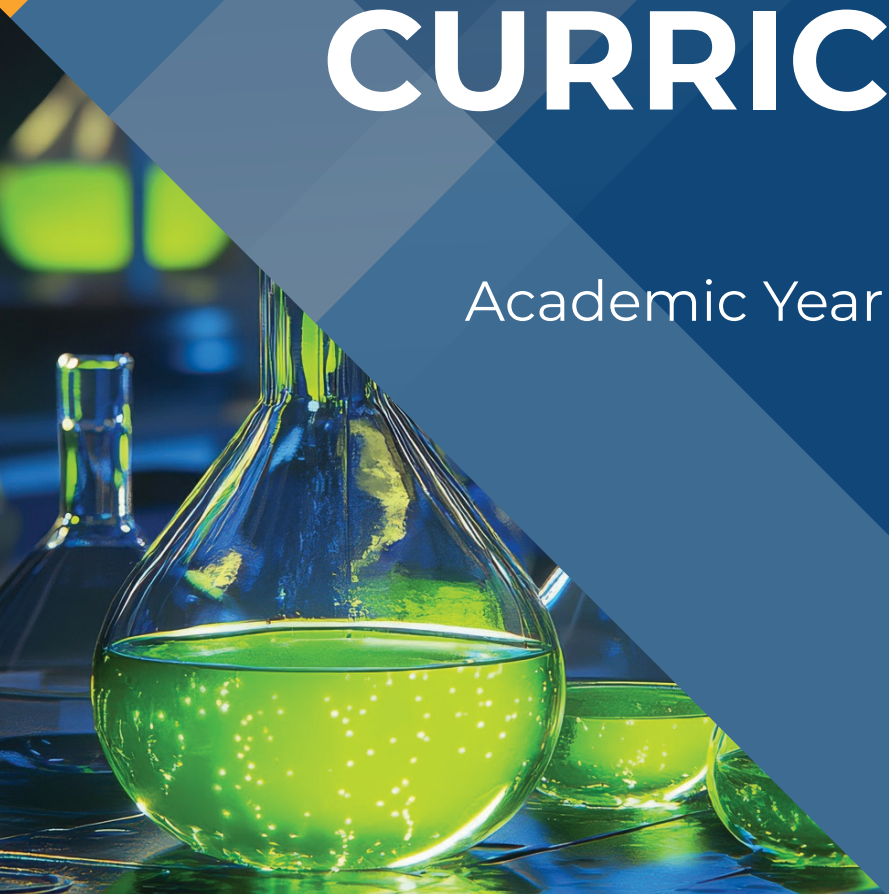
INSTITUTE OF CHEMISTRY CEYLON

BSc Hons
(Chemical Science)
Degree Programme

CURRICULUM

Academic Year 2026/2027



Institute of Chemistry Ceylon

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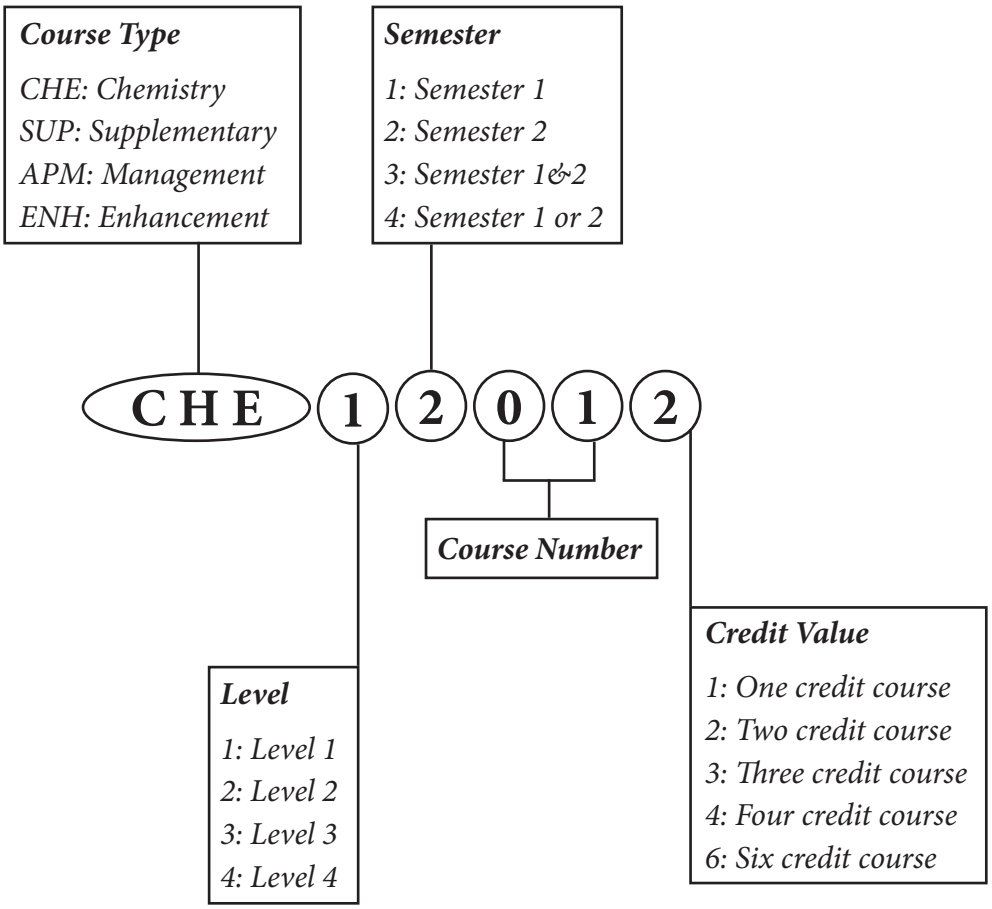
Academic Year 2026/2027

Contents

BSc Hons Course Code Description



BSc Hons Course Contents

Orientation Programme

Enhancement

ENH 11101	Biology for Physical Science Students* or
ENH 11111	Mathematics for Biological Science Students*
ENH 11122	General English and Effective Communication

*[Note: *Students who have faced GCE A/L or London A/L in the physical science stream are required to complete ENH 11101 (Biology for Physical Science Students) and students who have faced GCE A/L or London A/L in the bioscience stream are required to complete ENH 11111 (Basic Mathematics)].*

Level 1

Semester 1

Chemistry

CHE 11012	Principles of Chemistry
CHE 11022	Organic Chemistry- I
CHE 11032	Chemistry of Main Group and *d*- & *f* - Block Elements
CHE 11041	Classical Methods in Chemical Analysis- I
CHE 11051	Fundamentals of Biochemistry-I
CHE 11061	Elementary Chemistry Laboratory

Management

APM 11072	Principles of Management
APM 11082	Optimization Methods in Management Science

Supplementary

SUP 11092	Statistics for Chemistry

Enhancement

ENH 11131	Basic Mathematics for Chemistry

Total Credits : 15

Enhancement Credits : 01

Semester 2

Chemistry

CHE 12012	Concepts in Inorganic Chemistry-I
CHE 12022	Principles of Physical Chemistry-I

CHE 12031	Fundamentals of Biochemistry-II
CHE 12042	Organic Chemistry-II
CHE 12051	Classical Methods in Chemical Analysis-II
CHE 12061	Analytical Chemistry Laboratory

Management

APM 12072	Introduction to Industrial Economics
APM 12082	Accounting Concepts and Costing

Supplementary

SUP 12092	Physics and Basic Electronics for Chemists

Total Credits : 15

Level 2

Semester 1

Chemistry

CHE 21012	Organic Synthesis and Spectroscopy
CHE 21022	Principles of Physical Chemistry-II
CHE 21032	Separation Methods and Atomic Spectroscopy
CHE 21041	Organic Chemistry Laboratory

Management

APM 21052	Principles of Human Resource Management and Leadership
APM 21062	Marketing Management
APM 21072	Total Quality Management

Supplementary

SUP 21081	Mathematics for Chemistry I

Total Credits : 14

Semester 2

Chemistry

CHE 22012	Concepts in Inorganic Chemistry-II
CHE 22022	Heterocyclic Chemistry and Natural Products
CHE 22032	Principles of Physical Chemistry-III
CHE 22041	Introduction to Metabolisms in Biochemistry
CHE 22052	Environmental Chemistry
CHE 22061	Green Chemistry
CHE 22071	Physical Chemistry Laboratory

Management

APM 22082	Computer Based Tools for Management
APM 22092	Operations Management

Supplementary

SUP 22101	Mathematics for Chemistry II

Enhancement

ENH 22111	English for Scientific Writing

Compulsory Credits : 16

Enhancement Credits : 01

Level 3

Semester 1

Chemistry

CHE 31012	Advanced Topics in Inorganic Chemistry-I
CHE 31022	Physical Organic Chemistry, Pericyclic Reactions and Advanced Natural Products Chemistry
CHE 31032	Quantum Chemistry and Molecular Spectroscopy
CHE 31042	Electroanalytical Chemistry and Optical Spectroscopy
CHE 31052	Polymer Chemistry
CHE 31062	Advanced Physical Chemistry Laboratory
CHE 31071	Advanced Biochemistry-I
CHE 31081	Advanced Inorganic Chemistry Laboratory
CHE 31091	Industrial Analytical & Environmental Chemistry Laboratory

Total Credits : 15

Semester 2

Chemistry

CHE 32012	Advanced Synthetic Organic Chemistry
CHE 32021	Supramolecular Chemistry
CHE 32033	Seminar Presentations and Essays
CHE 32042	Advanced Coordination Chemistry
CHE 32052	Advanced Topics in Physical Chemistry-I
CHE 32062	Advanced Chromatography
CHE 32072	Advanced Organic Chemistry Laboratory
CHE 32081	Biochemistry Laboratory

Enhancement

ENH 32091	Industrial Training

Compulsory Credits : 15

Enhancement Credits : 01

Level 4

Semester 1

Chemistry

CHE 43016	Research Project
CHE 41012	Special Topics in Inorganic Chemistry
CHE 41022	Advanced Topics in Physical Chemistry-II
CHE 41032	Advanced Spectroscopic Techniques and Photochemistry
CHE 41042	Molecular Modeling and Molecular Simulations (T + P)
CHE 41051	Advanced Biochemistry-II
CHE 41062	Material Science
CHE 41072	Generative AI for Chemistry and Chemical Industry

Management

APM 41082	Innovation and New Product Development

Total Credits : 15

Semester 2

Chemistry

CHE 43016	Research Project (continuation)
CHE 42022	Chemical and Process Engineering for Chemical Industry
CHE 42051	Mineral Resources and Processing

Management

APM 42032	Project Management
APM 42042	Professional Practices

Compulsory Credits : 13

Elective Credits : 02

Level 4 - Elective Courses

Elective

CHE 42062	Chemical Education
CHE 42072	Pharmaceutical Chemistry
CHE 42082	Food Chemistry & Technology

Course Summary

BSc (Hons)									
Level	1		2		3		4		Total
Semester	1	2	1	2	1	2	1	2	
Chemistry compulsory	9	9	7	11	15	15	13	9	**88**
Chemistry elective	0	0	0	0	0	0	0	2	**2**
Supplementary	2	2	2	0	0	0	0	0	**6**
Management	4	4	6	4	0	0	2	4	**24**
Enhancement	4	0	0	1	0	1	0	0	**6**
Total GPA credits	15	15	15	15	15	15	15	15	**120**
Total credits per year	30		30		30		30		
Total non GPA credits	4	0	0	1	0	1	0	0	**6**

LEVEL 1

CHE 11012 - Principles of Chemistry

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Course Unit Code	CHE 11012			
Course Unit Name	Principles of Chemistry			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	GCE A/L Chemistry or an equivalent			
Hourly breakdown	**Theory**	**Practical**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	to provide the basic knowledge in atomic structure and concepts of chemical bonding			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: apply quantum theory of radiation and basic wave mechanics to explain the atomic structure

ILO 2: compare properties of quarks with those of leptons

ILO 3: determine the electrical charge of a proton, neutron and mesons based on the quark structure

ILO 4: apply conservation laws to predict whether a given particle decay process would occur or not;

ILO 5: apply Valance Shell Electron Pair Repulsion Theory, Valance Bond Theory and Molecular Orbital Theory to explain bonding/geometry/magnetic properties of molecules;

ILO 6: explain energetics of ionic solids

ILO 7: identify the intermolecular forces present between molecules.

Course Content

1. Quantum theory and atomic structure (6 h)

Evolution of Atomic Theory: Early Greek Theories, Dalton's Atomic Model, Thomson's Cathode Ray Tube Experiment and Rutherford's Gold Foil Experiment.

The quantum theory of radiation: Wave nature of light, Planck's Postulate of Quantization, photoelectric effect; Wave mechanics: Wave–particle duality of matter, de Broglie equation, Introduction to the Heisenberg Uncertainty Principle.

Bohr Theory: The Bohr Theory of the hydrogen atom, Bohr radius, hydrogen spectrum
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and origin of the line spectrum, application of Bohr Theory to hydrogen like systems, Rydberg's Empirical Formula.

Quantum numbers: quantum numbers and atomic orbitals, electron spin and Pauli Exclusion Principle, orbital shapes and energies.

2. Subatomic particles and nuclear properties (6 h)

Subatomic particles: Examples for subatomic particles; introduction to fundamental particles, composite particles, fermions & bosons; flavors and properties of quarks and leptons; color confinement; force carrier particles; introduction to the Standard model, particles and antiparticles.

Atomic nucleus: Fundamental forces and their properties; role of fundamental forces and force carrier particles; introduction to hadrons, baryons and mesons; determination of the electric charge of a proton, neutron and mesons based on their quark structure

Conservation Laws and Particle decay: Introduction to Lepton numbers, baryon number and strangeness number, conservation laws for charge, lepton number, baryon number, strangeness number and energy; application of conservation laws to predict whether a given particle decay process would occur or not, β-decay at quark level, Higgs bosons, dark matter

3. Chemical bonding (18 h)

Slater rules.

Basic concepts: Lewis Symbols; Types of chemical bonds (ionic, covalent, metallic), properties of covalent bonds (energy and length); octet rule, exceptions to octet rule; definition for electronegativity (Pauli, Muliken, Allred and Rochow), bond polarity and dipole moment, net molecular dipole moment and examples (NH_3, NF_3, NCS^- etc.); polarization of ions and Fajan's rules; rules to draw Lewis structure, resonance structures and resonance hybrids of neutral polyatomic molecules (e.g. N_2O) and polyatomic ions (e.g. SO_4^{2-})

Shapes of molecules and ions: VSEPR Theory: Application of the VSEPR theory to predict shapes of neutral molecules EX_n (e.g. BF_3) and EmXn (e.g. N_2O), ions $[E_m]^-$ (e.g. N^{3-}), $[E_mX_n]^{p+/-}$ (e.g. SO_4^{2-}) and hetero-polyatomic ions such as NCS-; effect of lone pairs on bond angles and the shape of the molecule/ion (NH_3, NO_3^- etc.)

Theories of covalent bonding

- Valence Bond Theory (VBT): Introduction; hybridization of atomic orbitals and corresponding molecular shapes; application of VBT for homonuclear diatomic molecules (e.g. H_2), heteronuclear polyatomic molecules AX_n (e.g. CH_4) and heteronuclear polyatomic ions having multiple bonding (e.g. NO_3^-)
- 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 (e.g. H_2), hetero-diatomic molecules (e.g. CO) and polyatomic molecules/ions with σ bonding only (e.g. $BeCl_2$) and σ and delocalized π- bonding (e.g. NO_2^- , O_3); Molecular orbital energy level diagram of organic molecules/ions (e.g. ethylene, acetylene, allyl ion, butadiene, cyclobutadiene, cyclopentadienyl anion, benzene, 1,3,5-hexatriene, and formaldehyde), Prediction of bond order and magnetism of molecules/ions based on molecular orbital energy level diagrams.

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

Intermolecular forces

- Types of intermolecular forces: Ion-dipole, dipole-dipole, ion-induced dipole, dipole-induced dipole, hydrogen bonding, and instantaneous dipole-induced dipole.
- Effect of intermolecular forces on properties of liquids: e.g. Surface tension, capillarity and viscosity.

Methods of Teaching and Learning

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

Recommended Readings

- Housecroft, C. E..; Sharpe, A. G.. (2012), Inorganic chemistry, 4th Edition, Pearson.
- Brown, T. E.; LeMay, E. H.,; Bursten, B. E.; Murphy C. (2017). Chemistry: The Central Science, 14th Edition, Pearson.
- Lee, J. D. (2006). Concise Inorganic Chemistry, 5th Edition, Blackwell science,
- Pfennig, B.W. (2021). Principles of Inorganic Chemistry, 2nd Edition, John Wiley & sons.
- Zumdahl, S. S.; Zumdahl S.A. (2009), Chemistry, 9th Edition, Houghton Mifflin Company,
- Atkins, P.W.; Overton, T.L.; Rourke, J. P.; Weller, M. T.; Armstrong, F. (2010). Shriver & Atkins Inorganic Chemistry, 5th Edition, W. H. Freeman and Company, New York.
- McMurry J. I.,; Fay R. C. (2020). Chemistry, 8th Edition Pearson.
- Ebbing D. D; Gammon, S. D. (2016). General Chemistry, 11th Edition, CENGAGE Learning

CHE 11022 - Organic Chemistry I

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Course Unit Code	CHE 11022			
Course Unit Name	Organic Chemistry I			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	None			
Hourly breakdown	**Theory**	**Practical**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	To introduce basic principles and reaction in Organic Chemistry			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: Bridging Advanced Level Organic Chemistry and the Undergraduate Chemistry Curriculum

ILO 2: compose the structure of an organic molecule based on the IUPAC nomenclature and *vice versa*

ILO 3: correlate reaction mechanisms with bonding aspects of the functional group and propose synthetic pathways for conversion of functional groups of aliphatic and aromatic compounds

Course Content

1. **Introduction to Organic Chemistry (4 h)**

   Correlating bonding, functionality and reactions

2. **Chemistry of Alkanes, Alkenes, Alkynes, Alkyl halides and Alcohols, ether and epoxides (12 h)**

   Structure and reactivity of alkanes, alkenes, alkynes, alkyl halides, alcohols, ethers, epoxides.

