafter

Any candidate who has passed Level 1 & 2 of the Graduateship Examination as per regulation 7 **AND passed** the **FOUR** Practical Assessment Papers as given below,

C 11201	General Chemistry Assessment
C 21202/31202	Practical Inorganic Chemistry Assessment (A)
C 21212/ 31212	Practical Organic Chemistry Assessment (A)
C 21222/ 31222	Practical Physical Chemistry Assessment (A)

will be eligible to obtain a (two year) “**Advanced Diploma in Chemistry**” and obtain an Advanced Diploma Certificate if he exits from the Graduateship Programme at any stage.

Supplication

10.2 Any student who wishes to exit the Graduateship Programme as prescribed under regulation 10.1 will be required to supplicate for the Advanced Diploma in the prescribed form not later than the end of October or such other date that may be prescribed by the Academic Board during each year.

10.3 The Graduateship Board of Examiners shall determine before the end of December each year the list of students eligible to be awarded Advanced Diplomas from amongst those who supplicate as per regulation 10.2.

10.4 A student who has been placed on the list of eligible Advanced Diplomate as per regulation 10.1 should obtain **Affiliate Membership*** of the Institute of Chemistry Ceylon and would then become eligible to be conferred the Advanced

Diplomate Designation and Medal at a subsequent Convocation of the College after such list is confirmed by the Academic Board and on payment of the requisite supplication fee.

***Note:** An application for Affiliate Membership should be submitted.

10.5. Advanced Diplomates in Chemistry reentering the Graduateship Programme

Obtaining such an Advanced Diploma in Chemistry and exiting the Graduateship Programme (as per regulation 10.1) will however not prevent such a student from reentering the Graduateship programme, during the two academic years subsequent to the academic year in which he exited the programme. Nevertheless, the period permitted for such reentry could be extended by the Academic Board on the recommendation of the Board of Examiners on an individual basis for justifiable reasons on an appeal made by the student at least two months prior to the commencement of academic activities in the relevant year.

In the event a student re-enters the Graduateship Programme, such a student will be granted exemption from whatever papers he has already completed at the time of exiting the programme and any marks and grades earned by such student will be given full credit as he continues with the Graduateship Programme. However the provision of regulation 21.2 pertaining to the number of attempts the candidate has appeared at examinations for awarding an Honours Pass at the Graduateship Examination will apply.

Such a Candidate will however be required to surrender to the College registrar the Advanced Diploma Certificate & Medal he has been previously awarded before he is awarded a subsequent higher qualification as per regulations 18 and/or 23. He will not be entitled to the award of a higher qualification until and unless he surrenders the said Advanced Diploma Certificate and Medal.

LEVEL 3 & 4

(With effect from the 2017 examination for Level 3 & the 2018 examination for Level 4)

11.

11.1 The Examinations at Levels 3 & 4 will comprise compulsory theory papers (11.2.1), compulsory practical papers (11.2.2) and **optional** papers (11.3).

11.2

11.2.1 **Compulsory theory papers** will be

Level 3

- C 31003 - Energetics & Kinetics
- C 31012 - Special Topics in Physical Chemistry I
- C 31022 - Special Topics in Physical Chemistry II
- C 31033 - Advanced Topics in Organic Chemistry
- C 31043 - Physical Organic Chemistry
- C 31053 - Special Topics in Inorganic Chemistry I
- C 31062 - Special Topics in Inorganic Chemistry II
- C 31072 - Analytical Chemistry: Instrumental Methods I
- C 31082 - Analytical Chemistry: Instrumental Methods II
- C 31092 - Environmental Chemistry
- C 31363 - Fundamentals of Chemical and Process Engineering
- C 31102 - Research Methods

These twelve papers will amount to a total of 29 credits.

These TWELVE (12) papers at Level 3 are compulsory for all candidates.

Level 4

All the candidates should offer

C 41193 - General Chemistry Paper

C 41001 - Seminar

and one of the papers given below.

C 41152 - Literature Survey in Chemical Sciences

OR

C 41172 - Internship

OR

C 41185 - Research Project

These three papers will amount to a total of 9 or 6 credits.

Those who are eligible to follow Research Project will be selected after Level 2 Examination and may commence their research work from 2nd semester of Level 3.

These THREE (3) course units at Level 4 are compulsory for all candidates.

11.2.2. The **compulsory** (practical) papers will be

i. Continuous Assessment of Practical Course at Section A comprising,

C 11201 - General Chemistry

C 21202/31202 - Practical Analytical Chemistry

C 21212/31212 - Practical Physical Chemistry

C 21222/31222 - Practical Organic Chemistry

These four compulsory papers will amount to a total of 07 credits

ii. Continuous Assessment of Practical Course at Section B comprising,

C 31233/41233 - Practical Advanced Analytical & Inorganic Chemistry

C 31243/41243 - Practical Advanced Physical Chemistry

C 31253/41253 - Practical Advanced Organic Chemistry

These three compulsory papers will amount to a total of 09 credits

Total Credits = 16

11.2.3 Subject to space and other limitations candidates will however be able, permitted and encouraged to offer the practical courses and examinations at an earlier Level/year.

11.3 Optional Courses/ Papers

The courses that have been approved are given below.

C 31313/41313 - Analytical Industrial Biochemistry

C 31323/41323 - Biochemistry II

C 31333/41333 - Chemical Education*

C 31342/41342 - Further Topics in Environmental & Green Chemistry

C 31353/41353 - Food Chemistry & Technology

C 31373/41373 - Industrial Chemistry & Technology

- C 31383/41383 - Natural Products
- C 31393/41393 - Pharmaceutical & Medicinal Chemistry
- C 31403/41403 - Polymer Chemistry & Technology
- C 31413/41413 - Further Management, Economics and Finance
- C 31422/41422 - Agrochemicals
- C 31432/41432 - Atomic Spectroscopic Methods of Analysis
- C 31442/41442 - Chemical & Molecular Toxicology
- C 31452/41452 - Computational Chemistry
- C 31462/41462 - Electrochemical Technology
- C 31472/41472 - Industrial Safety, Health and Environmental Technology
- C 31482/41482 - Information Technology
- C 31492/41492 - Molecular Biology & Biotechnology
- C 31502/41502 - Particle Physics
- C 31512/41512 - Photochemistry
- C 31522/41522 - Quantum Mechanics
- C 31542/41542 - Petroleum and Petrochemistry
- C 31552/41552 - Quality Management
- C 31562/41562 - Cosmetic Science
- C 31572/41572 - Nanotechnology
- C 31582/41582 - Clinical Herbal Products Development
- C 31592/41592 - Materials Chemistry
- C 31602/41602 - Chemistry of Gem Minerals & Synthetic Gem Materials*
- C 31611/41611 - Agro Industries
- C 31622/41622 - Mini Project

- 11.3.1 The number and titles of optional courses available from year to year could vary depending on the circumstances; however optional courses amounting to a total of at least 25 credits will be made available within any two successive years of study at levels 3 & 4.
- 11.3.2 The titles of optional courses available to be offered in each year will be announced for the information of students not later than the end of May. The Academic Board however reserves the right to alter, modify or substitute such optional courses at any time due to unavoidable circumstances.
- 11.3.3 The overall list of optional courses approved by the Academic Board together with the relevant course contents and other necessary information will be made available from time to time in the Programme Prospectus and/ or Examination Regulations and/ or Supplements that will be issued.
- 11.3.4 Pre-requisites to offer an optional course could be prescribed by the

Academic Board in order to ensure the attainment of the necessary academic standards and quality.

11.3.5 Course Evaluation

Papers will be of three hours duration for a three credit paper (15 minutes reading time), two hours duration for a two credit paper (10 minutes reading time) and one hour duration for a one credit paper (5 minutes reading time). The number of questions that will appear in each paper will be as announced and/or varied from time to time in the Programme Prospectus and/ or Supplements *etc.*

12. Credit Weightage and Grade Point Value

All papers will be weighted according to their corresponding credit value (n) indicated by the last digit. Grade point value (GPV) for a given course will be assigned as per regulation 3.

Course Number	Credit Value (n)	Grade Obtained	GPV
C 31003	3	B	3.00
C 31012	2	C+	2.30
C 31611	1	A-	3.70

13. **Grades** will be assigned for each paper as indicated in regulation 3.

14. Pass in a paper

A candidate obtaining at least a C (GPV of 2.00) grade in a given paper shall be deemed to have passed in that paper.

15. Sitting the Examination at Levels 3 & 4

- 15.1 A candidate who obtains a GPA of 1.2 or above in Level 2 will be eligible to sit any papers at Level 3 & 4 in the subsequent year.
- 15.2 A candidate eligible to sit Level 3 and/ or Level 4 papers as per regulation 15.1 are recommended to sit all compulsory papers (29 credits) at Level 3 at his first attempt.
- 15.3 Any candidate who is sitting for any paper at Level 3 and/ or Level 4 are recommended to concurrently sit for any failed papers at Levels 1 & 2.
- 15.4 Candidates are strongly encouraged and would be permitted to sit the compulsory **practical** examination papers in a given area as soon as possible after they are eligible to sit the formal practical examination as per regulation 11.2.2. (iii) irrespective of eligibility as per regulation 15.1

16. Papers to be sat

- 16.1 A candidate could sit all the compulsory papers and optional courses at Level 3 and/ or 4 subject to regulations 15.1, 15.2 & 15.3
- 16.2 Every candidate will be compulsorily required to sit for each of the compulsory courses before passing out as a Graduate Chemist.
- 16.3 The results of **all examination** sat by a student will appear in the individual transcript of the student.

17. Repetition of Paper

Where a candidate has repeated a paper at any level, at subsequent attempts, the maximum GPV/grade that can be considered for the purpose of computing the overall GPA and assignment of grades to be considered for an Honours Pass (class) as per regulation 21 will be 2.00/Grade C irrespective of any higher GPV/grade he might have obtained at subsequent attempts. (Regulation 5.5 shall, mutalis mutandis, apply for level 3 and 4 papers as well.)