   Alkanes: Substitution reactions (free radical mechanism)

   Alkenes: Synthesis, reactions (electrophilic addition, oxidation) and mechanisms

   Alkynes: Synthesis, reactions (hydroboration/oxidation, reduction) and mechanisms

   Alkyl halides: Synthesis, reactions and mechanisms (S_N2, S_N1, E2 and E1)
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Alcohols: Synthesis, reactions (reduction, oxidation) and mechanisms.

Ethers and Epoxides: Synthesis, reactions and mechanisms.

3. Chemistry of Carbonyl Compounds (14 h)

Carbonyl Compounds: Nucleophilic addition reactions (including Wittig reaction). Nucleophilic addition followed by Elimination of water (derivatives of carbonyl compounds). Reactions at the α-carbon (Aldol condensation and related reactions, Iodoform reaction).

Carboxylic acids and their derivatives: Preparation, Nucleophilic substitution reaction. Reactions at the α-carbon (Claisen condensation and related reactions). Amides and Amines: Preparation and reactions (including Hoffman Degradation, Hoffmann exhaustive elimination).

Methods of Teaching and Learning

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

Recommended Readings

- Solomons, T. W. G.; Fryhle, C. B.; Snyder, S. A. (2013). Organic Chemistry, 11th Edition, John Wiley.
- McMurry, J. E. (2011). Organic Chemistry, 8th Edition, Brooks Cole.
- Wade Jr, L. G. (2012). Organic Chemistry, 8th Edition, Pearson.
- Bruice, P. Y. (2013). Organic Chemistry, 7th Edition, Prentice Hall.
- Ebbing D. D.; Gammon, S. D. (2016). General Chemistry, 11th Edition, CENGAGE Learning,

CHE 11032 -
Chemistry of Main Group and *d* & *f* block elements

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Course Unit Code	CHE 11032			
Course Unit Name	Chemistry of Main Group and *d* & *f* block elements			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	None			
Hourly breakdown	**Theory**	**Practical**	**Independent learning**	**Notional learning hours**
	30	-	15	100
Objective of the Course Unit	to provide the basic knowledge in chemistry of Main Group and *d*- & *f*-block elements.			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: discuss chemistry of main group elements

ILO 2: explain 3-centre 2-elctron bonding

ILO 3: compare chemistry of the first element of a main group with the rest of the elements in the same group

ILO 4: describe possible uses of main group elements and their compounds

ILO 5: discuss colour and magnetic properties of transition elements

ILO 6: compare chemistry of lanthanides with actinides

ILO 7: describe reasons for lanthanide contraction.

Course Content

1. Chemistry of Main Group Elements (13 h)

Modern periodic table and periodicity

Introduction to modern periodic table, periodicity in atomic properties and other properties of the main group elements, introduction to diagonal relationship

Chemistry of *s*-block elements

Occurrence; electronic configuration of the valance shell, trends in important physical and chemical properties of the elements and some selected compounds down their respective groups, anomalous properties of Li and Be, diagonal relationship, uses; Hydrogen - properties of hydrogen, classification of hydrides, Protonic concept of acids and bases
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(Bronsted – Lowry concept)

Chemistry of *p*-block elements

Occurrence; electronic configuration of the valance shell of Group 13 to 18, common oxidation states and valence, General features of *p*-block elements, (gases/liquids/solids; nonmetals/metalloids/metals, allotropes, d-block contraction, inert pair effect etc.), trends in physical (atomic/ionic radius, IE, EA, EN, MPts etc.) and chemical properties (catenation, ionic/covalent nature, pπ-pπ and pπ-dπ bonding, consequences of inert pair effect, electron deficiency in Group 13, hydrolysis of covalent compounds) of the elements and some selected compounds, acidity of hydrides and oxoacids etc.

Chemistry of some selected elements, Boron and Silicon

Hydrides, electron deficiency in BH_3 and B_2H_6, 3-center 2 electron bonding in B_2H_6, boron trihalides: Lewis acid property and π-bonding; borates, silicates and silicones; hydrolysis of halides and B_2H_6, H_3BO_3, structures of silicon complex ions having higher coordination numbers, B-N compounds, diagonal relationship between B ad Al, uses.

Nitrogen and phosphorus

Bonding in N_2 and P_4, Oxides of N and P, P-N compounds, Liquid NH_3 as a non-aqueous solvent, Anomalous properties of N, uses

Oxygen and sulfur

Bonding in dioxygen, acidic/basic/amphoteric/neutral oxides, Anomalous properties of O, structure of S compounds having higher coordination numbers, uses

Halogens

Trends in bond dissociation enthalpy of X_2, standard reduction potentials and oxidizing power of halogens, acidity of aqueous solutions of HX, halogen oxides, interhalogen compounds, Anomalous properties of fluorine, uses

Noble Gases

Properties of noble gases, structure and bonding in fluorides, oxides and oxofluorides of xenon, uses

2. Chemistry of *d*-block Elements (10 h)

d-block elements vs. Transition metals

First row transition elements

Properties, Electron configurations, Ionization energies, atomic radii of 3*d*, 4*d*, and 5*d* transition elements, Melting points, Electronegativity

Bond character

The relationship between electronegativity and oxidation states, the effect of electronegativity on acidic/basic properties

General characteristics of transition elements

Variable oxidation states, Redox potentials, Introduction to color and magnetic properties

of their compounds, Catalytic properties of transition elements, Coordination number and molecular geometries of compounds of transition elements, Kepert model

3. Chemistry of *f*-block elements (7 h)

Chemistry of Lanthanides, Electron configurations of lanthanides, Various oxidation states of lanthanides, Lanthanide contraction, Consequences of lanthanide contraction, Colors of lanthanide complexes, Magnetic properties of lanthanide complexes, Separation of lanthanides

Chemistry of Actinides, Properties of actinides, Electron configuration of actinides, Various oxidation states of actinides, Actinide contraction, Consequences of actinide contraction, Colors of actinide complexes. Magnetic properties of actinides

Methods of Teaching and Learning

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

Recommended Readings

- Housecroft, C. E..; Sharpe, A. G.. (2012), Inorganic chemistry, 4th Edition, Pearson.
- Brown, T. E.; LeMay, E. H.; Bursten, B. E.; Murphy C. (2017). Chemistry: The Central Science, 14th Edition, Pearson.
- Lee, J. D. (2006). Concise Inorganic Chemistry, 5th Edition, Blackwell science.
- Atkins, P.W.; Overton, T.L.; Rourke, J. P.; Weller, M. T.; Armstrong, F. (2010). Shriver & Atkins Inorganic Chemistry, 5th Edition, W. H. Freeman and Company, New York.
- Norman, N. C. (1995). Periodicity & the p-block elements, Oxford University Press.

CHE 11041 -
Classical Methods in Chemical Analysis I

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Course Unit Code	CHE 11041			
Course Unit Name	Classical Methods in Chemical Analysis I			
Credit value	1			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	None			
Hourly breakdown	**Theory**	**Practical**	**Independent learning**	**Notional learning hours**
	15	-	-	50
Objective of the Course Unit	To provide a comprehensive understanding of neutralization titrimetry and gravimetry			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: apply appropriate principles to determine concentrations of unknown acids, bases, or mixtures of acids/bases using titration data, considering both mono- and polyprotic species

ILO 2: construct titration curves for various scenarios, including titrations involving strong acids and bases, weak acids and bases, polyprotic acids and bases, mixtures of acids or bases and titrations involving salt hydrolysis

ILO 3: select acid-base indicators for specific titrations based on the expected pH range and the nature of the titrants involved.

ILO 4: apply conditional solubility product concepts in cation analysis

ILO 5: assess the properties of a good precipitate to select appropriate gravimetric methods for specific analytical scenarios.

Course Content

1. Introduction to chemical analysis (1 h)

Overview of analytical chemistry and chemical analysis: Qualitative and quantitative analysis; Classical and Instrumental analysis; Different analytical methods used in analysis. Introduction to accuracy and precision in quantitative analysis.

2. Neutralization titrations (8 h)

Criteria for the reaction used in titration; Principles of neutralization titrations: primary and secondary standards, neutralization titrations (strong, weak and poly functional acids,
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hydrolysis of salts), titration curves, theory of indicators; Buffer solutions: Henderson–Hasselbach equation, buffer capacity and buffer value for a buffer system, preparation of buffer solutions.

3. Precipitation methods of analysis (6 h)

Solubility products in qualitative analysis: Conditional solubility product; solubility product applications in cation analysis; Gravimetric methods of analysis: basic principles, Von Weimarn's precipitation theory, common ion effect, properties of a good precipitate, applications of gravimetry; Contamination of a precipitate, precipitation from homogeneous solution (PFHS), post-precipitation, minimizing of post-precipitations, simple applications of volatilization gravimetry.

Methods of Teaching and Learning

A combination of lectures, tutorials, peer assisted student support (PASS) sessions and small group discussions.

Recommended Readings

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

CHE 11051 -
Fundamentals of Biochemistry I

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Course Unit Code	CHE 11051			
Course Unit Name	Fundamentals of Biochemistry I			
Credit value	1			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	E/ENH 11101 or GCE/AL Biological Science			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	15	2	-	50
Objective of the Course Unit	To provide the students with a basic understanding of the molecular architecture of cells and the associated biomolecules, the fundamental processes that maintain a viable cellular environment conducive for life and the protein catalysts that facilitate the molecular interactions that make life possible.			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: Explain the concept of pH, buffer concepts, calculations and its applications in biological systems

ILO 2: Describe the important biomolecules found in the human body and their significance.

ILO 3: Describe the structure of biological membranes and their function.

ILO 4: Describe the principles of enzyme, isoenzymes, types of enzyme inhibition and their catalytic action and applications.

Course Content

1. **pH & Buffers. (3 h)**

   Principle of pH, biological range, calculation & importance for life. Buffers, calculation of pH & their action. Buffering systems present in organisms.

2. **Biomolecules, Structure & functions. (5 h)**

   Carbohydrates – structure & functions, Lipids & functions, Proteins & functions. Prion proteins & their significance.

3. **Cell membrane. (3 h)**

   Basic structure of the biological membrane. Molecular components of membranes. Role
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of Cholesterol in membrane. Methods of Transport of material across membranes.

4. Enzymology. (4 h)

Enzymes, classification and nomenclature. Enzyme catalysis and basic Kinetics. Enzyme inhibitions & relevance to regulation of Metabolisms in living organisms. Isoenzymes & why they are there in living systems. Diagnostic, analytical and Industrial applications.

Methods of Teaching and Learning

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

Recommended Readings

- Abali, E. E.; Cline, S. D.; Franklin, D. S.; Viselli, S. M. Lippincott® Illustrated Reviews: Biochemistry; Lippincott Williams & Wilkins, 2024.

CHE 11061 -
Elementary Chemistry Laboratory

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Course Unit Code	CHE 11061			
Course Unit Name	Elementary Chemistry Laboratory			
Credit value	1			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	Laboratory safety workshop, Fire safety workshop			
Hourly breakdown	**Theory**	**Practical**	**Independent learning**	**Notional learning hours**
	-	45	-	50
Objective of the Course Unit	To provide fundamental skills in chemistry laboratory			
Evaluation Method	Attendance 10 % Mid-term Assessment 20%		Lab Reports 10% Final Assessment 60%	

Intended Learning Outcomes (ILO)

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

ILO 1: develop fundamental laboratory skills

ILO 2: practice correct techniques in performing titrations

ILO 3: illustrate solubilities and reactions of 's', 'p' and 'd' block elements

ILO 4: apply the knowledge in neutralization titration in quantitative analysis of samples.

ILO 5: determine the buffer capacity

ILO 6: identify the functional groups present in an organic compound using simple tests

Course Content

1. **Elementary chemistry Practice (9 h)**

   Separation of an inorganic mixture.

2. **Chemistry of '*s*', '*p*' and '*d*' block elements (9 h)**

   Solubility of '*s*' and '*p*' block elements, solubility of '*d*' block elements, semi micro qualitative analysis of anions and cations.

3. **Neutralization titrations (27 h)**

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

A combination of lab lectures, practical sessions.

Recommended Readings

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

APM 11072 - Principles of Management

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Course Unit Code	APM 11072			
Course Unit Name	Principles of Management			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	None			
Hourly breakdown	**Theory**	**Practical**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	To provide students with a foundational understanding of the basic principles of management, including organizational structure, culture, behavior, and the evolution of management thought.			
Evaluation Method	Final Assessment 100%			

Intended Learning Outcomes (ILO)

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

ILO 1: demonstrate understanding of different historical perspectives in management and organization studies;

ILO 2: demonstrate understanding of the characteristics of contemporary organizations and the different approaches to organizational structure and design;

ILO 3: demonstrate understanding of the fundamentals of individual, team and group behavior;

ILO 4: analyze the process of organizational learning, adapting, and change.

Course Content

1. **Organizations and evolution of management thought (4 h)**

   Concept of organizations, key characteristics and purposes, evolution of management thought.

2. **Organizational structure and the environment (14 h)**

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

3. **Organizational culture (12 h)**

   Drivers of individual behavior and group/team behavior. Generational diversity in the workplace with focus on Millennials and Gen Z. Organizational culture, learning, and processes of organizational change.
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Methods of Teaching and Learning

A combination of lectures, in-class discussions, real world case studies and self-study.

Recommended Readings

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

APM 11082 -
Optimization Methods in Management Science

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Course Unit Code	APM 11082			
Course Unit Name	Optimization Methods in Management Science			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	None			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	To equip students with the knowledge and skills to model, analyze, and solve business problems using optimization methods and relevant software tools, enabling effective and informed managerial decision-making.			
Evaluation Method	Final Assessment 100%			

Intended Learning Outcomes (ILO)

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

ILO 1: identify and analyze business problems and formulate business decision problems as mathematical models and lay out as spreadsheet models;

ILO 2: apply appropriate quantitative techniques and perform sensitivity analysis in managerial decision-making;

ILO 3: identify and use software to solve complicated problems;

ILO 4: communicate the analysis and results of business decision problems.

Course Content

1. **Operations research and linear programming (12 h)**
   Introduction to operations research, linear programming (LP), problem formulation, algebraic representation, solving LP problems, applications of LP.

2. **Performance measurement and resource optimization (15 h)**
   Data envelopment analysis for performance measurements, evaluation, assignment problem, network modules.

3. **Project scheduling (9 h)**
   Project scheduling with known and uncertain activity times, time and cost trade-offs.
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4. Decision analysis and data relationships (9 h)

Decision analysis, correlation analysis and simple linear regression.

Methods of Teaching and Learning

A combination of lectures and computer assisted learning.

Recommended Readings

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

SUP 11092 - Statistics for Chemistry

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Course Unit Code	SUP 11092			
Course Unit Name	Statistics for Chemistry			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	None			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	15	30	-	100
Objective of the Course Unit	To enhance students critical thinking and decision-making skills and provide solid foundation in statistical methods necessary for conducting and evaluating research.			
Evaluation Method	Final Assessment 100%			

Intended Learning Outcomes (ILO)

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

ILO 1: Explain fundamental statistical concepts and terms used in data analysis, including discrete and continuous variables.

ILO 2: Apply probability and hypothesis testing techniques to analyze experimental data.

ILO 3: Compute and interpret measures of central tendency, dispersion, and variability, including skewness and kurtosis in frequency distributions.

ILO 4: Compare different statistical measures and assess relationships between variables.

ILO 5: Conduct inferential statistical tests, including t-tests, ANOVA, and regression analysis.

ILO 6: Use statistical software for data analysis, visualization, and interpretation.

ILO 7: Implement experimental design principles and understand different sources of variability, including independent and dependent variables

Course Content

1. **Introduction to Statistics (Theory: 2 h; Practical: 4 h)**

   Importance of statistics in scientific research. Descriptive vs. inferential statistics. Data types and measurement scales (nominal, ordinal, interval, ratio)

   Sampling methods and sampling error. Discrete and continuous variables.

2. **Descriptive Statistics (Theory: 1 h; Practical: 2 h)**

   Measures of central tendency (mean, median, mode), Measures of dispersion (variance, standard deviation, range, IQR), Skewness and kurtosis in frequency distributions, Data
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visualization: histograms, box plots, scatter plots, bar charts.

3. **Probability and Hypothesis Testing (Theory: 2 h; Practical: 4 h)**

   Probability theory, conditional probability, Bayes' theorem, Null and alternative hypotheses, significance levels, and p-values, Type I and Type II errors, power of a test, Confidence intervals and their interpretation.