Graduateship Examination / Qualification

18. Evaluation of a Pass in the Graduateship Examination

18.1 The evaluation procedure for the final evaluation consists of theory papers, assignments, reports, presentations, oral examinations and practical examination papers or a combination of the above comprising a minimum of 120 credits as given below.

	Number of Credits
17 courses at Levels 1 & 2 (regulation 1.1)	42
Courses at Levels 3 & 4 (regulation 11.2.1 & 11.3)	
Compulsory Courses	35 or 38
Optional Courses	27 or 24
Practical Examination (regulation 11.2.2)	<u>16</u>
Total	<u>120</u>

Graduate Chemist Designation

18.2 A candidate shall be deemed to have passed the overall Graduateship Examination and qualified to become a **Graduate Chemist** if he

- (i) passes in the noncredit course (regulation 6) **and obtains**
- (ii) GPA* of 2.00 or above from all the courses offered (greater than or equal to 120 credits) as per regulation 18.1 **and obtains**
- (iii) C grade in at least 75 credits of the 93 OR 96 compulsory courses amongst courses offered at Levels 1, 2, 3 & 4 as per regulations 1.1 & 11.2.1 and a C grade in at least 15 credits of the 27 or 24 optional courses amongst courses offered at Level 3 and 4 as per regulation 11.3 **and obtains**
- (iv) minimum of C grade in at least two of the three practical examinations (C 31262, C 31272 and C 31282)as per regulation 11.2.2 (iii)

* **GPA will be calculated from all the credits taken (≥ 120)**

** **No E grades are allowed for compulsory courses**

*** **Maximum of E grades aggregating to 3 credits is allowed for optional courses within the 120 credits as per regulation 18.1**

19. Pass with a class at Graduateship Examination

19.1 A candidate who secures an overall pass in accordance with section 18 shall be awarded a pass with class (Honours) provided the GPA is in accordance with the table below.

Note: No E grades are allowed for a class within the 120 credits as per regulation 18.1.

Class	GPA
First Class Honours	3.70 or above
Second Class (Upper Division) Honours	3.30 or above
Second Class (Lower Division) Honours	3.00 or above

19.2 A candidate is eligible for a pass with a class as per regulation 19.1 only if he successfully completes all the examinations within 4 academic years. (equivalent to four attempts at examinations) However a candidate is permitted to defer sitting examinations fully (Theory and Practical Final Examinations; C 31262/41262, C 31272/41272 & C 31282/41282) in a given academic year; such a deferment will not be considered as an attempt.

20. Failure

A candidate who does not qualify for a pass under regulation 18.2 shall be deemed to have failed the overall Graduateship Examination.

21. Completing the overall Graduateship Examination

A candidate who fails the Graduateship Examination as per regulation 20 shall be deemed to have passed the Graduateship examination if and when he satisfies regulation 18 at subsequent attempts. Such a candidate shall not be entitled to an Honours Pass as per regulation 19.1 if he is not qualified to be so awarded as per regulation 19.2

22. Calculation of Grade Point Value (GPV) and Grade Point Average (GPA)

22.1 The transcripts shall include the grades obtained together with their respective credit rating for all courses offered by the student.

22.2 Grade Point Average (GPA)

GPA shall be computed to the second decimal place according to the following formula.

$$\text{GPA} = \frac{\sum(n \times \text{GPV})}{\sum n}$$

Example: (refer regulation 12)

$$\text{GPA} = \frac{3 \times 3.00 + 2 \times 2.30 + 1 \times 3.70}{6} = 2.883 = 2.88$$

Licentiate Qualification

(for students who registered on or after 2015)

23. Option of Reverting to a 3 year Licentiate qualification

Any candidate who has completed at least three years of study for the Graduateship Programme and has offered

- (i) one zero credit course (regulation 6)
- (ii) seventeen courses at Level 1 & 2 (42 credits) (regulation 1)
- (iii) general chemistry and the three section A practical assessment courses at Level 2 and/ or 3 as per regulation 11.2.2 (7 credits) and
- (iv) courses adding up to a further 41 credits in Level 3 and/or 4. (regulation 11.3)

shall be eligible to be considered for the award of the **Licentiate Qualification in Chemistry** on the basis of the 90 credit courses offered if he opts to exit from the Graduateship Programme at the end of Level 3 or thereafter.

24. Award of a Licentiate Qualification in Chemistry for students exiting the Graduateship Programme at Level 3 or thereafter.

A candidate who is eligible to be considered for the award of Licentiate as per regulation 23 shall be deemed to have passed the Licentiate (3rd year) examination and qualified to become a Licentiate Chemist if he

- (i) passes in the zero credit course, **and**
- (ii) passes in the general chemistry and three section A Practical Assessment Papers, **and**
- (iii) obtains an overall weighted average of at least 2.00 amongst the best of the 90 credit courses offered by him as per regulation 23, **and**
- (iv) obtains at least C grades in at least 65 of the 90 courses offered including at least 15 from amongst the papers at levels 3 and/or 4

Supplication to obtain Licentiate in Chemistry Qualification and Award of Licentiateship Chemist Designation

25. Supplication

Any candidate who wishes to be considered for the award of the Licentiate in Chemistry Qualification as per regulation 23 & 24 or 25 & 26 or 27 or 28 should supplicate for same in the prescribed form not later than the end of November of each year or such other date that may be prescribed by the Academic Board during each year.

26. The Graduateship Board of Examiners shall determine before the end of December each year the list of students eligible to be awarded the Licentiate from amongst those who supplicate as per regulation 29.

27. **Licentiate**

A person who has been placed on the list of eligible Licentiate as per regulation 30 should obtain **Licentiate Membership*** of the Institute of Chemistry Ceylon and would then become eligible to be conferred the Licentiate Chemist Designation and Medal at a subsequent Convocation of the College after such list is confirmed by the Academic Board and on payment of the requisite supplication fee.

***Note:** An application for Licentiate Membership should be submitted.

28. **(A) Licentiate Chemists re-entering the Graduateship Programme**

Obtaining the licentiate chemist designation and exiting the Graduateship Programme (as per regulation 29) will however not prevent such a student from re-entering the Graduateship Programme, during the two academic years subsequent to the academic year in which he exited the programme. Nevertheless, the period permitted for such re-entry could be extended by the Academic Board on the recommendation of Board of Examiners at least two months prior to the commencement of academic activities in the relevant year.

In the event such a student re-enters the Graduateship Programme, such a student will be granted exemption from whatever papers he has already completed at the time of exiting the programme and any marks and grades earned by such student will be given full credit as he continues with the Graduateship Programme. However the provisions of regulation 21.2 pertaining to the number of attempts the candidate has appeared at examination for awarding an honours pass at the Graduateship Examination will apply.

Such a candidate shall however be required to surrender to the College Registrar the Licentiate Chemist Certificate & Medal he has previously awarded before he is awarded a subsequent higher qualification as per regulations 18. He shall not be entitled to the award of a higher qualification until and unless he surrenders the said Licentiate Chemist Certificate and Medal.

28. **(B) Licentiate Chemists reentering the Graduateship Programme by only sitting the Graduateship Examination**

Provision of regulation 31.(A) will mutatis mutinus, apply expect that the minimum two academic year period specified there in will not apply.

29. **Confirmation of Results**

All results, level wise and overall wise, shall be determined by the Board of Examiners at a duly constituted meeting but under all circumstances shall be subject to confirmation by the Academic Board. Information copies would be forwarded to the Council after the confirmation by the Academic Board.

Examination Regulations

30. Admission Card

- 30.1 An admission card based on the eligibility to sit for course unit examination shall be issued to the candidate by the SAR/AR of the Examination Division two weeks before the commencement of the relevant examination. Candidates shall be informed to bring their Student identity card and the admission card to the examination hall.
- 30.2 The course unit number and title of the question paper are printed in the admission card. During the examination period, the candidate and the invigilator shall sign the admission card for the relevant examination paper. At the end of the last examination paper, candidate shall handover the admission card to the Supervisor and the supervisor shall handover those admission cards to the SAR/AR (Examination).

31. Conduct of Candidates

- 31.1 Candidates shall,
- maintain the silence in the examination hall
 - bring the student identity card and the admission card to the examination hall
 - shall not write subject matter on the admission card
 - be at the examination hall at least 15 min. before the commencement of the examination, but not enter the examination hall until the supervisor requested to do so
 - bring pens, pencils, calculators, and other approved equipment. Examination stationary supplied shall be used for writing answers
 - not to keep any sort of document, notes, mobile phones, other electronic communication equipment or any other unauthorized equipment with him/her during the examination
 - write the index number of the candidate clearly in all papers used for answering the questions
 - not to write his/her name or any symbol of identification on the answering sheets
 - stop all work as soon as the supervisor announces to stop

- not to take away the papers used for rough work, from the examination hall
- promptly produce any document, object or any instrument which is with him/her, when the supervisor requests for it.
- handover his/her answer script at the end of the examination only to the supervisor or an invigilator
- carry out original research, write the dissertation according to the given format, clearly identify direct quotations from the published or unpublished work of others inside quotation marks and provide a full reference to their source in the proper form.
- After the defense of the dissertation, resubmit the amended bound version on or before the deadline given

32. Examination Offences

The Institute of Chemistry Ceylon expects and demands the highest degree of honesty and integrity from all candidates and some of the examination offences are listed below.