4. **Comparison of Means and Variability (Theory: 2 h; Practical: 4 h)**

   Z-tests, t-tests (one-sample, independent, paired t-test), Q-test and Grubbs test for outlier detection, Analysis of Variance (ANOVA: one-way, two-way, repeated measures), Relationship between ANOVA, regression, and correlation.

5. **Regression and Correlation Analysis (Theory: 2 h; Practical: 4 h)**

   Simple linear regression, correlation coefficients, Multiple regression models, least squares method, Polynomial, exponential, and logistic regression models.

6. **Categorical Data Analysis (Theory: 2 h; Practical: 4 h)**

   Chi-square tests for independence, Odds ratio and risk ratio analysis, Logistic regression for categorical data.

7. **Statistical Software and Applications (Theory: 2 h; Practical: 4 h)**

   Introduction to statistical software, Data input, cleaning, and basic analysis. Interpretation of statistical outputs and visualization techniques.

8. **Spreadsheet Applications in Statistical Analysis (Theory: 2 h; Practical: 4 h)**

   Data processing, visualization, and analysis using spreadsheets, Curve fitting, trend analysis, and error estimation, Automating calculations with spreadsheet functions.

Methods of Teaching and Learning

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

Recommended Readings

- Agarwal, B. L. (2006). Basic Statistics. New Age International.
- Box, G. E. P., Hunter, J. S., & Hunter, W. G. (2005). Statistics for Experimenters: Design, Innovation, and Discovery (2nd ed.). Wiley.
- Cronk, B. C. (2020). How to Use SPSS®: A Step-By-Step Guide to Analysis and Interpretation (11th ed.). Routledge. ISBN: 978-0367175144.
- Harris, D. C. (2007). Quantitative Chemical Analysis. W.H. Freeman and Company.
- Moore, D. S., McCabe, G. P., & Craig, B. A. (2017). Introduction to the Practice of Statistics (9th ed.). W.H. Freeman and Company. ISBN: 978-1319013387.
- Witte, R. S., & Witte, J. S. (2017). Statistics (11th ed.). Wiley. ISBN: 978-1119455385.

ENH 11101 -
Biology for Physical Science Students

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Course Unit Code	ENH 11101			
Course Unit Name	Biology for Physical Science Students			
Credit value	1			
Compulsory/Elective/ Enhancement	Enhancement; Compulsory for Physical Science Students			
Prerequisites	none			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	15	-	-	50
Objective of the Course Unit	Understanding the structure and function of cells is fundamental to the study of biology and life sciences. This course is designed to provide students with a strong foundation in cellular biology, enabling them to comprehend the complexity of living organisms, their biological processes, and genetic principles.			
Evaluation Method	Continuous Assessments			

Intended Learning Outcomes (ILO)

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

ILO 1: explain the structure of cells in living organisms.

ILO 2: identify basic features of cells in plants, animals and microorganisms.

ILO 3: describe the structure and functions of cellular organisms;

ILO 4: explain the biological processes occurring in an animal and plant cell;

ILO 5: explain the principles involved inheritance and fundamentals of molecular human genetics

Course Content

1. **The cell (2 h)**

   Structure of the cell. Comparison of prokaryotic and eukaryotic cells, plant and animal cells. Structure and function of cellular organelles: Nucleus, cell membrane, cytoplasm, endoplasmic reticulum, ribosome, lysosome, mitochondria, cell wall, vacuole, chloroplast.

2. **Cell division (2 h)**

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

3. **Important microorganisms (2 h)**

   Classification of bacteria. Basic characteristics of viruses.
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4. **Biological processes (2 h)**

   Human biological processes, biological samples for analysis. Plant biological processes: Transport-xylem and phloem, gaseous exchange

5. **Molecular basis of inheritance (3 h)**

   DNA and RNA. Protein synthesis.

6. **Genetics (4 h)**

   Mendel's laws. Chromosomal basis of inheritance. Mutations. Genetics that deviate from Mendel's laws: Incomplete dominance, co-dominance, polyallelism, gene interaction, polygenic inheritance, gene linkage. Human genetic disorders.

Methods of Teaching and Learning

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

Recommended Readings

- Molecular Biology of the Cell – Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P.
- Essential Cell Biology – Alberts, B., Bray, D., Hopkin, K., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P.
- Genetics: A Conceptual Approach – Pierce, B. A.

ENH 11111 -
Mathematics for Biological Science Students

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Course Unit Code	ENH 11111			
Course Unit Name	Mathematics for Biological Science Students			
Credit value	1			
Compulsory/Elective/ Enhancement	Enhancement; Compulsory for Biological Science students.			
Prerequisites	None			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	15	-	-	50
Objective of the Course Unit	To provide basic knowledge in mathematics required to follow courses in chemistry			
Evaluation Method	Continuous Assessments			

Intended Learning Outcomes (ILO)

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

ILO 1: apply the basic mathematical concepts of numbers in solving problems in chemistry

ILO 2: solve problems in chemistry using the basic knowledge of algebra and trigonometry

ILO 3: draw graphs of various functions

Course Content

1. **Numbers (3 h)**

   Real numbers, integers, prime numbers, rational and irrational numbers, complex numbers, laws of indices, logarithms, laws and properties of logarithms, natural logarithm and logarithmic functions, relationship between logarithms and exponential terms, permutations and combinations, factorials

2. **Basic algebra (4 h)**

   Expressions and terms, products, factors and quotients, simplification, expansion, types of equations, simple (first degree), quadratic (second degree), simultaneous, formulae, variables/constants; Solving of equations.

3. **Functions (2h)**

   Variables, functions with one and more than one variable, linear and nonlinear functions, exponential functions, partial fractions, infinity, binomial theorem, polynomials
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4. **Graphs (2h)**

   Equations of straight line and circle, relationships between Cartesian and polar coordinates, tangents to a curve

5. **Basic trigonometry (2h)**

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

6. **Problem Solving (2h)**

   Solving chemistry-based problems combing above key concepts

Methods of teaching and learning

Interactive lectures, tutorial discussions, student-centered small group discussions and think-pair-share activities

Recommended readings

- Hanifa, M. R. M. (2009). Mathematics for Chemistry and Biology Students (PSE3117), Open University of Sri Lanka publication
- Ball, H and Pearce C (2018) Pure Mathematics 1,2 & 3 Collins (UK)

ENH 11122 -
General English and Effective Communication

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Course Unit Code	ENH 11122			
Course Unit Name	General English and Effective Communication			
Credit value	2			
Compulsory/Elective/ Enhancement	Enhancement; Compulsory			
Prerequisites	None			
Hourly breakdown	**Theory**	**Practical**	**Independent learning**	**Notional learning hours**
	15	30	-	100
Objective of the Course Unit	To enhance students' English language proficiency and communicative competency in English			
Evaluation Method	Continuous Assessments			

Intended Learning Outcomes (ILO)

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

ILO 1: Demonstrate improved proficiency in reading, writing, speaking, and listening in English, with an expanded vocabulary and more accurate use of grammar.

ILO 2: Apply principles of effective communication in various contexts, including interpersonal, group, and professional settings, ensuring clarity, coherence, and engagement.

ILO 3: Analyze and construct well-reasoned arguments in both spoken and written forms, using evidence and logical reasoning to support your ideas.

ILO 4: Deliver confident and persuasive oral presentations, using appropriate language, tone, and non-verbal communication to engage and inform an audience.

ILO 5: Produce clear, coherent, and structured written texts for a range of purposes, including reports, essays, emails, and formal correspondence.

Course Content

1. **Language Proficiency Essentials (Theory:2 h; Practical: 4 h)**

   Vocabulary expansion strategies, grammar fundamentals and common errors, reading comprehension techniques, vocabulary quizzes and flashcard exercises, grammar correction drills and sentence restructuring, reading comprehension exercises with diverse text types

2. **Advanced Listening and Speaking (Theory: 2 h; Practical: 4 h)**

   Active listening skills for different contexts, pronunciation and fluency practice, engaging
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in structured dialogues and discussions, listening to various English dialects and summarizing content, role-playing conversations with emphasis on clarity and fluency, participating in debates or group discussions

3. **Writing Effective Laboratory Reports (Theory: 2 h; Practical: 4 h)**

   Writing activities: composing lab reports that comprehensively detail scientific experiments, documenting experimental procedures, recording observations made, discussing precautions taken, justifying obtained results, and reporting the conclusions drawn from the experiment

4. **Effective Written Communication Theory: 2 h; Practical: 4 h)**

   Structuring essays, reports, and other written documents, formal vs. Informal writing style, proofreading and editing techniques. Writing assignments including essays, business emails, and reports, peer review sessions for feedback on writing, editing exercises to refine written work

5. **Interpersonal and Group Communication (Theory:2 h; Practical: 4 h)**

   Definition and features of interpersonal communication, Verbal and non-verbal communication, Elements of effective interpersonal communication, Group dynamics and teamwork communication, Group projects that require collaboration and communication, Simulations of team meetings and decision-making processes

6. **Integrated Communication Projects (Theory:2 h; Practical: 4 h)**

   Reflection on personal communication strengths and areas for improvement. Capstone project integrating writing, speaking, and group communication skills, Final presentation or report demonstrating mastery of course content

7. **Professional Presentation Skills (Theory: 3 h; Practical: 4 h)**

   Designing and structuring presentations, Effective use of visual aids and body language, Techniques for engaging and persuading an audience, Creating and delivering presentations on selected topics, Peer and instructor feedback sessions, Practice sessions focusing on voice modulation and audience interaction

Methods of Teaching and Learning

Teaching methods may vary and include lectures, tutorials, and audio-visual aids. Classroom activities will provide hands-on learning experiences, while group discussions and seminars encourage collaborative learning through peer interaction.

Recommended readings

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

Communicate Effectively and Avoid Common Barriers to Effective Communication.

- Soars, L., Soars, J., & Hancock, P. (2019). Headway. Upper Intermediate, Student's book. Oxford University Press.
- Soars. L & Soars. J. (2009). American Headway: The World's Most Trusted English Course. Oxford: Oxford University Press.
- Soars. L & Soars. J. (2003). New Headway: Advanced Workbook with Key. Oxford: Oxford
- Communication in the Real World: An Introduction to Communication Studies - Open Textbook Library. (2016). Umn.edu; University of Minnesota Libraries Publishing.
- Hewings, M. (2002). Advanced English Grammar. Cambridge: Cambridge University Press.
- Meldrum, J. (2013). Speak Now: Communicate with Confidence. Oxford: Oxford University Press.

ENH 11131 - Basic Mathematics for Chemistry

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Course Unit Code	ENH 11131			
Course Unit Name	Basic Mathematics for Chemistry			
Credit value	1			
Compulsory/Elective/ Enhancement	Enhancement; Compulsory for both biological science and physical science students			
Prerequisites	ENH 11111 for Biological Science students			
Hourly breakdown	**Theory**	**Practical**	**Independent learning**	**Notional learning hours**
	15	-	-	50
Objective of the Course Unit	To provide students with a fundamental understanding of mathematical principles involving calculus to improve student learning in Physical Chemistry			
Evaluation Method	Continuous Assessments			

Intended Learning Outcomes (ILO)

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

ILO 1: perform differentiation and integration on various functions (algebraic, exponential, trigonometric, logarithmic etc.)

ILO 2: solve chemistry-related problems using differentiation techniques

ILO 3: solve chemistry-related problems applying integration

ILO 4: apply differentiation to determine turning points in various functions in chemistry-related problems

Course Content

1. Limits (2h)

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

2. Differentiation (5h)

Introduction, first principles, notations; Differentiation of sums, products, quotients, functions of functions and composite functions; Differentiation of logarithmic, exponential and trigonometric functions; Solving chemistry-based problems involving differentiation including think-pair-share activities.

4. Integration (4h)

Basic integrations, integration by parts, integration by partial fractions, definite and indefinite integrals, applications of integrations.
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5. Problem Solving (4h)

Solving chemistry-based problems involving differentiation and integration

Methods of Teaching and Learning

Interactive lectures, tutorial discussions, student-centered small group discussions and think-pair-share activities

Recommended Readings

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

CHE 12012 -
Concepts in Inorganic Chemistry I

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Course Unit Code	CHE 12012			
Course Unit Name	Concepts in Inorganic Chemistry I			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 11012			
Hourly breakdown	**Theory**	**Practical**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	To provide a comprehensive knowledge on radio and nuclear chemistry, Structure and properties of inorganic solids.			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: correlate nuclear stability with radioactivity

ILO 2: calculate binding energy per nucleon, energy release in fission/fusion reactions, half-life and age of fossils

ILO 3: describe detection methods for radioactivity

ILO 4: explain structures and properties of inorganic solids

ILO 5: apply band theory to metals, semiconductors and insulators;

ILO 6: apply X-ray diffraction methods in the study of solids

Course Content

1. Nuclear and Radiochemistry (15 h)

Definition for Nuclear chemistry, radiochemistry, nuclides, isotopes, isobars, isotones and radioactive nuclei; Stable and unstable isotopes, formation of radioisotopes and their properties; Introduction to mass defect, Einstein equation, binding energy and binding energy per nucleon; Calculation of binding energy and binding energy per nucleon; Properties of α, β and γ particles. Stability of the nucleus,

Stability of the nucleus: Explain the stability of the nucleus by using nuclear models - liquid drop model and shell model, odd-even rule, magic numbers, n/p ratio & band of stability and variation of binding energy per nucleon with mass number. Radioactive decay: Types of radioactive decay; Prediction of mode of decay/ possible products due to decay processes; Radioactive displacement law; Radioactive decay series: 4n, 4n+1, 4n+2
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and 4n+3; Radioactivity of actinides with special reference to thorium and uranium.

Kinetics of radioactive decay: Half-life, Rate of decay, Radioactive decay law, derivation of equations; Calculation of radioactive decay constant.

Nuclear power: Induced nuclear reactions by neutron bombardment, Charged particle accelerators, transuranium elements; Introduction to Nuclear fission, critical mass, fission of 235U; Energy balance of fission process, calculation of energy released from fission process; Introduction to Nuclear fusion; Chain reactions; Controlled and uncontrolled nuclear reactions, Principal components of a nuclear power plant and process involved, Nuclear reactors, Difference between a nuclear reactor and an atomic bomb, Fusion reactions in the sun.

Measurement of radiation:

Geiger Muller Counter; principle, instrumentation, plateau graph; Scintillation counter; Dosimeter.

Uses of radioisotopes:

In the Food industry. Nuclear medicine - Diagnostic and therapeutic purposes, radiopharmaceuticals: Tcm99, I131, P32, Inm113; synthesis of transuranium elements; Radiocarbon dating, Calculation of half-life and age of fossils; Isotope dilution analysis; activation analysis; Isotope exchange reactions.

2. Inorganic solids (15 h)

Definition of solid; classification of solids as crystalline and amorphous; Classification of crystalline solids as ionic, covalent, molecular and metallic.

Structure of ionic solids and metallic solids. Introduction to limiting radius ratio and structures, unit cell, close packing (cubic and hexagonal close packing) and non- close packing (body centered); interstitial holes; structures of ionic solid types AX and AX2, layer structures; defects in solids. state lattices: Stoichiometric and non-stoichiometric defects, colour centers; structures of metallic solids.

Electronic/electrical, magnetic and optical properties of inorganic solids. Electronic/ electrical properties of inorganic solids. Band theory: (applications only) Fermi level, band gap, electrical conductivity and classification of solids; Ionic conductivity, Superconductivity (explanation only).

Magnetic properties of inorganic solids. Origin of magnetism; Classification of magnetic behavior, Paramagnetic, diamagnetic, ferromagnetic; Temperature dependence of magnetism, curie temperature, Applications of magnetic materials

Optical properties of inorganic solids. Dielectric properties, Interaction of inorganic solids with electromagnetic radiation, How metals, semiconductors and insulators interact with

electromagnetic radiation; Nanoparticles and how they interact with electromagnetic radiation and the origin of the color of nanoparticles; Examples for application of solid materials in optical devices; X-ray powder diffraction and X-ray crystallography: unit cell parameters, crystal systems, Miller indices, application of above two methods in the study of solids. Synthesis and preparation of materials. Particles, ceramics, layers and coatings, chemical and physical processes, diffusion in solids.

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

Methods of Teaching and Learning

A combination of lectures, tutorials, and small group discussions.

Recommended Readings

- Housecroft, C. E; and Sharpe A.G. (2012). Inorganic chemistry, 4th edition, Pearson, England
- Brown,T. E.; H. Eugene H. LeMay, E. H.; Bursten, B. E.; and Murphy, C. (2017). Chemistry: The Central Science, 14th edition
- Stout G. H.; & Jensen,L. H.; X-ray Structure Determination.(1991), 2nd Ed, Wiley.
- Giacovazzo, C. Fundamentals of Crystallography (2011). Edited by F.M. Henry, Chapman and Hall Ltd.
- J. D. Lee, J. D. (2006). Blackwell science, Concise Inorganic Chemistry, 5th Edition, Pearson, England,
- Pfennig, B. P.; (2015). Principles of Inorganic Chemistry, John Wiley & sons

CHE 12022 -
Principles of Physical Chemistry I

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Course Unit Code	CHE 12022			
Course Unit Name	Principles of Physical Chemistry I			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	none			
Hourly breakdown	**Theory**	**Practical**	**Independent learning**	**Notional learning hours**
	30	-		100
Objective of the Course Unit	To provide knowledge on states of matter, thermodynamics and kinetics.			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: describe properties of ideal and real gasses using gas laws.

ILO 2: analyze chemical reactions using energetics.

ILO 3: calculate various thermodynamic parameters.

ILO 4: establish the rate law of a chemical reaction.

ILO 5: apply principles of chemical kinetics to different systems.

Course Content

1. States of matter (3 h)

Gaseous state of matter, properties of gases, perfect gases, real gases, review of the ideal gas equation of state, deviation of gases from ideal behaviour, van der Waals equation of state and other equations of state, kinetic molecular theory of gases, liquefaction of gases, reduced equation of state and law of corresponding states. Liquid state, random and orderly arrangement of molecules, solid state, crystalline and amorphous solids, plasma.

2. Introduction to thermodynamics (15 h)

Zeroth law of thermodynamics; First law of thermodynamics: Concepts of work, heat and energy, different types of work, isochoric, isobaric, isothermal and adiabatic processes; Thermal capacity, enthalpy, variation of internal energy and enthalpy with temperature; Thermochemistry: Hess' Law, standard state, enthalpy change of reactions, Kirchoff's equation; Univariant systems; Second law of thermodynamics and entropy functions, calculation of entropy changes, entropy as a criterion for spontaneity and equilibrium;
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Introduction to the concept of free energy, Gibbs and Helmholtz functions. Temperature, volume and pressure coefficients of ΔA and ΔG; Change in thermodynamic functions during isobaric, isochoric, isothermal and adiabatic processes. Standard change in Gibbs energy and equilibrium constant.

3. Introduction to kinetics (12 h)

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

Methods of Teaching and Learning

A combination of lectures and tutorial discussions.

Recommended Readings

- Atkins, P.; de Paula, J. (2014). Physical Chemistry, 9th Edition, W H Freeman.
- Levine, I.N.(2007). Physical Chemistry, 5th Edition, Tata McGraw-Hill.

CHE 12031 -
Fundamentals of Biochemistry II

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Course Unit Code	CHE 12031			
Course Unit Name	Fundamentals of Biochemistry II			
Credit value	1			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 11051			
Hourly breakdown	**Theory**	**Tutorial**	**Independent learning**	**Notional learning hours**
	15	2	-	50
Objective of the Course Unit	To provide the students an understanding of the structure and function of the Genetic Material of the living world and the different types of errors that can occur in it.			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: explain the structure of nucleosides, nucleotides, DNA & RNA, (mRNA & tRNA).

ILO 2: explain DNA damage, mutations, their effects and repair mechanisms

ILO 3: explain the biological processes associated with DNA & RNA

ILO 4: explain the gene, genetic code, its expression, regulation & function of telomeres

Course Content

1. **Nucleic acids. (3 h)**

   Structure and nomenclature of nucleosides & nucleotides. Molecular structure of DNA and forces stabilizing & different types of RNA and their functions.

2. **Functions of Nucleic acids. (4 h)**

   DNA replication (semiconservative) process. Enzymes involved.

   Replication on leading & lagging strands. Transcription process – synthesis of mRNA. Translation process (protein synthesis). Role of mRNA & tRNA in protein synthesis. 2nd genetic code.

   Proof reading of mRNA translation. Signal peptide & function.

3. **The gene, gene expression & regulation. (4 h)**

   The Gene – structure & function. The genetic code (triplet code, codon), The characteristics of code. Regulation of gene expression – operon concept.
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4. DNA Mutations, DNA Damage and repair & telomeres. (4 h)

Types of DNA mutations and their effects. DNA damage – causes of DNA repair mechanisms. Telomeres, their functions.

Methods of Teaching and Learning

A combination of lectures, guided Learning Sessions & tutorials.

Recommended Readings

- Abali, E. E.; Cline, S. D.; Franklin, D. S.; Viselli, S. M. Lippincott® Illustrated Reviews: Biochemistry; Lippincott Williams & Wilkins, 2024.
- Rodwell, V. W.; Bender, D. A.; Botham, K. M.; Kennelly, P. J.; Weil, P. A. Harper's Illustrated Biochemistry 31E; 2018.
- Devlin, T. M. Textbook of Biochemistry with Clinical Correlations; Wiley-Liss, 2002

CHE 12042 - Organic Chemistry II

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Course Unit Code	CHE 12042			
Course Unit Name	Organic Chemistry II			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 11022			
Hourly breakdown	**Theory**	**Practical**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	To introduce further principles and reaction in Organic Chemistry			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: differentiate between stereo isomers as well as conformational isomers

ILO 2: Identify intermediates encountered in Organic reactions and to rationalize their stability

ILO 3: Illustrate the feasibility of a reaction using energy profiles

ILO 4: Propose mechanisms for reaction proceeding through the reactive intermediates

ILO 5: Identify aromatic, antiaromatic and nonaromatic compounds

ILO 6: Propose pathways for intramolecular and multistep reactions

ILO 7: Predict the rate and orientation of electrophilic substitution of substituted benzene

ILO 8: Propose pathways for Nucleophilic Aromatic substitution

Course Content

1. Aromatic Compounds (10 h)

Aromaticity: Huckel rule, overview of aromatic, anti-aromatic and non-aromatic compounds. Non benzonoid aromatic Compounds. Electrophilic aromatic substitution: energy profile, activating, deactivating groups and position of electrophilic substitution of substituted benzenes. Acidity of phenol and substituted phenols. Basicity of aliphatic amines and substituted aromatic amines.

Nucleophilic aromatic substitution. Addition-elimination mechanism involving carbanion intermediate; effect of electron withdrawing group at ortho, para positions and effect of leaving group on the rate of reaction as illustrated through energy profiles.
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Elimination- addition mechanism involving bezyne as intermediate.

2. Reactive intermediates in Organic Chemistry (10 h)

Structure and factors affecting stability of Carbocations, carbanions, free radicals, carbenes, nitrenes.

Reactions and rearrangement reactions involving these intermediates. Carbocations – Pinacol Pinacolone, Carbanions - Benzoin condensation, Carbene – Riemer Tieman Reaction, Nitrene – Curtius rearrangement and Lossen rearrangement.

Doubly Stabilized carbanions (active hydrogen compounds) – Reactions of ethyl acetoacetate and diethyl malonate.

3. Structure, nomenclature and stereochemistry of organic compounds (10 h)

Basic concepts in organic chemistry: Resonance, IUPAC nomenclature of organic compounds, hybrid atomic orbitals, bond polarity, intermolecular forces.

Isomerism: Geometrical (E and Z) and optical (R and S) isomerism, optical activity, enantiomers, diastereomers, meso compounds, chiral compounds without asymmetric atoms, Fisher projections, Newman projection, conformational isomers of acyclic and cyclic compounds, structural isomerism, stereoisomerism.

Methods of Teaching and Learning

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

Recommended Readings

- Solomons, T. W. G.; Fryhle, C. B.; Snyder, S. A. (2013). Organic Chemistry, 11th Edition, John Wiley.
- McMurry, J. E. (2011). Organic Chemistry, 8th Edition, Brooks Cole.
- Wade Jr, L. G. (2012). Organic Chemistry, 8th Edition, Pearson.
- Ege, S. N. (2003). Organic Chemistry, Structure and Reactivity, 5th Edition, Houghton Mifflin Harcourt.

CHE 12051 -
Classical Methods in Chemical Analysis II

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Course Unit Code	CHE 12051			
Course Unit Name	Classical Methods in Chemical Analysis II			
Credit value	1			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 11041			
Hourly breakdown	**Theory**	**Practical**	**Independent learning**	**Notional learning hours**
	15	-	-	50
Objective of the Course Unit	To provide a comprehensive understanding of redox and complexometric titrimetry			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: sketch redox titration curves for single step and multistep titrations involving different thermodynamic properties

ILO 2: explain conditional formation constants

ILO 3: apply complexometric titrations in analysis

Course Content

1. **Redox titrations (7 h)**
   Redox titrations and titration curves, selection of redox indicators, thermodynamic aspects of redox titrations, iodometric titrations.

2. **Complexometric titrations (8 h)**
   pM calculations, theoretical titration curves, conditional formation constants, effect of pH on conditional formation constant; Indicators for complexometric titrations.

Methods of Teaching and Learning

A combination of lectures, tutorials, peer assisted student support (PASS) sessions and small group discussions.

Recommended Readings

- Skoog, D. A.; West, D. M.; Holler, F. J.; Crouch, S. R., Fundamentals of Analytical Chemistry. Cengage Learning: 2013.
- Day; Underwood, Quantitative Analysis. Prentice Hall PTR: 1991.
- Harris, D. C.; Lucy, C. A., Quantitative Chemical Analysis. WH Freeman: 2018.
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CHE 12061 -
Analytical Chemistry Laboratory

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Course Unit Code	CHE 12061			
Course Unit Name	Analytical Chemistry Laboratory			
Credit value	1			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 12051			
Hourly breakdown	**Theory**	**Practical**	**Independent learning**	**Notional learning hours**
	-	45	-	50
Objective of the Course Unit	To provide fundamental skills in chemistry laboratory			
Evaluation Method	Attendance 10 % Mid-term Assessment 20%		Lab Reports 10% Final Assessment 60%	

Intended Learning Outcomes (ILO)

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

ILO 1: prepare buffer solutions;

ILO 2: determine analyte concentration using complexometric titrations

ILO 3: practice techniques in gravimetry

ILO 4: perform quantitative analysis in colorimetry

Course Content

1. **Redox titrations (18 h)**
   Titrations with potassium permanganate and potassium dichromate, iodometric titrations.

2. **Complexometric titrations (18 h)**
   Differentiation of Mg and Ca ions in a mixture, elimination of interferences in EDTA titrations.

3. **Gravimetry (6 h)**
   Homogeneous precipitation, weight measurement techniques, gravimetry using sintered glass crucibles, gravimetry using sample ignition techniques.

Methods of Teaching and Learning

A combination of Lab lectures, practical sessions.
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Recommended Readings

- Svehla, G. (1996). Vogel's Qualitative Inorganic Analysis, 7th Edition, Prentice Hall.
- Skoog, D. A.; West, D. M.; Holler, F. J.; Crouch, S. R. (2013). Fundamentals of Analytical Chemistry, 9th Edition, Cengage Learning.

APM 12072 -
Introduction to Industrial Economics

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Course Unit Code	APM 12072			
Course Unit Name	Introduction to Industrial Economics			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	None			
Hourly breakdown	**Theory**	**Practical**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	To equip students with the principles and tools of industrial economics for analysing investments and making informed business decisions under varying economic conditions.			
Evaluation Method	Final Assessment 100%			

Intended Learning Outcomes (ILO)

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

ILO 1: explain difference between microeconomics and macroeconomics;

ILO 2: explain scarcity, choice, opportunity cost, demand, supply, production, cost and revenue;

ILO 3: evaluate alternative capital investments;

ILO 4: explain current economic challenges related to investment projects and expansion of business operations;

ILO 5: explain how to deal with inflation, taxes, depreciation and uncertainty;

ILO 6: assess risks and uncertainty associated with industrial economic decisions.

Course Content

1. **Introduction to economics (6 h)**
   Microeconomics, macroeconomics. Demand, supply, production, cost and revenue.

2. **Capital investment alternatives (6 h)**
   Capital investment alternative, present worth (PW), annual cash flow analysis, rate of return analysis, future worth analysis, benefit-cost ratio analysis, payback period, sensitivity and breakeven analyses

3. **Introduction to Industrial economics (9 h)**
   The role and purpose of industrial and engineering economic analysis, costs and cost estimating, interest and equivalence, income and cash flow fundamentals.
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4. Depreciation, Taxation, and Inflation in Decision-Making (9 h)

Basic aspects of depreciation, causes of depreciation, depreciation for tax purposes, depreciation and asset disposal, taxation and capital cost allowance, impact of taxes on decisions, impact of inflation on economic decisions.

Methods of Teaching and Learning

Lectures, case discussions, presentations

Recommended Readings

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

APM 12082 -
Accounting Concepts and Costing

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Course Unit Code	APM 12082			
Course Unit Name	Accounting Concepts and Costing			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	None			
Hourly breakdown	**Theory**	**Practical**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	To equip students with essential accounting and costing skills for preparing financial statements, reconciling accounts, and supporting business decisions.			
Evaluation Method	Final Assessment 100%			

Intended Learning Outcomes (ILO)

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

ILO 1: explain the principles of financial and managerial accounting

ILO 2: record economic transactions and develop the key financial statements for the enterprise

ILO 3: reconcile a bank statement

ILO 4: identify and estimate the cost components for a product or service

Course Content

1. **Fundamentals of financial accounting (6 h)**

   Concepts and principles of financial accounting.

2. **Bookkeeping and financial statements (14 h)**

   Practice of bookkeeping including books of prime entry, ledgers and trial balance; preparation of trading, profit and loss account, and balance sheet; cash flow statement; bank reconciliation.

3. **Managerial use of accounting information and costing (10 h)**

   Application of accounting information for managerial decision-making in planning and control; cost classification; estimation and analysis; job-order costing, variable costing, and activity-based costing.
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Methods of Teaching and Learning

Lectures, case discussions, presentations

Recommended Readings

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

SUP 12092 -
Physics and Basic Electronics for Chemists

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Course Unit Code	SUP 12092			
Course Unit Name	Physics and Basic Electronics for Chemists			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	None			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	To impart knowledge on the application of physics in explaining chemical phenomena and electronics in signal measurement.			
Evaluation Method	Final Assessment 100%			

Intended Learning Outcomes (ILO)

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

ILO 1: apply optical principles to explain chemical instrumentation.

ILO 2: apply wave mechanics to molecular spectroscopy.

ILO 3: explain the working principles of basic electronic circuits used for chemical measurements.

ILO 4: explain the use of semiconductor devices in chemical instrumentation.

ILO 5: explain basic digital circuits, and the role of memory elements in simple digital systems.

Course Content

1. Optics (8 h)

Geometric Optics: Reflection, refraction, Snell's Law, lens equations (thin lenses); Optical systems in chemistry (e.g., microscopes, spectrophotometers).

Polarization & Optical Activity: Linear polarization, Malus's Law, circular/elliptical polarization; Polarizers and optical activity (chirality in molecules, sugar concentration measurements).

Wave Optics & Diffraction: Interference: Young's double slit, coherence; Diffraction: Single/double slit, diffraction gratings (spectroscopy applications).

X-ray diffraction: Bragg's Law, crystal structure analysis (emphasis on chemical applications).
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Mass Spectrometry Basics: Ion production/detection, basic MS principles (time-of-flight, quadruple).

2. Waves and Vibrations (10 h)

Harmonic Motion & Resonance: Simple harmonic motion (SHM), damped/forced vibrations; Resonance in molecular spectroscopy (IR, NMR).

Wave Physics: Wave equation, phase/group velocity (pulse propagation); Impedance matching (e.g., ultrasound in material analysis); Fourier analysis (brief intro to spectral decomposition).

Sound & Acoustics: Speed of sound, Doppler effect (ultrasonic); Acoustics in labs (noise reduction, pressure level measurements); Applications of Electromagnetic Radiations: Microwave, Ultrasound.

3. Circuit Theory (4 h)

DC & AC Circuits: Voltage/current sources, RMS values, resistor networks; Thevenin's theorem (circuit simplification for sensors).

Transients & Signal Processing: RC/RL circuits (time constants, filtering noise in instruments); LC oscillations (brief, for NMR/RF applications).

4. Analog Electronics (5 h)

Semiconductors & Diodes: Introduction to p-type & n-type semiconductors; p-n junction diode: Forward & reverse bias; Diode as a circuit element (rectifiers, Zener diodes for voltage regulation); Applications in chemistry (LEDs, photodiodes in spectroscopy)

Transistors & Amplifiers: Bipolar junction transistor (BJT): n-p-n operation & biasing; Transistor as an amplifier (common emitter configuration); Transistor as a switch (basic concept); Brief introduction to FETs (JFET/MOSFET)

Operational Amplifiers (Op-Amps): Inverting & non-inverting amplifiers; Summing amplifiers (basic applications); Op-amp in chemical instrumentation (e.g., signal conditioning)

5. Digital Electronics (3 h)

Logic Gates & Boolean Algebra: Basic logic gates (AND, OR, NOT, NAND, NOR); Boolean laws & simplification techniques; Designing simple combinational circuits.

Karnaugh maps, Adders & Memory Elements: K-maps; minimization (2 variable example), Haff adder circuit (brief introduction), Flip-flop as memory (basic concept).

Methods of Teaching and Learning

Lectures, tutorial discussions, small group discussions and computer assisted learning.

Recommended Readings

- University Physics with Modern Physics Technology by Hugh D. Young Roger A. Freedman 13th Edition, 2014.
- Vibrations and waves, George C. King, John Wiley & Sons Ltd., 2009.
- Practical Electronics for Inventors, Paul Scherz and Simon Monk, 4th Edition, McGraw-Hill, 2016.
- The Art of Electronics, Paul Horowitz & Winfield Hill, Cambridge University Press, 3rd Edition, 2015.
- Basic Electronics for Scientists, J. J. Brophy, McGraw-Hill College, 1990.
- Digital Systems Principles and Applications, Ronald J. Tocci, Neil Widmer and Greg Moss, Pearson, 11th Edition, 2010.