- Keeping unauthorized documents in one's possession
- Copying/Plagiarism
- Coming to the examination hall having written notes (relevant or irrelevant to the question paper) on palm or any other part of the body or on one's clothes or on the admission card/ identity card
- Improper behavior of disturbing the examination activities
- Arranging somebody else to sit the examination on one's behalf or sitting the examination on someone else's behalf
- Getting to know or trying to know the contents of a question paper through improper means
- Getting/trying to get answers for questions in the examination paper through improper means
- Encouraging, supporting or getting assistance to commit an examination irregularity
- Influencing the examiner or other examination officers improperly
- Not following or obeying the orders or instructions of the supervisor or disputing with the supervisor or the staff serving in the examination hall
- Taking mobile phones or any such unauthorized equipment in to the examination hall
- Taking the stationary belonging to the university out of the examination hall

- Submit assignments/ reports copied from another person

33. Inquiries on Malpractices at Examinations

- 33.1 All candidates shall abide by the regulations given in the Examination regulations. Candidates who disobey the regulations shall be penalized as instructed by the Academic Board of the Institute of Chemistry Ceylon. A specific form is provided to the supervisor to report malpractices to the SAR/AR, Examination division.
- 33.2 Once the Examinations irregularity is witnessed by the invigilator, it shall be reported to the supervisor immediately. Supervisor shall not take a statement from the candidate until the examination is over.
- 33.3 Soon after the examination, supervisor shall take statements from the invigilator, and the candidate. Supervisor's statement shall also be included. The duly filled form shall be handed over to the SAR/AR, Examination Division in a separate envelope, with the packet of answer scripts.
- 33.4 SAR/AR of the examination division shall report the above matter to the AB-IchemC. AB-IChemC shall appoint an Examination offence committee. Above committee consists of the Dean, Head of the Department, a senior academic who is not the supervisor or invigilator of the examination, appointed by the Academic Board-Institute of Chemistry and SAR/AR of the Examinations Division.
- 33.5 The committee shall carry out an investigation to see whether the allegation can be proved. Based on the observation following recommendations can be made.

Observation	Recommendation
Evidence are not sufficient to prove the allegation	Reject the allegation
Evidence are sufficient to prove the allegation	Recommend one of the following punishments based on the gravity of the examination offense. <ul style="list-style-type: none"> • Zero marks for that examination and request to sit as a repeat student next year for that course unit examination • Cancel his/her results of all the course units examinations in that semester • Not allowed to participate in the convocation

- 33.6 Observations and recommendations given by the committee shall be sent by the Examination offence committee to the AB-IChemC. Considering those observations and recommendations, final decision shall be taken by the Academic Board of the Institute of Chemistry Ceylon and the Dean shall inform it officially to the candidate.

Exit Points

- (i) Advanced Diploma (Recognition for Advanced Diploma in Chemistry by the Northumbria University, Newcastle on Tyne, UK and Truman State university)
- (ii) Licentiate Qualification

RSC Accreditation

The Royal Society of Chemistry, UK has accredited the GIC Programme in addition to accepting the Graduateship qualification for the membership. The grades of Fellow, Member and Associate have been recognized and accepted by the government of Sri Lanka as alternative qualifications to the parallel grades of Fellow (FRSC), Member (MRSC) and Associate (AMRSC) respectively of the Royal Society of Chemistry, UK for the purposes of recruitment and promotion of Chemists.

Royal Society of Chemistry (RSC), is the oldest chemical society in the world with membership of over 50,000 in the business of international publishing and knowledge. It is United Kingdom's professional body for the chemical scientists supporting and representing members and bringing together chemical scientists from all over the world. The Chemical Society of London which is the fore-runner to the RSC celebrated its 175th anniversary in 2016. RSC was formed by joining together four societies: Chemical Society, Society of Analytical Chemistry, Royal Institute of Chemistry and Faraday's Society. RSC publishes 43 peer reviewed journals, books, collection of a live data base and literature.

Recognition for post-graduate degrees

A pass in Graduateship Examination conducted by the Institute has also been recognized and accepted by the Government of Sri Lanka as an alternate qualification to a Degree in Sciences with Chemistry as a subject awarded by a recognized University. (Vide Public Administration Circular No. 334 of 17.07.86)

Currently Graduate Chemists from the GIC programme are employed as Chemists in private sector and some semi-government organizations.

Over 300 Graduate Chemists have obtained Postgraduate Degrees (MSc, MPhil and PhD) from universities in Sri Lanka and foreign countries such as USA, UK, Canada and Australia. Many of those who have received PhD from foreign countries are employed overseas.

IChemC graduates are recruited by the Chemistry Departments of State Universities and other tertiary education institutes in Sri Lanka and abroad. It has achieved this recognition through the commitment of the Institute of Chemistry to offer and deliver quality educational program in Chemistry and revise and improve core and extracurricular activities through its educational arm, the College of Chemical Sciences.

Financial Assistance, Awards and Scholarships

Financial Assistance and Scholarships

Entrance Scholarships & Merit Bursaries at Level 1

The College holds a special Entrance Scholarships Test for all newly registered students for the purpose of selecting recipients for two Entrance Scholarships, several other Entrance Merit Bursaries and CCS Bursaries.

Scholarships/Merit awards are given entirely on merit irrespective of financial need. The Two Entrance Scholarships are presented using fund donated by the Chemical Industries of Colombo Ltd and the Sudath Kumarasinghe Commemoration Fund. The Scholarships are tenable for a two year period (Levels 1 & 2) and cover the registration, tuition and examination fees in full. ENTRANCE MERIT BURSARIES are given annually to those placed third and beyond (actual number will vary from year to year depending on the performance) and will cover the Level 1/2 examination fee in full or in part, depending on the performance.

Two CCS Bursaries are also now awarded based on merit and financial need and will cover all the expenses in the first year. However, the continuation of the scholarships & merit bursaries for the second year will be possible only if the Entrance scholars perform reasonably well (overall) at the Level 1 examination that is held during of the first year of study.

Level 1

- (a) Charles Jayaweera Memorial Scholarship
- (b) Nandawathie Jayaweera Memorial Scholarship
The above two scholarships were set up in 1991/ 92 by Dr S Amara A Jayaweera (then Principal Lecturer in Chemistry at the Teeside University, Middlesbro, UK) in memory of his parents through an initial donation of Rs. 61,258.
- (c) Professor R S Ramakrishna Memorial Scholarship set up by the College of Chemical Sciences.
- (d) Dr. Dilanjan & Ms. Gowri Soysa Scholarship setup in 2010 through a donation of Rs. 100,000 by Ms. P L A Soysa.
- (e) Second Charles Jayaweera (Southern Province) Memorial Scholarship
- (f) Second Nandawathie Jayaweera (Southern Province) Memorial Scholarship
The above two scholarships were established in 1996 by Dr S Amara A. Jayaweera, (then Principal Lecturer in Chemistry, Teeside University UK) in memory of his parents through an initial donation of Rs 70,000.

Level 2

- (a) W F Peiris Memorial Scholarship
The W F Peiris Memorial Scholarship Trust Fund was set up in May 1986 by

Professor (Mrs) Pearlyn Pereira in memory of her father to assist Graduateship students with good academic records. The Trust Fund originated with Rs 50,000/- donated by Prof. Pereira and the interest has been used since 1987 to award scholarships to graduateship students

- (b) Prof (Mrs) Pearlyn Pereira Commemoration Scholarship
The Prof (Mrs) Pearlyn Pereira Commemoration Scholarship Trust Fund was set up in March 1989 by the Council of the Institute of Chemistry Ceylon in memory of Professor (Mrs) Pearlyn Pereira (Professor of Physical Chemistry of the University of Colombo & Past President of the Institute, 1986/87). Donations amounting to over Rs 50,000 were received from friends, well-wishers, colleagues and students of Prof (Mrs) Pereira.
- (c) Dr G C N Jayasuriya Memorial Scholarship
The Dr G C N Jayasuriya Memorial Scholarship Trust Fund was set up in July 1992 by the Council of the Institute of Chemistry, Ceylon in memory of Dr. G C N Jayasuriya (formerly Dean/ Science, Vidyodaya University, Secretary- General of the National Science Council of Sri Lanka. Director of the Ruhuna University College. Director / MST of the Open University of Sri Lanka & Director General of NARA and Past President, Chemical Society of Ceylon, 1969) Donations were received from members of the family (including his daughter, Ms Kumari Jayasuriya) friends, well - wishers, colleagues and students of Dr.Jayasuriya.
- (d) Family Leelaratne Scholarship
The above scholarship was set up in the year 2007 through an initial donation of Rs. 100,000 by Mr. H Don Lalith Leelaratne, Graduate Chemist (1992), who is presently in Australia to award a scholarship annually to a student entering Level 3.

Level 4

- (a) Mandrupa & Oleap Fernando Hall Opening Scholarship
The above scholarship was set up in the year 2005 through a donation of Rs. 100,000 made by Professor J N Oleap Fernando (then Dean, College of Chemical Sciences & then Senior Professor of Chemistry, Open University of Sri Lanka & Past President of the Institute of Chemistry Ceylon, 1984 – 1986) and his wife Mrs Mandrupa Fernando in appreciation of the Council decision to name the Lecture Hall at Level 3 of Adamantane House as the J N O Fernando Hall.
- (b) Susila Jayaweera Memorial Scholarship
The above scholarship was set up in the year 2005 through a donation of GBP 600 (Rs. 106,656) made by Dr S Amara A Jayaweera in memory of his wife Mrs Susila Jayaweera, BSc (Peradeniya).
- (c) Graduate Silver Jubilee Scholarship

This scholarship was created by the College of Chemical Sciences in 2004 out of the funds lying to the credit of the Graduateship Silver Jubilee Commemoration fund and at present stands at about Rs 9,963,563/-. The fund also includes funds collected from the Graduateship Silver Jubilee (25th Batch passing out) Fund in 2007/08.

(d) Institute of Chemistry President's Scholarship

This scholarship of an initial value of Rs. 30,000/- was created in 2011 by the Council (on the recommendation of Prof. M D P De Costa, President 2010/2011) to be awarded annually in Level 4 for the best overall performance in theory courses in the first three levels of study subject to the attainment of a minimum overall GPA of 3.50.

Eligibility for Graduateship Scholarships

The above-mentioned scholarships are awarded to Graduateship students on the basis of outstanding performance at their first attempt in respect of examinations held at each of the Levels 1, 2 & 3.