LEVEL 2

CHE 21012 -
Organic Synthesis and Spectroscopy

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Course Unit Code	CHE 21012			
Course Unit Name	Organic Synthesis and Spectroscopy			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 12042			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	To introduce intermediary level Organic Synthesis and to introduce Spectroscopic methods to elucidate structure of simple Organic Compounds			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: propose pathways to synthesize simple organic molecules

ILO 2: device routes for the transformation of functional groups

ILO 3: strategize pathways for multi-step synthesis

ILO 4: illustrate rearrangement reactions using mechanisms

ILO 5: identify and describe the fundamental principles of electromagnetic radiation and its applications in ultraviolet and visible spectroscopy

ILO 6: analyze and interpret the molecular vibrations and absorption characteristics of functional groups using infrared spectroscopy

ILO 7: demonstrate the understanding of nuclear magnetic resonance (NMR) spectroscopy, including ^{1}H and ^{13}C NMR techniques

ILO 8: evaluate and apply the principles of mass spectrometry for molecular ion identification and fragmentation pattern analysis

Course Content

1. Organic Synthesis (12 h)

Polynuclear aromatic hydrocarbons. Properties, Synthesis and reactions of naphthalene, anthracene and phenanthrene. Synthetically useful Organic reactions Knoevenagel reaction, Dieckmann condensation, Micheal Addition, Robinson annulation. Extensions to Wittig reaction.
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Rearrangement reactions. Benzil to Bezillic acid conversion, Favroski, Claisen and para Claisen rearrangements, Bayer Villiger oxidation, Beckmann rearrangement, Cope rearrangement. Transition metal complex catalyzed reactions in organic synthesis. Baldwin's rule for ring closure reactions.

2. Organic Spectroscopy (18 h)

Introduction to Electromagnetic Spectrum. Basics of UV-visible spectroscopy, Chromophores, auxochromes, and solvent effects; applications. Infrared Spectroscopy; Introduction to infrared spectroscopy, Molecular vibrations and absorption characteristic of functional groups and Interpretation of infrared spectra. Nuclear Magnetic Resonance (NMR) Spectroscopy; Magnetic properties of nuclei and nuclear excitation, Principles of ^{1}H NMR spectroscopy: chemical shifts, spin-spin coupling, coupling constants, Interpretation of ^{1}H NMR spectra, Chemical shifts in ^{13}C NMR spectroscopy, Off-resonance spectra and broadband decouple ^{13}C NMR. Principles of mass spectrometry: Molecular ion and fragmentation patterns, Analysis and interpretation of mass spectra.

Methods of Teaching and Learning

A combination of lectures, tutorial, discussions.

Recommended Readings

- Solomons, T. W. G.; Fryhle, C. B.; Snyder, S. A. (2013). Organic Chemistry, 11th Edition, John Wiley.
- McMurry, J. E. (2011). Organic Chemistry, 8th Edition, Brooks Cole.
- Wade Jr, L. G. (2012). Organic Chemistry, 8th Edition, Pearson.
- Organic Chemistry Volume 2, 3rd Edition, I L Finar
- Spectrometric Identification of Organic Compounds, Silverstein, Webster, and Kiemle
- Organic Structures from Spectra, Leslie D. Field, Sebatian K. Schnung, Alan G. Maunder
- Interpretation of Mass Spectra, Fred W. McLafferty, Frantisek Turecek
- Introduction to Organic Spectroscopy, Laurence M. Harwood, Timothy D. W. Claridge

CHE 21022 -
Principles of Physical Chemistry II

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Course Unit Code	CHE 21022			
Course Unit Name	Principles of Physical Chemistry II			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	ENH 11131			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	To provide basic knowledge in quantum mechanics and molecular spectroscopy			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: describe the fundamentals of quantum mechanics and its postulates.

ILO 2: construct operators and normalize wave function.

ILO 3: solves the Schrodinger equation for a particle in 1-D, 2D, 3-D box models, calculate eigenvalues and expectation values.

ILO 4: describe rotational and vibrational spectra of diatomic molecules, interpret spectra, in terms of selection rules, accounts for the effect of anharmonicity in spectral features.

Course Content

1. Introduction to quantum mechanics (15 h)

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

2. Fundamentals of molecular spectroscopy (15 h)

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

Methods of Teaching and Learning

A combination of lectures, tutorials discussions.

Recommended Readings:

- Atkins, P.; de Paula, J. (2014). Physical Chemistry, 9th Edition, W H Freeman.
- Levine, I.N.(2007). Physical Chemistry, 5th Edition, Tata McGraw-Hill.
- Mcquarrie, D.A. (2007). Quantum Chemistry, 2nd Edition, University Science Books.
- Levine, I. N. (2008). Quantum Chemistry, 6th Edition, Prentice Hall.
- Bandarage, G; Physical Chemistry Part III, Introduction to molecular spectroscopy, OUSL.
- Bandarage, G; Understanding the basics of molecular spectroscopy, OUSL.

CHE 21032 -
Separation Methods and Atomic Spectroscopy

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Course Unit Code	CHE 21032			
Course Unit Name	Separation Methods and Atomic Spectroscopy			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 12061			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	To provide a fundamental understanding of analytical atomic spectroscopy, including its principles, instrumentation, and quantification. To provide a fundamental understanding of separation methods and theory of elution chromatography			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: apply Beer's law in quantitative analysis

ILO 2: illustrate the optical configuration of a typical atomic absorption and emission spectrometer

ILO 3: explain sample preparation methods in atomic spectroscopy

ILO 4: explain the principles of discontinuous liquid-liquid extraction

ILO 5: explain the fundamentals of ion exchange

ILO 6: define basic terminologies and interpret theoretical aspects of elution chromatography

Course Content

1. Beer's law and quantification techniques (6 h)

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

2. Atomic absorption and emission spectrometry (7 h)

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

3. Sample preparation for atomic spectrometry (2 h)

Mineral acid digestion, dry ashing methods and other sample preparation methods. Digestion efficiency and certified reference materials in atomic spectroscopy.

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

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

5. Principles in elution chromatography (8 h)

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

Methods of Teaching and Learning

A combination of classroom teaching, demonstrations, visual aids, spreadsheet application workshops and small group discussions.

Recommended Readings:

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

CHE 21041 -
Organic Chemistry Laboratory

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Course Unit Code	CHE 21041			
Course Unit Name	Organic Chemistry Laboratory			
Credit value	1			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 11022			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	-	45	10	50
Objective of the Course Unit	To develop basic practical skills in Organic Chemistry			
Evaluation Method	Attendance 10 % Mid-term Assessment 20%		Lab Reports 10% Final Assessment 60%	

Intended Learning Outcomes (ILO)

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

ILO 1: identify an organic compound using melting point and mixed melting points

ILO 2: purify an organic compound using recrystallization

ILO 3: plan a method and carry out the separation of components of a mixture of organic compounds

ILO 4: identify an unknown compound by derivatization

ILO 5: synthesize an organic compound

ILO 6: analyze the progress of a reaction using thin layer chromatography

Course Content

1. **Purification and identification of organic compounds**

   Re-crystallizations form single and mixed solvents, identification of compounds by boiling points, melting points and mixed melting point determinations.

2. **Separation of mixtures into their components**

   Acid-neutral; base–neutral, phenol-neutral, acid-phenol, three component mixture and identification of the components.

3. **Preparation of derivatives and characterization of organic compounds.**

4. **Synthesis of simple organic compounds (one pot synthesis).**
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5. Thin layer chromatography

5.1. Determination of purity of an organic compound;

5.2. Monitoring of the progress of a reaction.

Methods of Teaching and Learning

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

Recommended Readings

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

APM 21052 -
Principles of Human Resource Management and Leadership

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Course Unit Code	APM 21052			
Course Unit Name	Principles of Human Resource Management and Leadership			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	None			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	To introduce key HRM functions and leadership styles for effective people management.			
Evaluation Method	Final Assessment 100%			

Intended Learning Outcomes (ILO)

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

ILO 1: demonstrate understanding of the theoretical aspects of HRM functions;

ILO 2: analyse the application of HRM techniques of staffing, recruitment, selection, training and development, performance appraisal and reward systems in less complex scenarios;

ILO 3: identify different leadership styles and their application.

Course Content

1. **Fundamentals of Human Resource Management (HRM) (18 h)**

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

2. **Leadership and communication in organizations (12 h)**

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

Methods of Teaching and Learning

Lectures, discussion of cases and self-study
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Recommended Readings

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

APM 21062 -
Marketing Management

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Course Unit Code	APM 21062			
Course Unit Name	Marketing Management			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	None			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	To provide students with the knowledge and skills to understand core marketing concepts, analyze diverse marketing situations, and develop effective marketing plans for organizational success.			
Evaluation Method	Final Assessment 100%			

Intended Learning Outcomes (ILO)

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

ILO 1: explain the increasingly significant role of marketing in modern organizational management;

ILO 2: identify the variables at work of various marketing situations;

ILO 3: prepare a comprehensive marketing plan for a business organization.

Course Content

1. **Marketing principles and evolution (6 h)**

   Evolution of marketing, conceptualization of marketing philosophies and concepts, overview of marketing goals and strategies.

2. **Strategies of marketing and consumer behavior (18 h)**

   Consumer behavior, market segmentation and targeting, marketing mix, strategies for products, pricing, distribution, and promotion, brand strategies and brand management.

3. **Marketing planning and implementation (6 h)**

   Preparation, presentation, and implementation of a marketing plan.

Methods of Teaching and Learning

Interactive classroom sessions, case analysis, projects
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Recommended Readings

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

APM 21072 -
Total Quality Management

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Course Unit Code	APM 21072			
Course Unit Name	Total Quality Management			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	None			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	To provide students with the knowledge and skills to understand quality management concepts, apply quality standards, conduct quality audits, and use statistical process control tools for improving processes in production and service systems.			
Evaluation Method	Final Assessment 100%			

Intended Learning Outcomes (ILO)

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

ILO 1: identify the difference between quality control and quality assurance
ILO 2: implement quality controlling quality assurance parameters
ILO 3: explain the term "Standards Formulation Process"
ILO 4: discuss different quality management systems
ILO 5: carry out a quality audit
ILO 6: apply statistical process control in production and service systems

Course Content

1. **Fundamentals of quality management (10 h)**

   Quality, quality control, quality assurance, total quality management, complaint mushroom, quality chain, process definition, Deming cycle, standardization concepts and levels, conformity assessment, accreditation, quality management principles, quality costs, standards formulation process, and the 5S concept.

2. **Standards, certification, and quality auditing (10 h)**

   Product certification schemes, ISO 9001:2015 standard requirements, ISO 14000 standard requirements, ISO 22000 standard requirements, ISO 17025 laboratory management system requirements; quality auditing – definition, types, classification, conducting audits, and audit reporting.
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3. Quality management tools and process capability (10 h)

Seven quality management tools (Pareto analysis, flow chart, check sheet, histogram, scatter diagram, control chart, cause-and-effect diagram), sampling methods, detailed study of histograms and control charts, variable and attribute control charts, process capability indices (Cp and Cpk).

Methods of Teaching and Learning

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

Recommended Readings

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

SUP 21081 -
Mathematics for Chemistry I

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Course Unit Code	SUP 21082			
Course Unit Name	Mathematics for Chemistry I			
Credit value	1			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	ENH 11131			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	15	-	-	50
Objective of the Course Unit	To provide students with basic knowledge on solving differential equations			
Evaluation Method	Final Assessment 100%			

Intended Learning Outcomes (ILO)

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

ILO1: solve chemistry problems related to partial differentiation

ILO2: determine turning points in non-linear graphs

ILO3: solve chemistry problems applying differential equations

Course Content

1. **Partial differentiation and total differentiations (4h)**

   Concept of partial derivative, notation, total differential; Turning points, maxima, minima and point of inflexion, exact and inexact differential equations, Eulers' theorem, homogeneous functions

2. **Differential equations (4 h)**

   Introduction to differential equations, solving first-order differential equations and applications in chemical kinetics, second-order differential equations and applications in physical chemistry

3. **Applications and Problem solving (7 h)**

   Applications of partial differentiation and differential equations in solving problems in Chemical Kinetics, Chemical Thermodynamics, Quantum Mechanics, Electrochemistry
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Methods of Teaching and Learning

Interactive lectures, Classroom discussions, Tutorial discussions, Quizzes, Take home assignments, VLE, LMS based independent learning activities, Interactive videos

Recommended Readings

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

CHE 22012 -
Concepts in Inorganic Chemistry II

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Course Unit Code	CHE 22012			
Course Unit Name	Concepts in Inorganic Chemistry-II			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 12012			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	To provide a solid foundation in elements of symmetry and symmetry operations, Concepts in Coordination Chemistry and Organotransition metal Chemistry			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: apply symmetry elements and symmetry operations for molecules.
ILO 2: Determine point group for molecules
ILO 3: Apply IUPAC nomenclature
ILO 4: Identify isomerism in coordination complexes
ILO 5: Calculate overall formation constant
ILO 6: Predict colour, magnetism and Jahn teller distortion in transition metal complexes
ILO 7: Apply VBT and MOT for different coordination complexes.
ILO 8: calculate oxidation state of the metal and total electron count at the metal in organometallic compounds;
ILO 9: explain bonding in metal-π-bonding ligands in organometallic compounds;

Course Content

1. **Molecular symmetry (6 h)**

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

2. **Coordination chemistry (18 h)**

   Definitions & HSAB theory, Central metal atom/ion, ligands and donor atoms, coordination sphere, coordination number, Determination of coordination number and oxidation number, monodentate, bidentate, etc. and polydentate ligands, ambidentate
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ligands, bridging ligands, chelate complexes, hard/soft acid base theory. Isomerism and nomenclature of coordination complexes: Types of isomerism, IUPAC nomenclature. Stability of complexes in aqueous solution: Stepwise and overall formation constants, thermodynamic and kinetic stability, Factors affecting stability of complexes: chelate effect, macrocyclic effect. Bonding in coordination complexes. Valence Bond Theory (VBT): Formation of metal-ligand bonds, Back-bonding, Werner's coordination theory, Effective atomic number (EAN), EAN of metal-nitrosyl complexes, Hybridization of octahedral complexes, Application of VBT to four-coordinated systems (tetrahedral and square planar complexes).

Crystal Field Theory: Octahedral and tetrahedral crystal fields, splitting of d-orbitals by octahedral, tetrahedral and square planar fields, determination of crystal field splitting energy and crystal field stabilization energy, factors affecting magnitude of (Δ), pairing energy, high spin and low spin complexes, spectrochemical series, CFT to explain thermodynamic and structural properties of transition metal complexes, colour and magnetism of transition metal complexes, tetragonal distortion, Jahn-Teller effect. Molecular Orbital Theory (MOT): Features of MOT, Types of molecular orbitals, Symmetry designation of molecular orbitals, MOTs of metal complexes with all sigma bonds, MOTs of metal complexes with pi bonding (pi-acceptors and pi-donors), Figuring out octahedral splitting energy of MOTs.

3. Introductory organotransition metal chemistry (6 h)

Introduction to organotransition metal chemistry, classification of ligands according to the number of electrons donated, oxidation state formalism, hapticity of a ligand (η^n). Total valence electron count and geometry Total valence electron count in organometallic compounds, the 18-electron rule, coordinative unsaturation, geometry of organotransition metal complexes.

Methods of Teaching and Learning

A combination of lectures, tutorials, peer assisted student support sessions and small group discussions.

Recommended Readings

- Housecroft, C. E; and Sharpe A.G. (2012). Inorganic chemistry, 4th edition, Pearson, England
- Shriver and Atkins (2010), Inorganic Chemistry, 5th Edition.
- Robert H. Crabtree, The Organometallic Chemistry of the Transition Metals, 5th Edition
- J. D. Lee, J. D. (2006). Blackwell science, Concise Inorganic Chemistry, 5th Edition, Pearson, England,
- Robert H. Crabtree, The Organometallic Chemistry of the Transition Metals, 5th Edition

CHE 22022 -
Heterocyclic Chemistry and Natural Products

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Course Unit Code	CHE 22022			
Course Unit Name	Heterocyclic Chemistry and Natural Products			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 21012			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	To introduce synthesis and reactivity Organic Compounds containing heteroatoms and natural products			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: relate the nature of bonding to structural features, properties and reactivity of the heterocyclic compounds

ILO 2: to relate basic heterocyclic moieties to important naturally occurring molecules

ILO 3: provide an overview of the field of natural product chemistry

ILO 4: identify different types of natural products, their occurrence, structure, biosynthesis and properties

ILO 5: Describe the chemistry of selected alkaloids, steroids, terpenoids, polyketides and phenyl propanoids

ILO 6: Evaluate the significance of natural product chemistry in various industries and applications

Course Content

1. Heterocyclic Chemistry (15 h)

Classification of heterocyclic compounds. Nomenclature of heterocyclic compounds. Molecular orbital picture. Structure and aromaticity of pyrrole, furan, thiophene and pyridine. Methods of synthesis, properties and chemical reactions of Pyrrole, Furan, Thiophene and Pyridine. Dipyrryl systems, tetra pyrryl systems, porphyrins, naturally occurring pyrrole systems (chlorophyll, heamaglobin, Vit B12), naturally occurring Thiophne (Biotin). Comparison of basicity of Pyridine, Piperidine and Pyrrole. Benzofuran, Benzothiophene and Benzopyrrole. Reactions of Benzopyrrole (Indole), Synthesis of Benzopyrrole (Indole), application of Indole in Drug Synthesis, Synthesis
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and Reactions of Benzofuran and Benzothiophene, Applications of the Benzofuran and Benzothiophene ring system in drug synthesis.