Entitlement of Graduateship Scholars & Award of Bursaries

The bulk of the income received from the investment of these endowed funds are however given in the form of appropriately named Bursaries. The Bursary holders will be selected by a Selection Committee from amongst students who have performed reasonably well at each of the various level examinations and are in financial need as judged by the Selection Committee usually made up from the internal academic staff. When a Scholar is selected as a bursary holder, he will be entitled to hold both the scholarship and the Bursary with the identical name. The Institute Bursary Fund is used to supplement the values of some of the named bursaries, which do not yield the required income for the purpose.

DLTC Prize Awards

Students who perform well at the Institute's Diploma in Laboratory Technology Programme Examination held every year are given Prizes which entitle them to a discount ranging from 50% of tuition fees to follow Levels 1 & 2 of the Graduateship Programmes. Those obtaining Honours passes are given CCS Scholarships covering the entirety of the tuition & examination fees for levels 1 & 2 with effect from 2009.

Graduateship Bursary Fund

The College credits 2 1/2% of all registration fees collected from students to the Graduateship Bursary Fund; the interest from this fund is used to award additional bursaries to academically good students in financial need.

Graduate Chemists' Welfare Fund

This fund has been set up by Council in 2011 with part of the Convocation Fund balance lying to the credit of the College in order to give benefits to Graduate Chemists going abroad for PG Studies etc. 2 ½% of all registration fees collected from incoming graduateship students will also be credited towards this fund.

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.

All donations qualify for income tax relief in accordance with the Inland Revenue Act since the Institute is an approved charity. Donations are solicited for the award of more Scholarships & Bursaries.

GIC Sports Scholarships

1. The awardee of the sports scholarship will be admitted to the Graduateship programme in chemistry (GIC) conducted by the College of Chemical sciences (CCS).
2. Awardee is required to pay the registration fee and the refundable deposit for in the particular year (Early bird All levels one-time payment) prior to the commencement of the course. Furthermore the relevant examination fee should be paid each semester.
3. The tuition fee for both theory and practical courses for all four years are waived and covered by the scholarship.
4. The prospective student should attend practices organized by the CCS team, for the respective sport with over 80% attendance.
5. The prospective student should be present for all the practice matches and tournament matches played by the CCS team of the particular sport, as well as the required amount of physical and gym training.
6. An exception can be considered by the academic board of CCS, if by any chance, the sports Scholarship awardee is unable to attend practices or matches, due to any health condition. On such matters evidence should be provided within a week of the missed sporting event.
7. The awardee should always maintain the sportsmanship and discipline throughout the practice sessions and matches. The suspensions and disciplinary actions during matches and practices should be minimized as much as possible.
8. Awardee must attempt all the compulsory courses offered every semester and maintain a GPA of 2.0. The awardee is not allowed to avoid or miss any examination offered in a particular semester for compulsory courses.
9. The awardee must sit for the entrance scholarship examination.
10. If the sports scholarship awardee is eligible for the entrance scholarship, the awardee is

given the choice to decide on which of the awards he or she will be accepting. The final decision should be given within two weeks after receiving the final scholarship.

11. In any case if the sports scholarship awardee receives the J N O Fernando level 1 or level 2 scholarships, no additional benefit will be granted as the as the tuition fees are already covered in the sports scholarship. However, the scholarship awardee designation for the particular year will be given along with the particular certificate.
12. The sports scholarship awardees are entitled to overall Graduateship best performance awards, medals and subject prizes received.
13. At the end of each semester when the results are released, the awardee should submit a progress report including both academic and extra-curricular activities to the Dean of the CCS.
14. If the GPA criteria is violated at a particular semester, the awardee will be given a probation period of one semester where the awardee is required to achieve an overall GPA of 2.0.
15. If any other regulations are violated by the student the scholarship will be invalid and the refundable deposit will be deducted as a penalty.
16. If the scholarship is terminated during the four years of the GIC programme, the candidate may continue as a regular student by paying the balance course fee. The course free for the year of enrolment will be applied.

Graduateship Scholarships/ Bursaries

Chemical Industries Ltd. & Dr. Sudath Kumarasinghe Entrance Scholarships, College of Chemical Sciences (CCS) Bursaries and other Merit Bursaries

Entrance Scholarships are offered to at least two students enrolling for level 1, and about 8-10 merit bursaries will also be given by the college to students performing reasonably well in the Entrance Scholarship Examination.

Dr. & Mrs. Senthe Shanmuganathan Family Bursary for Accommodation

Scholarships and Merit Bursaries are solely given on merit. However, the needy bursaries are given on reasonable merit but coupled essentially to financial need.

Level 1 Examination

Nandawathie Jayaweera (Open) Memorial Scholarship/Bursary

Mr. N M H N Thilakarathne (2015) Mr. P L Y V Alwis (2016)

Ms. N D Lokuge (2017)

Charles Jayaweera (Open) Memorial Scholarship/Bursary

Ms. M. A. F. Mushrifa (2015) Ms. U. P. Welikala (2016)

Ms. S M V S K Samarakoon (2017)

Professor R S Ramakrishna Memorial Scholarship/Bursary

Mr. H. M. O. K. Herath (2015) Ms. C. J. Lekamwasam (2016)

Ms. H N Disanayaka (2017)

Dr. Dilanjan & Mrs. Gowrie Soysa Scholarship/Bursary

Mr. M. R. A. Basith (2015) Mr. M. A. Udayanga (2016)

Ms. G G V V Gamage (2017)

Second Charles Jayaweera (SP) Memorial Scholarship/Bursary and Second Nandawathie Jayaweera Memorial Scholarship/Bursary (Only to students resident and or from a school in the Southern Province)

Ms. B G M S W Abeykoon (2016) Ms. N D Lokuge & Mr. P H L Sandaruwan (2017)

CCS Bursaries (On merit)

(2015)

Ms. I. L. Hettige, Mr. R. D. U. S. Deshapriya, Ms. K. K. A. S. Jayathilaka, Ms. J. A. S. Gayara, Ms. W. S. S. Perera, Mr. M. J. M. Afnan

(2016)

Mr. P A Sumathipala, Ms. B G M S W Abeykoon, Ms. P G H Pupulewatte, Ms. A N Wethalawe, Ms. R A H M A N Herath, Ms. M N Premanath, Ms. H K Medagedara, Ms. W G H Yasara, Ms. G A C D Perera, Mr. E A D N Madujith

(2017) not awarded

Level 2 Examination

W F Peiris Memorial Trust Scholarship/Bursary

Ms. M A F Mushrifā (2016)

Ms. C J Lekamwasam (2017)

Professor Pearlyn Pereira Commemoration Scholarship/Bursary

Mr. N M H N Thilakaratne (2016)

Mr. P L Y V Alwis (2017)

Dr. G C N Jayasuriya Commemoration Scholarship/Bursary

Ms. I L Hettige (2016)

Ms. U P Welikala (2017)

Family Leelarathne Scholarship/Bursary

Ms. W R P Somarathne (2016)

Ms. A N Wethalawe (2017)

CCS Merit Busaries (on merit)

(2016)

Ms. U V de S Jayasekara, Ms. K D N Rathnaweera, Mr. M J M Afnan, Ms. J A S Gayara

(2017)

Ms. F J Saneer, Ms. P G H Pupulewatte, Ms. H K Medagedara, Ms. G A C D Perera

Level 3 Examination

Mandrupa and Oleap Fernando Hall Opening Scholarship/Bursary

Ms. M A F Mushrifā (2017)

Susila Jayaweera Memorial Scholarship/Bursary

Ms. W H K Perera (2017)

Graduateship Silver Jubilee Scholarship/Bursary

Mr. N M H N Thilakaratne (2017)

CCS Merit Busaries (on merit)

(2017)

Ms. I L Hettige, Ms. J A S Gayara, Mr. M J M Afnan, Ms. B D Perera, Mr. R D U S Deshapriya,

Ms. W S S Perera, Ms. W R P Somarathne, Ms. W G B K K G Gunawardana, Ms. K D N

Rathnaweera, Ms. F N Iqbal, Ms. U V De S Jayasekera, Ms. M M F Mubeena

Levels 1,2 and 3 Examination

IChemC President's Scholarship for Best Performance at Levels 1,2 and 3

Ms. M A F Mushrifā (2017)

Awards and Prizes

Medals and Subject Prizes at Examinations

Level 1

Graduate Chemists Alumni Prize for General & Inorganic Chemistry

Mr. N M H N Thilakarathne (2015) Mr. P. L. Y. V. Alwis (2016)

Ms. J A D I Ranasinghe (2017)

Emerine Fernando Memorial Prize for Principles of Physical Chemistry

Mr. N M H N Thilakarathne & Mr. M S D Fernando (2015)

Ms. C. J. Lekamwasam & Mr. M. A. Udayanga (2016) Ms. L P L Jayasinghe (2017)

Prof. & Mrs. S Sotheeswaran Prize for Principles of Organic Chemistry

Ms. L. L. J. De Silva (2015) Mr. P. L. Y. V. Alwis (2016)

Ms. N D Lokuge (2017)

Bennett and Wimalin Prize for Mathematics for Biological Science Students

Ms. I L Hettige (2015) Mr. H. K. P. Lakshitha (2016)

Ms. M A S I Kularathne (2017)

Somawathie Mathew Memorial Prize for Biology for Physical Science Students

Ms. K K A Jayathilake (2015) Ms. D. H. Thanippuliarachchi (2016)

Ms. Y H Ranasinghe (2017)

Mr. & Mrs. J M Ranasinghe Banda Prize for Applications of Mathematics

Mr. H. M. O. K. Herath (2015) Ms. A N Wethalawe (2016)

Ms. N D Lokuge (2017)

Dr. M N Kaumal Prize for Analogue and Digital Electronics for Chemists

Mr. R D U S Deshappriya (2015) Ms. U. P. Welikala (2016)

Mr. B G C Chathuprabha (2017)

Abdul Salam Memorial Prize for Fundamentals of Physics for Chemists

Mr. M. S. V. Costa (2015) Mr. P. L. Y. V. Alwis (2016)

Ms. N D Lokuge (2017)

Dr. Infas and Family Prize for Basic Concepts

Ms. M A F Mushrifa (2015) Mr. B G C Chathuprabha (2017)

Ms. M. N. Premanath, Ms. D. H. Thanippuliarachchi & Mr. P. L. Y. V. Alwis (2016)

Level 2

Professor J N Oleap Fernando Prize for Physical Chemistry

Ms. M A F Mushrifa (2016) Ms. C J Lekamwasam (2017)

Professor Samitha P Deraniyagala Prize for Inorganic Chemistry

Ms. M A F Mushrifa (2016) Mr. P L Y V Alwis (2017)

Professor Siromi Samarasinghe Prize for Organic Chemistry I

Mr. N M H N Thilakaratne (2016) Ms. C J Lekamwasam (2017)

Mrs. Deepika Seneviratne and Family Prize for Titrimetric and Gravimetric Methods of Analysis

Ms. M A F Mushrifa (2016) Mr. P L Y V Alwis (2017)

Professor Jayantha Welihinda Prize for Biochemistry

Ms. M A F Mushrifa (2016) Ms. F J Saneer (2017)

Henry Ashmore Pieris Memorial Prize for Introduction to Management, Economics and Finance

Ms. M A F Mushrifa & Mr. N M H N Thilakaratne (2016) Ms. C J Lekamwasam (2017)

Nureshan Dias for Principles of Quantum Chemistry and Molecular Spectroscopy

Mr. M J M Afnan (2016) Ms. H K Medagedara & Ms. J K S Jayawardena (2017)

Mrs. Yasawathie Satharasinghe Memorial Prize for Organic Chemistry II

Ms. W R P Somarathne (2016) Ms. C J Lekamwasam (2017)

Mikhail Tswett Prize for Separation methods and Applications of Spectroscopic Methods in Analysis

Ms. M A F Mushrifa (2016) Mr. M S V Costa (2017)

Convocation Awards at Levels 3 & 4

W R O Fernando Memorial Prize for Energetics and Kinetics

Ms. K. M. Wijesinghe (2017) Mr. D. Manawadu (2016)

Professor P P G L Siriwardene Memorial Prize for Further Topics in Inorganic Chemistry

Ms. K. M. Wijesinghe (2017) Ms. A. A. S. V. Fernando (2016)

Dr. Sudath Kumarasinghe Memorial Prize for Special Topics in Physical Chemistry

Ms. Ms. L. N. Dayarathne (2017) Ms. K. H. D. Perera (2016)

Dharmachandra & Thamarasa Gunawardhana Memorial Prize for Selected Topics in Analytical Chemistry

Ms. U. K. M. Bopitiya & Ms. A. A. S. V. Fernando (2016) Ms. K Chandrakanthan (2017)

E R Eratne Memorial Prize for Cosmetic Science

Ms. A. A. S. V. Fernando (2016)

Ms. Careen Manel Abeywardene Memorial Prize for Natural Product Chemistry

Ms. K Chandrakanthan (2017)

Mr. & Mrs. H G Dias Memorial Prize for Electrochemical Technology

Ms. Ms. L. N. Dayarathne (2017)

Institute of Chemistry Ceylon Alumni Association North American Chapter Prize for Further Topics in Physical Chemistry

Ms. H. R. Atapattu (2016) Ms. W A K Gunarathne (2017)

Mr. P Rohan K Fernando Prize for Industrial Safety and Environmental Technology

Mr. W R C N Silva (2016)

Dharmarathne Wasala Prize for Computational Chemistry

Ms. K Chandrakanthan (2017)

Dr. S Lakshman De Silva Memorial Trust Prize for Physical Organic Chemistry

Ms. U. K. M. Bopitiya (2016)

Ms. K. M. Wijesinghe (2017)

Vidyajothi H R Premaratne Prize for Particle Physics

Ms. P S Ishtaweera (2017)

Mr. & Mrs. N I N S Nadarasa Prize for Advanced Topics in Organic Chemistry

Mr. D. Manawadu (2016)

Ms. M K B K Perera (2017)

Mevan Pieris Prize for Polymer Chemistry & Technology

Ms. K. H. D. Perera (2016)

Ms. K Chandrakanthan (2017)

Dr. Lakshman Ponnampereuma Memorial Prize for Special Topics in Inorganic Chemistry

Ms. U. K. M. Bopitiya (2016)

Ms. P S Ishtaweera (2017)

E G Somapala Prize for Food Chemistry & Technology

Ms. K. H. D. Perera (2016)

Ms. K Chandrakanthan (2017)

Mr & Mrs Suppaih & Seethadevi Prize for Analytical Industrial Biochemistry

Ms. K G Rajawasam (2017)

Lakshmi Award for Chemistry of Gem Minerals & Synthetic Gem Minerals

Ms. K Chandrakanthan (2017)

Susila Jayaweera Memorial Prize for Advanced Biochemistry

Ms. K M K G Perera (2017)

Denzil & Christobel Fernando Commemoration Prize for Agro Industries

Ms. D V C D Madushani (2016)

Mr. Cyril Suduwela Prize for Petroleum & Petrochemicals

Ms. K N M L N Kosgahakumbura (2017)

Piyadasa & Kalyanawathi De Silva Memorial Prize for Quality Management

Ms. K N M L N Kosgahakumbura (2017)

Mr. & Mrs. H S Dias Memorial Prize for Green Chemistry & Sustainable Technology

Ms. A. A. S. V. Fernando (2016)

A P De Silva Prize for Chemical Education

Ms. M T Fernando (2017)

Marina & R O B Wijesekara Prize for Molecular Biology & Biotechnology

Ms. D G A T Dassanayake (2016)

Mr. & Mrs. E Gajanayake Prize for Atomic Spectroscopic Methods of Analysis

Ms. U. K. M. Bopitiya (2016)

Vasanthan & Menaka Prize for Further Management, Economics & Marketing

Ms. A. A. S. V. Fernando (2016)

Professor Eugene De Silva Prize for Industrial Chemistry & Technology

Ms. U K M Bopitiya (2016)

Microchem Laboratories (Pvt) Ltd Prize for Environmental Chemistry

Ms. M S De A Goonatilleke (2016)

Professor Paul & Runy Prize for Fundamentals of Chemical Process Engineering

Ms. U K M Bopitiya (2016)

Ms. C T R Silva (2017)

Pincock Prize for Photochemistry

Mr. D C A Perera (2016)

Ms. K Chandrakanthan (2017)

Deepa Sotheeswaran Gaschik Prize for Agro Chemicals

Ms. A. A. S. V. Fernando (2016)

Ms. K Chandrakanthan (2017)

K G Karunasena Memorial Prize for Quantum Mechanics

Mr. D. Manawadu (2016)

Ms. K Chandrakanthan (2017)

Mr. A M Jayasekara & Mrs. Kusum Aththanayaka Family Prize for Separation Sciences

Ms. M. S. D. A. Goonathilake (2016)

Dr. and Mrs. Swaminathan Memorial Prize for Information Technology for Chemists

Mr. R. A. D. Y. R. Ranathunga & Ms. C T R Silva (2017)

Dr. Premaratne and Family Prize for Nanotechnology

Mr. W. C. S. Munindradasa (2017)

Dr. L Arambawela Prize for Research Project beneficial for the country

Ms. U K M Bopitiya & Ms. D V C D Madushani (2016)

Ms. R Y Madurawala (2017)

N M S Hettigedara Family Prize for Pharmaceutical & Medicinal Chemistry

Dr. Rohan Perera Prize for Chemical & Molecular Toxicology

Practical Chemistry

Professor R S Ramakrishna Memorial Award

Ms. N Gunawardhana (2016)

Ms. P S Ishtaweera (2017)

Mr. & Mrs. K Sivrajah & Family Award

Ms. H R Atapattu (2016)

Ms. N C Paranamana (2017)

B A Jayasinghe Memorial Award

Ms. U K M Bopitiya (2016)

Ms. L N Dayaratne, Ms. W A K Gunarathne, Ms. K Chandrakanthan (2017)

College of Chemical Sciences Award

Mr. A M C C S Bandara (2016)

Ms. K A S S Kuruppu, Ms. V S Samarasiri, Mr. D V H Dharmakeerthi, Mr. J A L I Sampath,

Mr. M S A Latheef (2017)

Level 3 and 4 Overall (Theory) Awards

Royal Society of Chemistry (Sri Lanka Section) Award

Ms. M. S. D. A. Goonathilake (2016)

Ms. K. Chandrakanthan (2017)

Professor and Mrs. H. W. Dias Award

Mr. D Manawadu (2016)

Ms. C T R Silva (2017)

Sasanthika Nayomi Jayathissa Memorial Prize

Ms. U K M Bopitiya (2016)

Ms. P S Ishtaweera (2017)

Awards for Overall Excellence in Principal Areas in all Levels of Study (Theory)

Professor J K P Ariyaratne Memorial Award for Overall Excellence in Inorganic Chemistry

Ms. U K M Bopitiya (2016)

Ms. L N Dayaratne (2017)

Professor Leslie Gunathilake Award for Overall Excellence in Organic Chemistry

Ms. U K M Bopitiya (2016)

Ms. K Chandrakanthan (2017)

Haniffa Award for Overall Excellence in Physical Chemistry

Ms. U K M Bopitiya (2016)

Ms. L N Dayaratne (2017)

Professors Saman & Asoka Pathirathna Award for Overall Excellence in Analytical Chemistry

Ms. U K M Bopitiya (2016)

Ms. P S Ishtaweera (2017)

Graduateship All Rounder Awards

Dr. R O B Wijesekara Felicitation Award for the Best All Rounder

Ms. U K M Bopitiya (2016)

Ms. L N Dayaratne (2017)

Prof. Noel G Baptist Memorial Prize for the Second Best All Rounder

Mr. D R H Saparamadu & Ms. A A S V Fernando (2016)

Ms. R Y Madurawala (2017)

Chamikara Wijesinghe Award for the Third Best All Rounder

Mr. T A Gamagedara (2016)

Mr. R A D Y R Ranathunga (2017)

Overall Graduateship Examination (Only for First Class Awardees)

Best Performance: Shireen Jayasuriya Gold Medal

Ms. U K M Bopitiya (2016)

Ms. K Chandrakanthan (2017)

Second Best Performance: Graduateship Programme (Silver Jubilee) Commemoration Prize

Ms. A A S V Fernando (2016)

Ms. P S Ishtaweera (2017)

Third Best Performance: Graduateship (25th Batch passing out) Silver Jubilee Prize

Ms. H R Atapattu & Mr. D Manawadu (2016)

Ms. L N Dayaratne (2017)

Use of Services

Adamantane House

The Adamantane House is the main building that is utilized by the Institute of Chemistry Ceylon for administration and academic purposes.