Benzopyridines: Reactions of Quinolines, synthesis of quinoline, application of the Quinoline ring system in drug synthesis, synthesis and reactions of Iso-quinolines, application of the Iso-quinoline ring system in drug synthesis. Dibenzopyrones, Pyrilium salts and other Benzopyrones, synthesis and reactions of Coumarins, reactions of Chromones, synthesis of Chromones, synthesis and reactions of dibenzopyrilium Salts, Application of the Coumarin and Chromones ring systems in drug synthesis. DNA and RNA related 2 heteroatom bases (purines and pyrimidines)

2. Natural Products Chemistry(15 h)

Introduction to primary and secondary metabolites: Define primary and secondary metabolites, classes of natural products. The importance of secondary metabolites in living organisms. Chemistry of selected terpenes; Classification of terpenes, identification of isoprene units, structures and functions of terpenes, biosynthesis of mono and sesquiterpenes, commercial significance of terpenes. Chemistry of selected steroids; Identify steroids like cholesterol, testosterone, estrone, etc., describe the biosynthesis pathways of steroids, analyze the roles of steroids in the body, discuss the industrial applications of steroids. Chemistry of selected alkaloids; Identify alkaloids such as ephedrine, nicotine, morphine, etc., Describe the structures and biosynthesis of selected alkaloids, Analyze the pharmacological properties of selected alkaloids, discuss the use of selected alkaloids in traditional medicine and modern pharmaceuticals. Polyketides and phenyl proponoids; Structural features of polyketides and phenyl proponoids, biosynthetic pathways of polyketides and phenylpropanoids, functions and biological activities of polyketides.

Methods of Teaching and Learning

A combination of lectures, tutorials, discussions.

Recommended Readings

- Gupta, R. R.; Kumar, M.; Gupta, V. (1998) Heterocyclic Chemistry, 1st Edition, Springer.
- Acheson, R.M. (1977). An Introduction to the Chemistry of Heterocyclic Compound, John Wiley & Sons
- W. Voelter, and D. G. Daves, (1984). Biologically active principles of natural products. Georg Thieme Verlag.
- Mann, J.; Davidson, R. S.; Hobbs, J.B.; Banthorpe, D.V.; Harbone, J.B. (1996). Natural Products: Their Chemistry and Biological Significance, Longman.
- Natural Products Chemistry: Sources, Separations and Structures" by R. A. Carlson

CHE 22032 -
Principles of Physical Chemistry III

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Course Unit Code	CHE 22032			
Course Unit Name	Principles of Physical Chemistry III			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 12022			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	To provide fundamental knowledge in electrochemistry, phase equilibrium and surface chemistry.			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: determine the electromotive force (emf) of galvanic cells, and apply principles of electrochemistry and thermodynamics to electrochemical cells.

ILO 2: determine conductivity, molar conductivity of electrolytes, apply Kohlrausch's Law to electrolytes.

ILO 3: calculate ionic strength, activity coefficient and ion activity

ILO 4: apply phase rule to systems, calculate changes in thermodynamic parameters during phase transitions.

ILO 5: explain phase diagrams of multicomponent systems.

ILO 6: calculate surface tension of liquids using experimental methods,

ILO 7: perform calculations involving adsorption isotherms in different systems, apply surface phenomena to coloids

Course Content

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

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

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

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

Methods of Teaching and Learning

A combination of lectures, tutorial discussions.

Recommended Readings

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

CHE 22041 -
Introduction to Metabolisms in Biochemistry

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Course Unit Code	CHE 22041			
Course Unit Name	Introduction to Metabolism in Biochemistry			
Credit value	1			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 11051, CHE 12031			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	15	-	2	50
Objective of the Course Unit	To provide the students an understanding of how living organisms release & trap energy from biofuels (carbohydrates, lipids and proteins), synthesize important lipids, control metabolisms through hormones.			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: explain what is implied by Metabolism and in redox reaction within biological systems

ILO 2: explain role of glycolysis & TCA in the release of energy from glucose, fructose & galactose (Carbohydrates).

ILO 3: explain biological process and application of phosphorylation, glycolysis, TCA in biological systems

ILO 4: explain the Chemiosmotic hypothesis.

ILO 5: outline the synthesis of fatty acids, triglycerides, Phospholipids, cholesterol & prostaglandins.

ILO 6: explain the endocrine system, hormones & outline the synthesis of hormones and signal transductions.

Course Content

1. **Pathways for the release of energy from biofuels – (6 h)**

   The glycolytic pathway: Where it occurs and the significance of phosphorylation of glucose as the first step. The molecular logic behind the reaction sequence of Glycolysis. The redox Rns of glycolysis. Regulation of glycolysis. Substrate level phosphorylation in glycolysis & its significance to maintaining life. Aerobic and anaerobic glycolysis & the significance. The logic behind lactate being produced under anaerobic conditions.
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Other pathways connected to intermediates of glycolysis. Entry of pyruvate into TCA – the pyruvatej). The Pyruvate dehydrogenase enzyme & the vitamins it requires as co – enzymes & its regulation. The TCA cycle. Where it occurs. Outline of the Rns. of TCA. The redox Rns. of TCA. Substrate level phosphorylation of TCA. Release of CO_2 from TCA. Regulation of TCA. Why TCA is inhibited under anaerobic conditions. Anaplerotic Rns. Oxidation. Release of fatty acids from lipids & entry of fatty acids into mitochondria. Regulation of FA entry into mitochondria. Outline of the β oxidation pathway. Why is it called oxidation. The molecular logic behind the Rn sequence. The redox Rns in pathway. Reason for the inhibition of β oxidation in hypoxia. oxidation of unsaturated fatty acids. Oxidation of fatty acids with odd number of Cs.

Entry of Ac CoA into TCA. Oxidative phosphorylation. Outline of arrangement of components of e transport chain – the 4 complexes. Flow of electrons along e transport chain. Entry of reducing equivalents into e transport chain. Complex 5 and its function. Why this ATP synthesis is called Oxidative phosphorylation. Mitchel's chemiosmotic hypothesis. Inhibitors & uncouplers.

2. **Lipid biosynthesis (fatty acids, Triglycerides, phospholipids, cholesterol & Prostaglandins) (5 h)**
   Outline of fatty acid synthesis & regulation. Importance of NADPH. Outline of TG synthesis. Outline of phospholipid synthesis. Outline of cholesterol synthesis. The Rn catalyzed by HMG Co A reductase. Effect of statins & propionic acid on cholesterol synthesis. Outline of prostaglandin synthesis and effect of aspirin.

3. **Hormones & mechanism of action. (4 h)**
   The endocrine system. Functions of hormones and their characteristics. Types of hormones / classification. Synthesis of amine & thyroid hormones. Hormone signal transduction process & types.

Methods of Teaching and Learning

Lectures, SGDs & tutorials.

Recommended Readings

- Abali, E. E.; Cline, S. D.; Franklin, D. S.; Viselli, S. M. Lippincott® Illustrated Reviews: Biochemistry; Lippincott Williams & Wilkins, 2024
- Rodwell, V. W.; Bender, D. A.; Botham, K. M.; Kennelly, P. J.; Weil, P. A. Harper's Illustrated Biochemistry 31E; 2018.
- Devlin, T. M. Textbook of Biochemistry with Clinical Correlations; Wiley-Liss, 2002
- Nelson, D. L.; Lehninger, A. L.; Cox, M. M. Lehninger Principles of Biochemistry; Macmillan, 2008.

CHE 22052 -
Environmental Chemistry

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Course Unit Code	CHE 22052			
Course Unit Name	Environmental Chemistry			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 11041, CHE 12051, CHE 12022			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	4	100
Objective of the Course Unit	This course provides an in-depth understanding of the chemical processes and interactions within the atmosphere, water, and soil systems, equipping learners with the knowledge necessary to address environmental challenges, assess pollution, and promote sustainable management of natural resources.			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: Explain the layered structure of Earth's atmosphere and analyze the role of atmospheric phenomena, such as the greenhouse effect and albedo, in Earth's heat balance.

ILO 2: Evaluate the chemistry of the troposphere, including photochemical reactions, particulate matter dynamics, and their effects on air quality and public health.

ILO 3: Analyze the stratospheric ozone cycle, including the Chapman cycle and catalytic destruction, to evaluate the effectiveness of international measures like the Montreal Protocol in mitigating ozone depletion.

ILO 4: Interpret water quality parameters such as pH, BOD, COD, and turbidity to design strategies for assessing and improving aquatic systems' health.

ILO 5: Construct pH-pE diagrams to illustrate metal speciation

ILO 6: Recommend appropriate water purification techniques based on an understanding of water pollution sources and chemical treatment methods.

ILO 8: Evaluate the impact of climate change on aquatic systems and water conservation techniques.

ILO 7: Assess soil quality parameters and propose sustainable strategies to manage pollution and solid waste, considering natural and anthropogenic influences on the lithosphere.
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Course Content

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

   Layered classification of Earth's atmosphere, global temperature from ice ages to present, Wien's displacement law, albedo, Earth's heat balance, the greenhouse effect, and remote measurements of atmospheric composition. Chemistry of the troposphere: atmospheric carbon dioxide, atmospheric methane, atmospheric water vapor, residence time of atmospheric gases, particulate matter (total suspended particulate test, classifications, health risks, residence time calculations), control of particulate emissions, radiative forcing, photochemical reactions in the troposphere, tropospheric ozone, photochemical smog, acid rain, and indoor air pollution. Chemistry of the stratosphere: Dobson unit, Chapman cycle, steady-state concentration of ozone, catalytic destruction of ozone, Montreal Protocol, Freon numbers, and environmentally friendly refrigerants.

2. **Aquatic Chemistry (10 h)**

   Introduction to Hydrosphere: Introduction to hydrosphere; Ground and surface water, Fresh water and saline water systems; distribution of fresh water systems on the earth; hydrological cycle; chemistry related to unique properties of water; stratification of lakes; chemical and biochemical processes in water bodies. Dissolved gases, dissolved inorganic salts and organic matter in water: Dissolved gases: Examples; application of Henry's law; effects of dissolution of acidic gases on water quality; buffer capacity due to HCO3- ions; species distribution diagram for carbonate species. Dissolved inorganic salts: Examples and their effects on water qualities such as salinity, buffer capacity of sea water, alkalinity and hardness. Organic matter: Humic substances and their effects on water quality, introduction to particulate matter. pE-pH diagrams and redox reactions in natural waters: pE-pH diagrams: Definition and importance of pE; relationship between pE and equilibrium constant, pE and ΔG; introduction to pE-pH diagrams; stability limits of water; pE-pH diagram for iron species in water. Redox reactions in natural waters: Chemical species in reducing and oxidizing environment in water; examples for redox reactions in a water body; calculations using the Nernst equation. Water quality parameters and assessment methods: Physical and chemical water quality parameters; collection, storage, preservation & transportation of water samples; water quality assessment methods; calculation of alkalinity, hardness, BOD, COD etc. Chemistry involved in municipal water treatment - water for drinking: Quality of raw water sources; drinking water quality standards; chemistry relevant to physical and chemical treatment methods used in municipal water treatment process. Water pollution and impacts of climate change on water sector: Water pollution: Water pollution due to animal wastes, detergents, chemical industries etc., point sources and nonpoint sources, parameters to describe the pollution level of water; effects of oxygen consuming pollutants on water quality, introduction to waste water treatment technologies. Climate change: possible impacts of climate change on water sector.

3. Soil chemistry (10 h)

Introduction to soil chemistry: Introduction to lithosphere; rocks and minerals, soil formation; phases, and composition of soil. Physical properties of soil: Color, soil structures: primary soil particles, soil aggregates; importance of soil structure; soil pores, definition on soil porosity, soil permeability, infiltration rate and their importance, experimental method to determine soil infiltration rate; properties of sand, silt and clay; introduction to bulk density; soil texture: definition, textural classes, determination of soil type using the soil textural triangle; importance of soil texture. Chemical properties of soil: Acidic soils and alkaline soils: Method to measure soil pH, causes of soil acidification, impacts of soil acidity on agriculture and on soil minerals, Remedial measures for soil acidity, introduction to alkaline soils. Ion exchange in soil: Introduction, involvement of minerals, soil organic matter and root hairs in ion exchange processes; formation of permanent negative charge sites on montmorinolite and variable negative charge sites on humic substances; adsorption of cations on to negative sites and cation exchange process; comparison of the structure, cation exchange capacity and other properties of kaolinite with montmorinolite; effect of soil texture on CEC; nutrient uptake by ion exchange; effect of CEC on buffering action of soils; experimental method to determine cation exchange capacity of soil. Effects of quality of irrigation water on soil properties and soil pollution: Effects of quality of irrigation water on soil properties: Effects of salinity, sodium adsorption ratio (SAR), alkalinity, toxic ions, nutrients etc. of irrigation water on properties of soil; Management practices for irrigation water having high SAR. Soil pollution: Soil pollutants, effects of soil pollution.

Methods of Teaching and Learning

Classroom teaching, demonstrations, visual aids, field visits and small group discussions.

Recommended Readings

- Girard, J., Principles of Environmental Chemistry. Jones & Bartlett Learning: 2013.
- Manahan, S. E., Environmental Chemistry: Eleventh Edition. CRC Press: 2022.
- Martínez, C. E.; McBride, M. B., Environmental Chemistry of Soils. Royal Society of Chemistry: 2023.
- Sposito, G., The Chemistry of Soils. Oxford University Press: 2008.
- Gopalan, R.; Sugumar, R. W., A Laboratory Manual for Environmental Chemistry. I.K. International Publishing House Pvt. Limited: 2013.

CHE 22061 -
Green Chemistry

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Course Unit Code	CHE 22061			
Course Unit Name	Green Chemistry			
Credit value	1			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 11041, CHE 12061			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	15	-	-	50
Objective of the Course Unit	To provide knowledge in green chemistry concepts			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: judge the fate of pollutants using concepts of material balance in the environment;

ILO 2: identify different pollutants and their behavior and fate in the environment;

ILO 3: explain environmental concerns of chemical industry;

ILO 4: Illustrate fundamentals of green chemistry and sustainable technology

Course Content

1. **Material balance in the environment (2 h)**
   Mass transfer of pollutants in the environment, steady-state conservative systems; non-conservative pollutants: Batch, steady-state and non-steady state systems.

2. **Pollutants in the environment (3 h)**
   Organic pollutants in the environment: Stockholm convention and persistent organic pollutants (POPs); Persistent, bioaccumulative and toxic Pollutants (PBTs); Polychlorinated biphenyls (PCBs); Pesticides in the environment; Dumping of banned chemical weapons of mass destruction; Contaminants of emerging concern (CECs); Pharmaceutical pollutants and endocrine disruptors in aqueous systems; Biogenic and anthropogenic organic chemicals in the atmosphere; Heavy metal pollutants: The big four - cadmium, lead, mercury and arsenic; Industrial explosions and release of chemicals into the environment - Bhopal disaster; Dioxin release (Seveso, Italy); Minamata disease (methyl mercury); Asbestos diseases; Fetal alcohol syndrome; Bioconcentration, biomagnification and bioaccumulation of pollutants in the environment; Nuclear waste: harmful effects of
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radiation on humans; Factors influencing radiation damage; Units of radiation; Harmful limits of radiation; Effect of chain reactions and nuclear accidents.

3. **Risk assessment (3 h)**
   Epidemiologic rate comparison: 2×2 matrix method, relative risk, attributable risk, and odds ratio; Dose response assessment - dose response curves for acute toxicity; Median lethal dose and lethal concentration; Carcinogens: UC EPA classification and NIH classification of carcinogens; Potency factor for carcinogens; Incremental lifetime cancer risk; Chronic daily intake; Non-carcinogenic toxins: reference dose and hazard quotient; Exposure limits: permissible exposure limit; Short-term exposure limit; Immediately dangerous to life and health; Signal words: Caution, warning and danger.

4. **Waste management (2h)**
   Types of solid waste: industrial, municipal, hazardous, radioactive and clinical; Treatment (processing) of solid waste: composting and biogas production, monitoring environmental impact and quality assurance.

5. **Fundamentals of green chemistry and sustainable technology (5h)**
   Fundamentals: concept of green chemistry; Green solvents, earth-friendly plastics, replacing chlorine, replacing toxic materials and environmentally benign pesticides; Carbon footprint and carbon neutrality; Renewable energy: Importance of renewable energy; Biofuels and green fuels; Sustainable consumption and production: Five axioms of sustainability; Putting sustainability into practice.

Methods of Teaching and Learning

Classroom discussions, Tutorial discussions, Quizzes, Take home assignments, VLE, LMS based independent learning activities, Interactive videos

Recommended Readings

- Girard, J. E.; Girard, J., Principles of Environmental Chemistry. Jones & Bartlett Learning: 2014.
- Manahan, S. E., Environmental Chemistry, Eighth Edition. Taylor & Francis: 2004.
- Sotheeswaran, S. "Environmental Organic Chemistry" 03rd Edition, 2012, Institute of Chemistry Publications, Monograph No: 11

CHE 22071 -
Physical Chemistry Laboratory

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Course Unit Code	CHE 22071			
Course Unit Name	Physical Chemistry Laboratory			
Credit value	1			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 11061			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	-	45	-	50
Objective of the Course Unit	To provide skills needed to conduct experiments in Physical Chemistry, collect data and estimate parameters, estimate errors and make predictions.			
Evaluation Method	Attendance 10 % Quizzes/Mid-term Assessment 20%		Lab Reports 10% Final Assessment 60%	

Intended Learning Outcomes (ILO)

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

ILO 1: Learn to setup experiments, make measurements

ILO 2: Learn to control conditions during experiments

ILO 3: Calculate physical parameters using graphical representation of data.