The facilities available at Adamantane House are;

- Office space and floor space to be used for administrative purposes
- Auditorium
- Lecture halls, rooms for tutorials
- Laboratories
- Library
- Cafeteria

Physical Resources for Administration

The main office of the Institute of Chemistry Ceylon is situated in the ground floor of the Adamantane House where administration and day to day activities are carried out. Accounts Division where financial transactions related to professional and educational activities are carried out is in the main office.

The Conference Room where all the formal meetings, interviews, etc. are held is found on the second floor.

The Confidential Room where the processing of confidential data pertaining to examination results is performed is also found on the second floor. It is the room in the new extension adjacent to the Conference Room.

Auditorium

The 'P. P. G. L. Siriwardena Auditorium' is situated on the fourth floor of the Adamantane House. At present it is used for conducting workshops, seminars and popular lectures organized by the Institute of Chemistry Ceylon and the College of Chemical Sciences. It is also used as a lecture hall for the GIC programme and other activities such as religious and social events.

Physical Resources for Academic Activities

The lecture halls and the laboratories used for the academic activities by the Institute of Chemistry Ceylon are housed in the Adamantane House. The lecture halls including the Auditorium are utilized for the purposes of conducting formal lectures, tutorials, group discussions, seminars and workshops organized by the Institute of Chemistry and the College of Chemical Sciences.

Lecture Halls

Five lecture halls and the auditorium which are housed in the Adamantane House are as follows (Table 4.1);

Table 4.1: Lecture Halls

Floor	Name of the Lecture Hall	Seating Capacity
3	Lecture Hall 1 (J. N. O. Fernando Hall)	80
4	Lecture Hall 2 (R. O. B. Wijesekara Hall)	100
4	Lecture Hall 3 (P. P. G. L. Siriwardene Auditorium)	180
4	Lecture Hall 4	120
5	Lecture Hall 5	80

Facilities in the Lecture Halls

Academics are encouraged to perform the educational activities at the Institute of Chemistry Ceylon by utilizing modern audio-visual lecture aids so that the best quality of communication is maintained. Lectures are supported by handouts, presentations and demonstrations.

Fixed multimedia, projectors (both overhead as well as mobile) and enhanced audio systems are used in all lectures. Overhead projectors and screens are available in all the lecture halls. Fixed enhanced audio facilities are available only in the large lecture halls, but mobile audio enhancement is available to be used in the other lecture halls whenever the need arises.

Apart from these the traditional black boards and white boards are available as an integral component of all the lecture halls.

Laboratories

Two teaching laboratories, a research laboratory and an 'Instrument Center' as well as a 'Computer and Information Technology Center' are available to the students, research assistants and the academics for teaching and research (Table 4.2). The laboratories are equipped with the standard safety measures such as fume hoods, fire extinguishers (as well as dry chemical powder) and eye washes.

Laboratory classes for students from outside the Institute (e.g. Biomedical Course of Northumbria University) and workshops are also carried out.

Table 4.2: Laboratories

Level	Usage	Laboratory
Level 2	Teaching	Laboratory 1: Ramakrishna Laboratory Laboratory 2: ER Jansz Laboratory
	Research	Laboratory 3: Sultanbawa Laboratory
Level 3	Research and Teaching	Laboratory 4: HD Gunawardhana Instrument Center
Level 3		Laboratory 5: Biochemistry and Microbiology Laboratory

Ramakrishna Laboratory (Laboratory 1) and ER Jansz Laboratory (Laboratory 2)

Ramakrishna Laboratory and ER Jansz Laboratory are used by the recent students of GIC and DLTC programmes for the laboratory courses.

Sultanbawa Laboratory (Laboratory 3)

The Laboratory 3 was used for conducting laboratory classes for the GIC and DLTC programmes until 2014. With the construction of the Laboratory 2 in the new wing the Laboratory 3 was transformed into a fulltime research laboratory. It is utilized for the conducting of bench work related to research projects by both undergraduate students as well as post-graduate students (MPhil. and PhD).

Laminar flow cabinet and a chemical reactor are housed in this laboratory in addition to all the other common facilities and equipment required for the conducting of benchwork.

Extension to the Laboratory 3 is air conditioned and used for research as most of the equipment including 'Electrochemical Station' are housed in this laboratory.

Gunawardhana Instrumental Center (Laboratory 4)

The exposure of students to the use of high- tech instruments is a key component of the education system at the Institute of Chemistry Ceylon and to achieve this, the 'H. D. Gunawardhana Instrumental Center' which is also air conditioned is continuously upgraded with new equipment.

At the 'H. D. Gunawardhana Instrument Center' there is a UV - visible Spectrophotometer, Fluorescence Spectrophotometer, Fourier Transform Infrared (FTIR) Spectrophotometer, Atomic Absorption Spectrophotometer (AAS) and a Gas Chromatogram (GC). These instruments are used for research purposes, laboratory classes involving Analytical Chemistry and analytical services for industries and research institutes.

Computational Research and Learning Centre (CRLC)

Computational Research and Learning Centre located on the fifth floor of the new wing and the air conditioned Lecture Hall 5 is utilized for providing the students with the necessary

exposure to Information Technology that is required by a chemist in the 21st century.

There are high performance computers for the Computational Chemistry research, one of which is in this center in addition to the laptops available in the Computational Research Laboratory in Level 5.

CRLC provides technical assistance for students in writing dissertations or thesis and is used by both postgraduate research students and GIC students.

Some courses conducted in the center are laboratory classes for Computational Chemistry, Information Technology for Chemists, and some laboratory courses in Physical Chemistry that involves computational and theoretical experiments. At present the air conditioned lecture hall adjoined to CRLC in Level 5 is used for laboratory classes for the Information and Technology for Chemist course.

Lecturers' Rooms

In the 'Adamantane House' there are eight rooms for the lecturers including one for the Rector and one for the Dean. These rooms are found in the 1st, 2nd, 3rd and 4th floor of the building. In addition there are three rooms in the building of the College of Surgeons that are used by the lecturers.

Clodagh Nethsinghe Library

The library of the Institute of Chemistry named as Clodagh Nethsinghe Library is located in the first floor.

The library of IChemC came into the existence in 1981 as a small reading room in the library of the Ceylon Institute of Scientific and Industrial Research (CISIR) now known as Industrial Technology Institute (ITI) with few books donated by the Overseas Development Administration (ODA). At that time the library area was supervised by the Ms. Clodagh Nethasinghe who was the librarian at CISIR. The library was finally shifted to its current location with the opening of the Adamantane House in 2005 after passing through several transformations and changes in venue. The fully air conditioned library was named after the late Ms. Clodagh Nethsinghe, the librarian of the Industrial Technology Institute (ITI) in recognition of the leading role she played to develop the library of the Institute of Chemistry Ceylon to its current status as well as being the first Chairperson of the Library Committee.

Today, the library has developed resources, services and infrastructure facilities including electronic media to render efficient services to the staff and students. In 2015, the library was automated using 'Koha Library Management System.' This enables accessing bibliographical data of the reading material in the library through an online catalogue.

Email address: ichemclibrary@gmail.com or library-ichemc@yahoo.com

The Library is managed by the Librarian (Mrs. I. Hendavitharane), Deputy Librarian (Mr. N. M. Waidyasuriya) and Assistant Librarian (Mr. N Mahindasiri).

Management

The Library committee which is a sub-committee of the Academic Board manages the functions of the library. The library is under the leadership of the librarian and supported by several non-academic staff. The finances of the library are controlled by the Academic Board Finance Committee.

Facilities and Services

The library is open on all seven days of the week. If the library is to be closed, prior notice will be given.

The opening hours of the library are given in Table 4.4.

The library caters to all information needed by the students, academic staff, non-academic staff and members of the Institute of Chemistry Ceylon. The collection of books in the library covers areas related to chemistry ranging from those required by undergraduates to those for professional development. At its current state the library has a seating capacity of 80.

Table 4.4: Library Hours

Days	Opening Hours	Lending and Borrowing Books
Monday, Tuesday	8.00 am - 5.00 pm	8.00 am - 4.30 pm
Wednesday to Sunday	8.00 am - 6.00 pm	8.00 am - 5.00 pm

During semester examination period library is opened for extended hours.

Bar coded membership cards are given to all members on enrollment and this enables them to interact with the circulation counter with greater speed and efficiency.

With the start of automated library transaction from 1st August 2015, the library stopped the issue of the conventional cards system. Recently the bar coded membership cards were merged with the Student Identity Cards that are given to all students on enrollment for the educational programmes at the Institute of Chemistry Ceylon. The resources available for lending and borrowing are available online. Past question papers of the GIC and DLTC programmes from 2006 are available in digitized form and the students could obtain photocopies of these from the library.

Resources Available

The following resources are available in the library;

- Books: More than 7000 books covering text books in subjects such as Chemistry, Biochemistry, Biology, Mathematics, Physics, Management, Industrial Application of the Chemical Sciences, Dictionaries, Encyclopedia, Glossaries, and Monographs.
- 10 periodicals that are obtained free of charge.

- Seven computers. 4 Computers are for the use of the students with Wi-Fi and Internet facilities
- Monographs and other publications of the Institute of Chemistry.
- Dissertation submitted by the research students of the GIC programme.
- Reports of seminars and workshops conducted by the Institute of Chemistry Ceylon and College of Chemical Sciences
- Photocopying services and spiral binding are offered to students at a discounted rate.
- Chemistry In Sri Lanka published by the Institute of Chemistry Ceylon and the News Letter published by the College of Chemical Sciences.
- Proceedings or reports on both international and local seminars and workshops conducted by the Institute of Chemistry and College of Chemical Sciences
- Annual reports and other resources pertaining to IChemC and College of Chemical Sciences
- Daily newspapers.

Rules Governing the Usage of Library

Rules governing borrowing of books are as follows;

- Registered members have to keep a security refundable deposit before registration in order to borrow books and other materials.
- Students having a library membership are allowed to borrow books from the lending section for a period of two weeks. They are also permitted to borrow books from the reference section for a period of 24 hours only.
- Academic staff and IChemC members are allowed to borrow books for a period of one month.
- During the orientation period the students are guided towards the usage of the library and are also given a handbook issued by the library on the usage of the library.

Fines and Lost Books

For overdue books a fine of Rs.50.00 per day is imposed. If a book is lost or damaged and needs to be replaced, the borrower is charged the replacement cost of the book and any other appropriate charges as determined by the Library Committee.

Reading Rooms

In the Adamantane House there is no formal reading room. An area in the library is demarcated as the reading room. Room in level 2 and the first floor of the building leased from College of Surgeons are used as reading rooms.

Rest Rooms

Institute is a place where a large number of students, staff and visitors frequently move around. Hence, the Institute has given an important consideration in providing adequate washroom facilities at the 'Adamantane House' and the maintenance of proper hygiene in them.

Rest rooms are found on each floor of the new wing as well as on the ground floor and second floor of the old wing.

Locations of the washrooms are as follows.

- (i) A staff washroom attached to the administration office in the ground floor of the old wing.
- (ii) Wash rooms to be used by academics, students and visitors are found in all floors. Apart from these there is a wash room to be used by the disabled at the fourth floor of the new extension which is easily accessible from the elevator.
- (iii) Wash room facilities for both males and females are found on each floor of the building leased from College of Surgeons as well as on the basement.

Cafeteria

A cafeteria is found in the closed roof terrace of the Adamantane House. It could house about 75 students at a given time.

Extra-Curricular Activities: Sports, Social, Cultural and Religious Events, Community Services, Popularization of Chemistry, Personality Development and Career Development

In a students' life it is essential that not only studies but participation in extracurricular activities is important, owing to the fact that extracurricular activities help in developing soft skills, personality, leadership qualities, communication skills, social activities as well as organization skills and exposes dormant talents.

The College of Chemical Sciences understands the benefits of extracurricular activities and supports a number of sports clubs, societies, religious and social events by providing substantial financial support and providing a comprehensive support framework to ensure their continued development.

Alumni Association of the College of Chemical Sciences

The Alumni Association of the College of Chemical Sciences was established to support the parent Institutional Organization (College of Chemical Sciences, Institute of Chemistry Ceylon) to achieve its goals and also to strengthen the ties between the members of the Alumni. It also provides a platform for networking and admitting professionals created by the College into the industries and academia. The Alumni Association works hand in hand on most occasions and maintains a close association with each other. Activities organized by the Alumni Association of the College of Chemical Sciences in 2015- 2018 are given below.

- Musical concert (Wayo Live in Concert) as a fundraiser
- Drinking water (Reverse Osmosis plant) project

Career Guidance Unit (CGU)

Career Guidance Unit of Institute of Chemistry was initiated in year 2014. It is a voluntary service initiated by the Alumni Association of College of Chemical Sciences in order to support, advise and guide students for the purpose of developing and enhancing skills such as communication, leadership, team work and managerial that are extremely important for the successful careers of graduating students as professionals in the industry as well as the academia. From 2016, the CGU will function under the guidance of CCS.

The CGU actively conducts the following programmes:

- Personal Development: CV writing, Mock interviews and interactive sessions.
- Professional Development: Talks on career opportunities, job bank/professional networking, industrial visits and seminars.

- Research and Academic Development: Advice for higher studies and research.
- Given below is a list of workshops and programmes conducted by the CGU-
 - o CV writing Workshop
 - o Graduate study pathways workshop
 - o Workshop on how to be successful in the cooperate sector

Out of the recent events conducted by the CGU in 2018, the CV writing workshop which was held at Adamantane house and the “Metanoia” leadership camp held at “Che Adventure Park Avissawella” takes a special place. The CV writing workshop was done in order to train students to write a CV which is suitable to approach foreign degrees and industries as well as approach local industries. It was a good session for the students to understand what really happens in an interview and how to get through an interview successfully.

Students’ Association of the College of Chemical Sciences

The Students’ Association elected annually comprises of all the students registered (DLTC and GIC) and the activities are guided by the internal academics and the Alumni Association of the College of Chemical Sciences.

To facilitate better coordination of activities and provide students with a productive outlet in terms of aesthetics, co-curricular and intellectual stimulation, there are societies and clubs under the Students’ Association. These societies are listed below.

- Sports Council
- Rotaract Club
- Analytical Club
- Photography Club
- Gavel Club
- Saukyadana Movement
- Society of Magicians
- Organic Club

Rotaract Club of CCS

The Rotaract Club of the College of Chemical Sciences was initiated by the Students Association to provide an opportunity for young men and women to enhance the knowledge and skills that will assist them in personal development, to address the physical and social needs of their communities, and to promote better relations between all people worldwide through a framework of friendship and service.

The goals of Rotaract are as follows:

- To develop social, professional and leadership skills;
- To emphasize respect for the rights of others, and to promote ethical standards and the dignity of all useful occupations;
- To provide opportunities for young people to address the needs and concerns of the community;
- To provide opportunities for working in cooperation with sponsoring Rotary club;
- To motivate young people for eventual membership in Rotary.

On recognizing the basic importance of a Rotaract Club, the Institute established their Charter Rotaract Club in the year 2013 under the guidance of the past President Rtr. Gautam Kumar.

Events organized by the Rotaract Club includes many social events such as “Readathon 2015”, which is a reading challenge, where the number of books a child is able to read within a month is been tested. It was mainly to celebrate world literary day and the winners were given prizes. Over the past years several community Development projects and Professional Development projects were organized by the Rotaract Club.

Also the “Cricketeract” project initiated by the 2015-16 group of Rotaractors was able to win the bronze award for the best fund raising project done by a club in the Rotaract Calendar year at Rotaract General Assembly held at Waters Edge Hotel Colombo. Cricketeract was a training camp to all Rotaractors and Non Rotaractors, done by well renowned Mr Anusha Samaranyake (past fast bowling head coach, SL Cricket)

The Rotaract Club of CCS was one of the leading Rotaract clubs to supply significant amounts of donations to the “Aranayake Landslide” victims. It was the leading project of the 2016-17 group of Rotaractors.

The Rotaract club of CCS received Gold award in the year 2018 for their cluster project “Habitat for Humanity”. A much acknowledgement was received for their project “Waariwaha” where they constructed a tank and a pipeline system for students of Bolunna Primary School Baduraliya to get access to pure drinking water.

Gavel Club

The Gavel club was also initiated by the CGU under the patronage of the Alumni Association in order to support students in their personal development, presentation and public speaking ability in 2015. One of the students of the College of Chemical Sciences, Samadhi Nawalage became the first runner-up in the Inter-University Speech Master Competition organized by the Gavel Club of the University of Sri Jayawardenapura. This is an important achievement as it was achieved within a short time of initiating the club.

Charter installation of the Gavel Club was on the 28th January 2016 at the Adamantane House.

The club actively took part in the Gavel Conference Sri Lanka 2016 organized by the Gavel Club of University of Moratuwa in collaboration with Gavel Clubs in Sri Lanka and Toastmaster International that was held on the 5th June 2016 at Taj Samudra.

Achievements of IChemC at the 'All Island Best Gavel Speaker 2016' contest are;

Ms. Samadhi Nawalage was selected as one of the six finalists of the 'All Island Best Gavel Speakers' 2016 prepared speech

Mr. Mohomed Afnan as one of the six finalists at the 'All Island Best Gavel Speakers' 2016 impromptu speech

The 2017-18 group of gaveliers yet again produced a finalist in "All Island Best Gavel Speaker" contest in prepared speech.

Photography Club

The Photography Club was established in 2014 under the supervision of the Honorary Rector at that time the late Emeritus Professor J. N. O. Fernando. Dr. S.R Gunatilake is the lecturer in charge of the club and Mr. S. M. Nawarathna is the founder and moderator of the club.

The aim of initiating the club was to make students more aware of different dimensions of photography as in relation to pleasure and professionalism. The club motivates students to learn and share new ideas and techniques with fellows with similar interest and imaginative power through photography. It inspires students to capture every memorable moment on film and share it with their peers. It instigates students so that every photographic task reflects our real life. Also, the club emphasizes high degree of aesthetic sense as it can be reflected in photography works.

The members also play a crucial part in providing photographic coverage for all important activities taking place at the Institute.

Analytical Club

The club was initiated in February 2015 by Dr. S.R. Gunatilake. The basic goal was to promote the interest of students in the latest in cutting edge technology used currently in the area of Analytical Chemistry by the research community worldwide. Meetings are held in order to educate people and students in a discussion forum. Guest lectures are also held to disseminate knowledge to students. This knowledge takes the students beyond the lectures; one such example was the knowledge disseminated in the lecture 'Paper Spray Ionization', which covered material that went beyond the content covered in the lecture 'Electro Spray Ionization' in the GIC syllabus. Although this extra content is by no means tested upon in the GIC exams, the value of such additional knowledge serves to give the members a holistic understanding of new technologies and methods to better them as professionals in the future. Details of lectures given are given below.