ILO 4: Identify the sources of errors

ILO 5: Analyze errors, and propagation of errors

Course Content

Error Calculations (3 h)

Estimation of errors in physical chemistry measurements, Propagation of errors, Graphical methods

Experiments (30 h)

Practical sessions covering thermodynamics (Enthalpy change, Gibbs energy change and entropy change), equilibria (Equilibrium constant, temperature dependence), chemical kinetics (order, rate constant, Arrhenius activation energy), phase equilibria (Solid-liquid Composition-temperature phase diagrams, electrochemistry (conductivity, potentiometry), spectroscopy (Optical absorption, Beer-Lambert law, calibration plot).
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Methods of Teaching and Learning

Practical sessions (12-14 sessions), pre lab quizzes, laboratory reports, discussions and demonstrations..

Recommended Readings

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

APM 22082 -
Computer Based Tools for Management

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Course Unit Code	APM 22082			
Course Unit Name	Computer Based Tools for Management			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	None			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	To equip students with the skills to develop, analyze, and present business models using spreadsheet tools, VBA programming, and decision-support applications for effective managerial decision-making.			
Evaluation Method	Final Assessment 100%			

Intended Learning Outcomes (ILO)

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

ILO 1: apply Visual Basics and spreadsheet modeling in business;

ILO 2: utilize Excel as a decision-making support tool;

ILO 3: emphasize the use of Excel to document and demonstrate models.

Course Content

1. **Spreadsheet modelling for managerial applications (15 h)**

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

2. **Decision modelling, simulation, and risk analysis (15 h)**

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

Methods of Teaching and Learning

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

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

APM 22092 -
Operations Management

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Course Unit Code	APM 22092			
Course Unit Name	Operations Management			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	None			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	To introduce students to the principles, practices, and strategic role of operations management, enabling them to plan, design, and control manufacturing and service processes effectively.			
Evaluation Method	Final Assessment 100%			

Intended Learning Outcomes (ILO)

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

ILO 1: define the role of operations in an organization;

ILO 2: demonstrate basic competencies in planning and controlling of manufacturing and service operations.

Course Content

1. **Basics of operations management (15 h)**

   Introduction to operations management, background and development of production management systems, product design and process selection, strategic capacity planning, and quality management.

2. **Operations planning, design, and control (15 h)**

   Facility and work design, plant location and supply chain design, materials planning and control, managing inventories in supply chains, forecasting and demand planning, operations scheduling and sequencing, and recent trends in operations management.

Methods of Teaching and Learning

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

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

SUP 22101 -
Mathematics for Chemistry II

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Course Unit Code	SUP 22101			
Course Unit Name	Mathematics for Chemistry II			
Credit value	1			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	ENH 11111			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	15	-	-	50
Objective of the Course Unit	To provide students with basic knowledge on matrix algebra			
Evaluation Method	Final Assessment 100%			

Intended Learning Outcomes (ILO)

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

ILO 1: solve problems related to vectors in chemistry

ILO 2: perform operations of matrices and determinants

ILO 3: solve chemistry problems involving matrices and determinants

Course Content

1. **Vectors (4 h)**

   Introduction to vectors, cross product, dot product; Argand diagrams, applications relevant to chemistry

2. **Matrices (4 h)**

   Definition of a matrix, types of matrices, transpose, inverse, diagonal and unit matrix, Addition, subtraction and multiplication of matrices

3. **Determinants (2h)**

   Determinants of a 2 x 2, 3 x 3 matrices, rules of determinants, minors and cofactors, applications in chemistry

4. **Applications and Problem solving (5 h)**

   Applications of matrices, determinants, in solving problems in Quantum Mechanics,
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Molecular Symmetry, etc.

Methods of Teaching and Learning

Interactive lectures, Classroom discussions, Tutorial discussions, Quizzes, Take home assignments, VLE, LMS based independent learning activities, Interactive videos

Recommended Readings

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

ENH 22111 -
English for Scientific Writing

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Course Unit Code	ENH 22111			
Course Unit Name	English for Scientific Writing			
Credit value	1			
Compulsory/Elective/ Enhancement	Enhancement			
Prerequisites	ENH 11122			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	-	50
Objective of the Course Unit	To provide the basic English language skills needed for scientific writing			
Evaluation Method	Continuous Assessments			

Intended Learning Outcomes (ILO)

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

ILO 1: attain at least an upper-intermediate proficiency in the four language skills: listening, speaking, reading and writing;
ILO 2: be competent in the use of compound and complex sentence structures;
ILO 3: use of advanced vocabulary in writing tasks individually;
ILO 4: be able to make speeches (prepared and impromptu) and presentations;
ILO 5: be competent language users related to their professional environments;
ILO 6: be able to use English in subjects related to Science and Management;
ILO 7: be able to effectively write, understand, conceptualize and analyse information through charts, tables, diagrams and graphs;
ILO 8: transfer information into another format or mode.

Course Content

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

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

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

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

3. **Academic writing II (Theory: 2 h; Practical: 5 h)**
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Writing a literature review on a given topic and preparing a paper which is to be presented; Use of proper citations and quotations according to the accepted referencing method.

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

Data interpretation and research ethics.

Methods of teaching and learning

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

Recommended readings

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

LEVEL 3

CHE 31012 -
Advanced topics in Inorganic Chemistry-I

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Course Unit Code	CHE 31012			
Course Unit Name	Advanced Topics in Inorganic Chemistry-I			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 12012, CHE 22012			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	4	100
Objective of the Course Unit	This course unit is designed to provide skills in interpretation/ prediction of spectroscopic data of inorganic molecules and advanced knowledge in organotransition metal compounds.			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: explain the theories of UV-visible, IR, NMR, ESR, NQR and Mossbauer spectroscopy

ILO 2: Determine structures of inorganic complexes using various spectroscopic methods

ILO 4: explain metal-ligand bonding for various ligands

ILO 5: identify type of organometallic reaction involved in a given reaction

ILO 6: design suitable catalysts for selected industrial synthesis processes

Course Content

1. Physical methods in inorganic chemistry (15 h)

Energy requirements for different transitions, Introduction to various types of spectroscopic methods for structure elucidation of inorganic molecules/complexes

UV-visible spectroscopy: Theory, Frank-Condone Principle, spin and Laporte selection rules for electronic transitions and deviations, d-d transitions vs, charge transfer transitions, factors affecting the energy requirements of charge transfer transitions

IR spectroscopy: Theory, Potential energy curve, molecular vibrations, Fundamental transitions, overtone bands and combination bands, bond dipole moment vs. molecular dipole moment, types of vibrational modes, selection rule, IR vibrational modes of homonuclear and heteronuclear diatomic molecules, polyatomic molecules, determination of molecular geometry through IR vibrations, Factors affecting IR frequency, fingerprint for molecular identifications.
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NMR spectroscopy: Selection rules, Chemically and magnetically equivalent nuclei, splitting tree diagrams, spin decoupling, theory and application of NMR spectroscopy for inorganic compounds/transition metal complexes containing (i) spin ½ nuclei (e.g. ^{1}H, ^{19}F, ^{31}P, ^{195}Pt etc.) (ii) spin >1/2 nuclei (e.g. ^{11}B, ^{14}N), fluxional molecules

Electron paramagnetic resonance spectroscopy (EPR): Instrumentation, selection rules, g-factor, hyperfine coupling and Zero field splitting, electron-nucleus hyperfine interaction, hyperfine splitting involving (i) more than one equivalent proton (ii) n-number of non-equivalent protons, (iii) several sets of non-equivalent protons, Kramer's degeneracy, (iv) nuclei with spin >1/2

Nuclear quadrupole resonance (NQR) spectroscopy: Instrumentation, Theory and selection rule, structural information from NQR.

Mossbauer spectroscopy: Instrumentation, Theory, Mossbauer spectroscopy for Fe and Sn compounds/complexes

2. Advanced organotransition metal chemistry (15 h)

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

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

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

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

Methods of Teaching and Learning

A combination of lectures, tutorials, peer assisted student support sessions and small group discussions.

Recommended Readings

- Drago, R. (2012). Physical Methods in Inorganic Chemistry, East-West Press (Pvt.) Ltd., New York.
- Perera, K.S.D. "Inorganic NMR Spectroscopy", Institute of Chemistry Ceylon, Monograph No 25
- Parish R. V. (1990). NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic

Chemistry, E. Horwood

- Housecroft, C. E., and Alan G Sharpe, A. G. (2012), Inorganic chemistry, 4th Edition. Pearson, England
- Atkins, P.W.; Overton, T.L.; Rourke, J. P.; Weller, M. T.; Armstrong, F. (2010). Shriver & Atkins Inorganic Chemistry, 5th Edition, W. H. Freeman and Company, New York
- GarryM. L., Donald A. T., "Inorganic Chemistry" 4th Edition, (2010), Prentice Hall

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

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Course Unit Code	CHE 31022			
Course Unit Name	Physical Organic Chemistry, Pericyclic Reactions and Advanced Natural Products Chemistry			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 22022			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	To expose students to correlation of structure of organic compounds to reactivity; to aspects of Pericyclic Reactions; extended knowledge of biosynthesis, synthesis and uses of Natural Products			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: correlate free energy changes with structural changes for a given reaction;

ILO 2: predict the effect of solvents and isotopes on reactivity of organic reactions;

ILO 3: determine the mechanism and products formed in concerted reactions;

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

Course Content

1. Physical organic chemistry (10 h)

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

2. Pericyclic reactions (10 h)

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

3. Natural products chemistry (10 h)

Advanced extraction and separation methods in of Natural Products Chemistry. Screening natural products. Detailed study of biosynthetic pathways of selected natural products, Chemical and pharmaceutical uses of natural products. Industrial applications of natural products, biopesticides. Value addition to natural products.

Methods of Teaching and Learning

A combination of lectures, tutorials, and discussions.

Recommended Readings

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

CHE 31032 -
Quantum Chemistry and Molecular Spectroscopy

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Course Unit Code	CHE 31032			
Course Unit Name	Quantum Chemistry and Molecular Spectroscopy			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 21022			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	Provide advanced knowledge in quantum mechanics and molecular spectroscopy.			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: apply Schrödinger equation to such as harmonic oscillator, rigid rotor, H atom and use approximation methods to solve problems in quantum mechanics.

ILO 2: apply molecular orbital and bonding information to calculate energies of He-like atoms.

ILO 3: apply symmetry and group theory to predict IR and Raman activity of molecules.

ILO 4: demonstrate the applicability of microwave, infrared, and Raman spectroscopy to various molecular systems.

ILO 5: Explain the action of different types of lasers.

Course Content

1. Quantum Chemistry (15 h)

Harmonic oscillator model, rigid rotor model and angular momentum; Application of the Schrodinger equation to the hydrogen atom, energy levels and stationary states of the hydrogen atom; probabilistic aspects and orbital shapes, effect of a magnetic field on energy levels; Approximate methods, perturbation theory and variation method; Introduction to quantum chemical calculations on atoms and molecules; Born Oppenheimer approximation, Definition of atomic units and status of quantum chemical calculations on helium atom; Application of the above method for multi – electronic systems. Huckel
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molecular orbital theory.

2. Symmetry and group theory (10 h)

Applications of molecular symmetry, group multiplication and character tables, two dimensional irreducible representations, prediction of IR/Raman active vibrational modes.

3. Molecular spectroscopy (15 h)

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

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

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

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

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

Methods of Teaching and Learning

A combination of lectures, tutorials, discussions.

Recommended Readings

- Atkins, P.W.; Paula, J. D. (2009). Atkins Physical Chemistry, 9th Edition, Oxford University Press.
- Levine, I. N. (2008). Quantum Chemistry, 6th Edition, Prentice Hall.
- McQuarrie, D. A. (2007). Quantum Chemistry, 2nd Edition, University Science Books.
- Vincent, A. Molecular Symmetry & Group Theory (2013) Wiley.
- Davidson, G. (1991). Introductory Group Theory for Chemists, Springer Nature.
- Engle, T. (2012). Quantum Chemistry and Spectroscopy, 3rd Edition, Pearson
- Struve, W. S. (1989). Fundamentals of Molecular Spectroscopy, John Wiley & Sons, Inc.
- Pavia, D.L.; Lampman, G.M.; Kriz, G.S.; Vyvyan, J.R. (2007). Introduction to Spectroscopy, 4th Edition, Cengage Learning Products.
- Ball, D.W. (2009). The Basics of Spectroscopy, PHI Learning Pvt Ltd.

CHE 31042 -
Electroanalytical Chemistry and Optical Spectroscopy

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Course Unit Code	CHE 31042			
Course Unit Name	Electroanalytical Chemistry and Optical Spectroscopy			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 21022, CHE 22032			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	4	100
Objective of the Course Unit	To offer a foundational understanding of electroanalytical techniques and optical spectroscopy instrumentation.			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: apply electroanalytical techniques for quantitative and qualitative analysis

ILO 2: comprehend the factors that must be controlled to obtain reliable and reproducible electroanalytical data

ILO 3: identify basic components in optical spectrometry

ILO 4: illustrate optical configurations in molecular absorption spectrometry

ILO 5: explain the concept of Fourier transform and FTIR instrumentation

ILO 6: employ signal to noise ratio in instrumental analysis

Course Content

1. Electroanalytical chemistry (10 h)

Electrodes and potentiometry; Reference electrodes: Calomel electrode, Silver/ silver chloride electrode, liquid junction potentials, double junction reference electrodes; Indicator electrodes: Metallic indicator electrodes; Metal electrodes of the first kind, second kind and redox electrodes; Membrane electrodes: Ion selective electrodes; Response and selectivity of ion selective electrodes; Ion selective electrodes of different types; Glass electrodes, solid state electrodes, liquid-liquid electrodes, precipitate electrodes, compound electrodes; Ion selective field effect transistors; Gas sensing probes; Direct potentiometric measurements; Potentiometric titrations. Electrogravimetry and coulometric methods of analysis: Current-voltage relationship during electrolysis, Ohmic potential drop, concentration polarization, kinetic polarization, over potential, problems associated with two-electrode cells, three-electrode cells and control potential electrolysis.
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Coulometry: Controlled working electrode potential Coulometry, Coulometric titrations, mediators. Classical polarography and miscellaneous methods; Chemical analysis using polarography and its limitations; Modified polarographic techniques: Tast Polarography, normal and differential pulse polarography, square wave polarography. Voltammetry: Anodic and cathodic stripping voltammetry, potentiometric stripping analysis; Potential sweep methods: Linear sweep and cyclic voltammetry at solid electrodes; Reversible, irreversible and quasi reversible voltammograms; Randles – Sevcik equation; Mechanistic studies using voltammetry; Amperometry: Amperometric titrations and biamperometry; Voltammetry under convection control; Introduction to convective systems; Hydrodynamic voltammetry; Rotating disk electrode voltammetry; Levich equation; Rotating ring disk electrode voltammetry; Chemical analysis and mechanistic studies using rotating disk electrode voltammetry.

2. **Optical spectroscopy (8 h)**

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

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

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

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

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

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

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

Methods of Teaching and Learning

A combination of classroom teaching, demonstrations, visual aids, spreadsheet application workshops and small group discussions.

Recommended Readings

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

CHE 31052 -
Polymer Chemistry

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Course Unit Code	CHE 31052			
Course Unit Name	Polymer Chemistry			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 12022, CHE 21022			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	To provide foundational knowledge and practical insight into the synthesis, properties, and applications of polymers, essential for innovations in materials science.			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: describe the structure and function of natural polymers

ILO 2: compare different polymerization reactions

ILO 3: express the size of polymer molecules in terms of their molecular weight

ILO 4: identify the differences in behaviour and molecular structure of thermoplastic and thermosetting polymers

ILO 5: identify functional requirement and applications of conducting polymers

Course Content

1. **Polymer vs. simple molecules (4h)**

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

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

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

3. **Molar mass of polymers (6h)**

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

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

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

5. **Thermal behavior of polymers (4h)**

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

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

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

7. **Conducting polymers (4h)**

   Synthesis, characteristics and applications

Methods of Teaching and Learning

Lectures, tutorial discussions, small group discussions and computer assisted learning

Recommended Readings

- Odian, G. (2004). Principles of polymerization. Hoboken, N.J.: Wiley-Interscience. ISBN: 978-0-471- 27400-1
- Young, R. and Lovell, P. (2011). Introduction to polymers. Boca Raton: CRC Press. ISBN-13: 978- 0849339295

CHE 31062 -
Advanced Physical Chemistry Laboratory

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Course Unit Code	CHE 31062			
Course Unit Name	Advanced Physical Chemistry Laboratory			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 12022, CHE 22032, CHE 22061			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	-	90	4	100
Objective of the Course Unit	To develop laboratory skills and computational chemistry competencies.			
Evaluation Method	Attendance 10 % Quizzes/Mid-term Assessment 20%		Lab Reports 10% Final Assessment 60%	

Intended Learning Outcomes (ILO)

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

ILO 1: perform experiments to determine thermodynamic and kinetic parameters

ILO 2: simulate experimental data using computational modeling

ILO 3: compare various experimental methods and results

ILO 4: obtain hands on experience on different instruments used in physical chemistry laboratory

ILO5: apply computer-based software to analyze data

Course Content

Experiments (60 h)

Advanced Physical Chemistry Experiments on, Chemical kinetics, Thermodynamics, Phase equilibria, Electrochemistry: conductometry, potentiometry, voltammetry, Spectrometry (Colorimetry), computational chemistry and quantum chemistry, Surface and colloidal chemistry

Methods of Teaching and Learning

15 practical sessions and writing lab reports

Recommended Readings

- Experiments in physical chemistry, 7th Edition, Garland, C. W., Nibler, J. W & Shoemaker, D. P., New York, McGraw-Hill, 2002
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- Experimental Physical Chemistry: A Laboratory Textbook, 3rd Edition, A. Halpern and G. McBane, W. H. Freeman, 2006.
- Physical Chemistry, 5th Edition, Robert J Silbey Robert A Alberty, George A Papadantonakis, and Moungi G Bawendi, John Wiley Sons, 2022

CHE 31071 -
Advanced Biochemistry I

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Course Unit Code	CHE 31071			
Course Unit Name	Advanced Biochemistry – I			
Credit value	1			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 11061, CHE 12061			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	15	-	-	50
Objective of the Course Unit	To provide the students with a basic understanding of structure & function of the main lipoproteins, endogenous & exogenous strong oxidants, their effects & their neutralization and unique metabolisms of microbes and plants.			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: Explain why lipoproteins are present, types and functions, synthesis and clinical corrilations

ILO 2: List the types of lipoproteins.