- Field Asymmetric Ion Mobility Spectroscopy (FAIMS)- Dr.S.R. Gunatilake
- Synchrotron XRD- Dr. H.M.M. Infas
- Photo lithography- Dr.(Ms) M. Lamabadusooriya
- Calibrations in Analytical Chemistry- Dr. K.A.S. Pathirathne
- Investigating the pathways of Fe(II)-mediated Mn(II) oxidation: Characterization of reaction products. – Dr. Case M. van Genuchten
- Structure-property correlatin of pharmaceutical solids: A crystal engineering approach - Dr. Ranjit Thakuria

Organic Chemistry Club

The organic chemistry club consists of students who have a greater interest in the subject of organic chemistry. Several projects have been undertaken and successfully completed *via* the organic club, such as organizing organic chemistry themed seminars and discussions, organizing a field trip to the Sri Lanka Institute of Nanotechnology, and several other projects.

Such innovation and imaginative thinking in the context of organic chemistry focused through such an outlet like the organic chemistry club will yield great opportunities for the future of the institute.

Society of Magicians

'Chemistry Magic Shows' are held by the Society of Magicians of the CCS that was initiated by Prof. M.D.P. de Costa as a means of popularizing the Chemical Sciences and developing enthusiasm in Chemistry among school children in Sri Lanka. During the show numerous magic tricks are performed utilizing different chemical reactions, illusions as well as theories. Of these few tricks are revealed to the audience through presentations in order to build awareness and to make students look through a perspective of science rather than a magic or an illusion. The magic shows have improved tremendously over the past few years due to the enormous contributions from the past and present students.

The team consists of at least five members which include Institute Teaching Assistants as well as students from the GIC programme. Each year new students are recruited and mentored in order to ensure the continuity as well as the maintenance of high standards in the magic. Given below are a few venues where the Society of Magicians have made their performance.

- St Thomas' College
- Gateway College Negombo
- Royal College Colombo
- MAS Holdings in Horana

Saukyadana Society

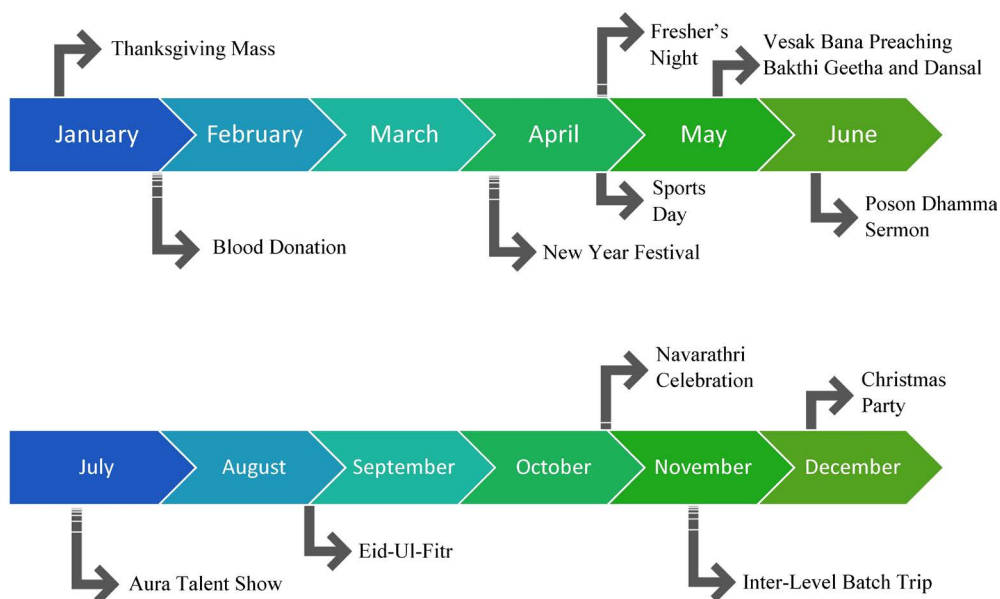
Saukyadana Society was established in May 2016 under the guidance of Dr. Chinthaka Ratnaweera. Two workshops on First Aid organized by the Saukyadana Movement, Sri Lanka was held for students as well as staff in 2016. Further it collected funds from the staff and students for the ‘Flood Relief’ in May 2016 and handed over a large consignment of bottled water and dry rations to the Headquarters of the Saukyadana Movement to be distributed among the flood victims.

The unit initiated maintenance of First Aid Boxes at the IChemC, while also going a step further and organizing a first aid camp for Adam’s Peak pilgrims.

Out of the leading projects organized by the Saukyadana Society the “Paduru Saajaya” takes a significant place. Here the students of Saukyadana Society get together and perform a classical music session to entertain the student body and the academics at CCS.

Social, Cultural and Religious Activities

The Students Association conducts a number of diverse social, cultural and religious events annually. These activities are encouraged and promoted by the academics to maintain high quality and standard in the activities. Both the students and the academic staff participate in these activities and show their hidden talents. The Institute makes use of either a lecture hall or the auditorium to conduct social, cultural and religious activities, although on occasion the venue is shifted to another location if deemed necessary. A list of events along with the months of the year they are usually held are given below-



- Thanks-giving Mass, January
- Blood donation, February
- New Year Celebration, April
- Sports Day ,April-May
- Freshers' Night, April-May
- Vesak Bana Preaching, Bakthi Geetha, May
- Vesak Dhansala, May
- Poson Dhamma Sermon and Bakthi Geetha, June
- AURA Talent Show, July
- Eid-Ul-Fitr, August-September
- Navarathri Celebration, October-November
- Inter-level batch trip, November
- Christmas Party, December

Inter Level Batch Trip

The inter-level batch trips are organized to promote unity and togetherness among students of different batches. It usually involves travelling to a scenic, enjoyable location. For the past two years the students have travelled to Sembuwatte, which has been a event of merriment and bonding for all students involved.

AURA Talent Show

This is one of the prime event organized by the Students' Association of the College. It provides students a chance to showcase and even develop their already considerable talents by presenting them onstage. AURA is an annual event that has evolved over the years to become an event of some magnitude, requiring careful planning and organization, which is looked into in a meticulous and thorough manner, ensuring that the reputation of the College of Chemical Sciences is always upheld, and sometimes even carried to ever grater heights.

The AURA talent show has been held in different venues over the years, and the venues for the last few years are listed below.

Year	Venue
2013	Mahanama College
2014	Kularathna Auditorium, Ananda College
2015	Kularathna Auditorium, Ananda College
2016	Kularathna Auditorium, Ananda College

2017 Kularathna Auditorium, Ananda College
2018 BMICH, Colombo

Fresher's Night and Sports day

The Fresher's Night and sports day are both events that are geared towards welcoming the new batches of students that join the Graduateship Programme. The event is a chance for the new students to integrate themselves into the student populace and have some measure of enjoyment.

Sinhalese and Hindu New Year

The Sinhala and Hindu New Year celebration is an event that is much anticipated by both the Students and Staff of CCS. A chance to indulge in some fun and games while also treating oneself to the New Year sweetmeats and delicacies, the New Year festival is not an event to miss. The Alumni Association played a major role in organizing and funding the festivities.

Thanks-giving mass

Celebrated at the start of the year, it is an event that hold great significance for those of the Christian faith, and is planned and organized by the CCS family together. A mass is held along with some beautiful hymns being sung to make the event ever so pleasant to be a part of

Vesak -Bakthi gee

The month of Vesak sees the College with much bustle and activity, from the decorating of the building with various vesak lanterns and paraphernalia, to the organizing of bakthi gee ceremonies, once more, an event to bring the whole populace of CCS, both student and faculty alike take part in making it a successful event.

Poson Bana Preaching

The month of poson marks the collective organizing of a Bana preaching ceremony to mark the occasion, which is taken part in by a great many in the institute.

Eid-UI-Fitr Celebrations

A celebration that is derived from the Islamic faith, it involves holding a small event of recitations and sermons at the auditorium, followed by fellowship over a lunch of biriyani. Students and academics alike take part to learn of the different understandings and beliefs of the multicultural nexus that is the college of chemical sciences.

Navarathri Celebration

A religious celebration that has its roots in Hinduism, it is an event that involves an evening of music and drama, and of following some customs and rituals of the Hindu faith. Everyone attends to have a wonderful time of music and cultural exposures, while indulging themselves with a taste of the sweetmeats offered to all during the event.

Christmas Party

A time for fun and merriment for all, the Christmas party is looked forward to by not only the Christians, to whom it hold very special significance to, but by the whole populace of the Institute. A night of entertainment, food and merriment awaits anyone who participates, making it a very popular event in the calendar of anyone at the Institute.

SPORTS

Cricket

Cricket is a sport that is very much popular at the Institute. Many students enjoy practicing and also taking part in a series of matches that are organized annually. A list of annual cricket big match encounters are given below, along with the team and institute against which the match was played.

Year	Team Opposed
2016	SAITM (South Asian Institute of Technology and Medicine)
2017	SAITM (South Asian Institute of Technology and Medicine)
2018	Informatics Institute of Technology

Rugby

Rugger is also a well-loved sport that has its fame rooted deep in both young men and women at the institute.

Intriguingly enough, women's tag rugger tournaments are a big hit throughout the student populace. It originated in the aptly named "Rugby Rebellion" where the women's version was introduced alongside the men's divisions.

Badminton

Badminton is a sport that has a big following at the institute, where the students interested coordinate with the relevant parties to schedule regular practices at a nearby court. Annually an event that involves all the batches in a competitive tournament is held, and given the moniker "The interlevel badminton tournament".

Karate

Karate is practiced at the institute premises itself, under the guidance of a trained and certified mentor. A set of training and sparring gear was recently acquired for the purposes of a more rigorous training regime.

Basketball

The sport of basketball has become another focus of interest, having a development in both number of interested students who participate regularly in practices and matches and also in terms of equipment and resources. An annual inter-level basketball tournament is also held, involving students of all batches who are interested, or who just want to have some fun.

Football

Much loved by both its fans and those who practice the sport, football also has a good following at the institute.

Resources and practice grounds have been allocated for the purpose of encouraging and developing the interests and talents of such football enthusiasts.

Chess

The game of chess is a great favourite among many students, helping the students explore another intellectually challenging arena in a very competitive sense. The institute has managed to organize the inter-level chess tournament, while also gaining the opportunity to play against teams of other universities in different tournaments.

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