ILO 3: Name the naturally occurring strong oxidants and explain biological role and pathways associate.

ILO 4: Explain the glyoxylate cycle and Photosynthetic process.

ILO 5: Describe the fermentation processes using microbs

Course Content

1. **Lipoproteins (4 h)**

   Necessity for lipid transport & problems associated with transport of lipids in blood. Structure of Chylomicrons, VLDL & HDL. Functions & metabolism of chylomicrons, VLDL & HDL. Uptake of LDL into tissues. Harmful & beneficial lipoproteins.

2. **Strong oxidants & Oxidative Stress (Redox Biology) (3 h)**

   Strong oxidants (naturally arising & exogenous - including lipid based free radicles arising from lipid peroxidation) and their effects on body.
   Hexose monophosphate (HMP) pathway & its role in oxidative stress mitigation.
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3. Microbial and Plant Metabolism (8 h):

Entner-Duodoroff pathway of gram-negative bacteria. Glyoxylate cycle. Photosynthesis. Fermentation. Production of ethanol by yeast. Production of foods – yogurt, cheese. Weizmann process (acetone-butanol-ethanol fermentation).

Methods of Teaching and Learning

A combination of lectures, tutorials, discussions.

Recommended Readings

- Abali, E. E.; Cline, S. D.; Franklin, D. S.; Viselli, S. M. Lippincott® Illustrated Reviews: Biochemistry; Lippincott Williams & Wilkins, 2024.
- Rodwell, V. W.; Bender, D. A.; Botham, K. M.; Kennelly, P. J.; Weil, P. A. Harper's Illustrated Biochemistry 31E; 2018.
- Devlin, T. M. Textbook of Biochemistry with Clinical Correlations; Wiley-Liss, 2002
- Nelson, D. L.; Lehninger, A. L.; Cox, M. M. Lehninger Principles of Biochemistry; Macmillan, 2008.

CHE 31081 -
Advanced Inorganic Chemistry Laboratory

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Course Unit Code	CHE 31081			
Course Unit Name	Advanced Inorganic Chemistry Laboratory			
Credit value	1			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 11061, CHE 12061			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	-	45	-	50
Objective of the Course Unit	To provide skills needed to design and synthesize Inorganic complexes, analyze them using different characterization techniques and application of chromatographic methods and solvent extraction for separation of selected metal cations from a mixture			
Evaluation Method	Attendance 10 % Quizzes/Mid-term Assessment 20%		Lab Reports 10% Final Assessment 60%	

Intended Learning Outcomes (ILO)

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

ILO 1 apply different methodologies to synthesize and purify Inorganic complexes

ILO 2 interpret the theory behind the formation of them.

ILO 3 analyze the results obtained from different characterization techniques

ILO 4 apply chromatographic methods and solvent extraction in separations/identification

Course Content

Experiments (30 h)

Synthesis of octahedral and tetrahedral complexes having monodentate ligands; synthesis of chelate complexes, geometrical isomers and optical isomers; recrystallization. Characterization of selected complexes using IR, UV-Vis, AAS, conductivity, oxidation-reduction potentials; Determination of electronic properties of the complexes. Chromatographic methods for identification and separation of selected metal cations (Paper chromatography and ion exchange chromatography); determination of concentration spectrophotometrically. Solvent extraction for separation of metal cations. Analysis of a mineral. Green synthesis of nanoparticles of a metal (e.g. copper) and characterization.
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Methods of Teaching and Learning

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

Recommended Readings

- Pass, G. and Sutcliff, H. Practical Inorganic Chemistry; 1974, Chapman & Hall, London.
- Jeffry G. H., Basset J., Mendhan J. Denny R.C.; Vogels Textbook of Quantitative Inorganic Analysis.

CHE 31091 -
Industrial Analytical & Environmental Chemistry Laboratory

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Course Unit Code	CHE 31091			
Course Unit Name	Advanced Inorganic Chemistry Laboratory			
Credit value	1			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 11061, CHE 12061			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	-	45	-	50
Objective of the Course Unit	To provide practical skills in analytical and environmental chemistry			
Evaluation Method	Attendance 10 % Quizzes/Mid-term Assessment 20%		Lab Reports 10% Final Assessment 60%	

Intended Learning Outcomes (ILO)

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

ILO 1: demonstrate skills of independently operating basic analytical instrumentation
ILO 2: assess quality of water, air and soil
ILO 3: carryout sampling, preservation and storage in a correct way
ILO 4: develop an analytical method to meet required quality assurance parameters
ILO 5: assess quality of water, air and soil
ILO 6: analyze results by data processing of basic software packages

Course Content

1. **Analytical chemistry laboratory (20 h)**

   Solvent extractions of metals by chelation, pharmaceutical analysis, hadrochemical analysis of irrigation water samples, analytical method validation, fluorescence spectrophotometry, Use of basic software packages for data processing and reporting of analytical results.

2. **Environmental chemistry laboratory (20 h)**

   Techniques for collection of environmental samples (air, water and soil); air sample analysis, on-site water quality measurements, Sample preparation and sample storage; Study of quality of water, rain water analysis by atomic absorption spectrometry, determination of chemical oxygen demand,
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Methods of Teaching and Learning

Classroom teaching, demonstrations, visual aids, spreadsheet application workshops and small group discussions.

Recommended Readings

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

CHE 32012 -
Advanced Synthetic Organic Chemistry

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Course Unit Code	CHE 32012			
Course Unit Name	Advanced Synthetic Organic Chemistry			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 21012, CHE 22022			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	To expose students' intermediate level and advanced aspects of synthetic organic chemistry and modern trends of organic chemistry			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: Explain the science of complex molecule synthesis with the strategic use of some reactions in synthesis

ILO 2: Explain the strategies to enhance the efficiency of multistep organic synthesis

ILO 3: Describe the developing trends in small molecular synthesis

ILO 4: Explain the use of modern methods in organic synthesis that are more efficient, specific, safer and environmentally friendly

Course Content

1. Foundations of Organic Synthesis and Retrosynthesis (5 h)

Introduction: History of organic synthesis (historical prospects and Pioneers of organic synthesis), Selectivity in synthesis (chemoselectivity and regioselectivity), synthetic methods and general strategies (Liner and convergent synthesis), synthesis efficiency (step economy and overall yield).

Retrosynthetic Analysis:
Concepts and strategies of disconnection approach, C-X disconnection strategies, 1,3 and 1,2 di-functional relationship, C-C single bond disconnection, C-C double bond disconnection, C-O and C-N bond disconnection.
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2. Carbon–Carbon Bond Formation and Olefination Reactions (6 h)

C-C bond forming reactions:
Enolate chemistry and C-C bond forming reactions, organolithium reagents, and cuprates (1,2- and 1,4 additions to carbonyls), 1,2-, 1,4-,1,5- and 1,6-dioxygenated systems. Reversal of polarity.

Alkene and Alkyne synthesis:
C-C double bond forming reactions, modifications to Wittig reaction, Peterson olefination and Julia coupling reactions.

3. Ring Synthesis, Oxidation and Reduction Methods (5 h)

Ring synthesis: 3 membered rings (Epoxides, aziridines and cyclopropanes, Simmons Smith reaction, chemistry of sulfur ylides), 5 and 6 membered rings, Cycloadditions and cyclizations: Baldwin's rules and selected macrocyclic synthesis.

Oxidation and reduction reactions in organic chemistry: Selective oxidation reactions (Dess-Martin and Swarn oxidation), selective reductions, Hydride and modified hydride based reducing agents.

4. Modern Synthetic Strategies and Organometallic Chemistry (5 h)

Strategic use of protecting groups in organic synthesis, Silicon based protecting groups, protecting group free synthesis.

Selected examples from multistep synthesizes of natural products and drugs.

Organometallic reagents in organic synthesis: Transition metals and organometallic reagents in organic synthesis, General Organometallic reaction mechanisms, Pd Catalyzed cross coupling reactions, Cross metathesis and ring closing metathesis (RCM). Selected examples from metal based organic reagents.

5. Multicomponent and Solid-Phase Synthesis (5 h)

Multicomponent reactions (MCRs) in organic synthesis
General introduction to MCRs in organic synthesis: Concepts and discovery of MCRs, Aryne based MCRs, Ugi-Smiles and Passerini-Smiles and Mannich reactions and few other selected MCRs from the recent literature, 1,3-dicarbonyls in MCRs, Synthesis and functionalization of heterocycles using MCRs, Applications of MCRs in complex molecular synthesis (Selected recent examples from the literature.

Solid phase organic synthesis (SPOS): General methods of SPOS, (solid supports and linkers used in SPOS), Reaction monitoring and separation techniques used in SPOS, Solid phase Peptides synthesis (SPPS)

Combinatorial synthesis: Concepts and principles in combinatorial chemistry, Combinatorial library synthesis (scaffold-based libraries and backbone-based libraries, Synthesis methods

in combinatorial chemistry (split-pool-synthesis and parallel synthesis, solid phase combinatorial, Synthesis and solvent phase combinatorial synthesis), Characterization methods of combinatorial libraries

6. Green and Two-Phase Organic Synthesis (4 h)

Green and solvent free organic synthesis: Green Chemistry Principles, Applications of green solvents and solvent free methods in organic synthesis Alternative solvent free methods (ionic liquids, fluorinated solvents, bio-solvents),

Two phase reactions in organic chemistry: Phase-Transfer Catalysis, Catalytic Two-Phase Reactions of Carbanions and Other Organic Anions, Catalytic Two-Phase Alkylation of Organic Anions.

Methods of Teaching and Learning

A combination of lectures, tutorials, discussions.

Recommended Readings:

- Organic synthesis, The Disconnection Approach, Stuart Warren, Paul Wyatt, 2008, John Wiley & Sons Ltd.
- Green Techniques for Organic Synthesis and Medicinal Chemistry, Wei Zhang, Berkeley W. Cue JR., 2012, John Wiley & Sons Ltd.
- Combinatorial Chemistry, Synthesis, Analysis, Screening, Gunther Jung., 2001, Wiley-VCH.
- Multicomponent Reactions in Organic Synthesis, Jieping Zhu, Qian Wang, Meixiang Wang., 2015, Wiley-VCH.
- Solid phase synthesis: A practical guide, Fernando Albericio, 2000, CRC press
- Current Review articles on specific topics

CHE 32021 -
Supramolecular Chemistry

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Course Unit Code	CHE 32021			
Course Unit Name	Supramolecular Chemistry			
Credit value	1			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 21012, CHE 22022			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	15	-	-	50
Objective of the Course Unit	To expose students' intermediate level and advanced aspects of synthetic organic chemistry and modern trends of organic chemistry			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: Explain the science of complex molecule synthesis with the strategic use of some reactions in synthesis

ILO 2: Explain the strategies to enhance the efficiency of multistep organic synthesis

ILO 3: Describe the developing trends in small molecular synthesis

ILO 4: Explain the use of modern methods in organic synthesis that are more efficient, specific, safer and environmentally friendly.

Course Content

1. Introduction and Intermolecular Forces (4 h)

Introduction and concepts: Development, Terminology and definitions in supramolecular chemistry, Nature of supramolecular interactions, Solutions and intermolecular forces, Solvent and solution properties, Intermolecular forces (Ion pairing, ion-dipole and dipole-dipole interactions, hydrogen bonding, pi interactions), Binding (binding constants, physical methods for binding constant determination).

2. Recognition Systems and Self-Assembly (5 h)

Concepts of supramolecular chemistry: Host-Guest chemistry, Classification of Host-Guest complexes, binding constant-K, Macrocyclic effect and chelation effect, Magnitude of binding in host-guest complexes.
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Molecular recognition: The Lock and Key Analogy, Complementarity and preorganization, Shapes and homochirality, Molecular recognition in water, the hydrophobic effect, coordination chemistry and the chelate effect, Cooperativity and multivalency.

3. Host–Guest Chemistry and Molecular Recognition (3 h)

Spherical recognition, Anion recognition, Multiple recognition, Amphiphilic receptors, determination of strength of supramolecular interactions, Solvation and Hydrophobic effect.

Molecular Self-assembly: Self-assembly process, Calixarenes, Rotaxans and molecular machines.

4. Analysis and Applications of Supramolecular Chemistry (3 h)

Methods of analyzing supramolecules: Microscopy, NMR, UV-VIS, CD and IR spectroscopy.

Applications of supramolecular chemistry: Supramolecular reactivity and Catalysis, Supramolecular transport processes and carrier design, other new practical applications of supramolecular chemistry.

Methods of Teaching and Learning

A combination of lectures, tutorials, discussions

Recommended Readings

- Organic synthesis, The Disconnection Approach, Stuart Warren, Paul Wyatt, 2008, John Wiley & Sons Ltd.
- Green Techniques for Organic Synthesis and Medicinal Chemistry, Wei Zhang, Berkeley W. Cue JR., 2012, John Wiley & Sons Ltd.
- Combinatorial Chemistry, Synthesis, Analysis, Screening, Gunther Jung., 2001, Wiley-VCH.
- Multicomponent Reactions in Organic Synthesis, Jieping Zhu, Qian Wang, Meixiang Wang., 2015, Wiley-VCH.
- Solid phase synthesis: A practical guide, Fernando Albericio, 2000, CRC press
- Current Review articles on specific topics

CHE 32033 -
Seminar Presentations and Essays

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Course Unit Code	CHE 32033			
Course Unit Name	Seminar Presentations and Essays			
Credit value	3			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	ENH 11122, ENH 22101			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	15	-	40	150
Objective of the Course Unit	To provide knowledge and train students to search literature, prepare and deliver presentations, write reports and design experiments			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: develop a research proposal for an identified research problem;
ILO 2: carry out a complete literature survey;
ILO 3: interpret the research data using statistical tools;
ILO 4: identify the requirement for scientific writing;
ILO 5: cite references in a scientific document using a proper style;
ILO 6: identify the ethical issues with respect to research.
ILO 7: survey scientific literature critically;
ILO 8: prepare an overview of the relevant literature for a specific research topic;
ILO 9: deliver a scientific presentation.

Course Content

1. **Scientific method**

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

2. **Literature survey**

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

3. **Scientific writing**

   Identify major components in a research paper, details to be included in each section.
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4. **Research proposal writing**

   Major components to be included in a research proposal.

5. **Research ethics**

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

6. **Data analysis**

   Honesty, objectivity, integrity, openness, respect for intellectual property, confidentiality, authorship of a publication.

7. **Research presentations**

   Writing a dissertation/publication and an oral presentation in a scientific way.

   Search, select and gather information and organize information on a given topic selected by an academic staff member; Prepare a suitable presentation and present it to an audience of academics; Submission of a survey report.

Methods of Teaching and Learning

Lectures, tutorials, assignments, self-studying, Group work, Literature survey, self-study, small group discussion, use of feedback from appointed academic staff member.

Recommended Readings

- The ACS Style Guide: effective Communication of Scientific information, An American Chemical Society presentation.
- Anne M Coghill, Lorrin R Garson. (2006). American Chemical Society.
- review article on a selected topic, identified by a senior academic staff member and other related literature.
- Text books, research papers, review articles related to a given topic.

CHE 32042 -
Advanced Coordination Chemistry

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Course Unit Code	CHE 32042			
Course Unit Name	Advanced Coordination Chemistry			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 31012			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	4	100
Objective of the Course Unit	To provide students with a deeper understanding of the behaviour and reactions of transition metal complexes and their importance in modern inorganic, industrial, biological, and materials chemistry.			
Evaluation Method	Mid-Semester Assessment 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: apply Molecular Orbital Theory to construct molecular orbital diagrams for M-L bonding in transition metal complexes

ILO 2: interpret electronic spectra of coordination complexes

ILO 3: explain substitution reactions in square planar and octahedral coordination complexes

ILO 4: predict possible electron transfer reactions between octahedral complexes

ILO 5: predict possible mechanism for reactions of coordination complexes

Course Content

1. Molecular Orbital Theory (MOT) for Transition Metal Complexes (5 h)

Limitations of Crystal Field Theory; requirements for effective overlapping of atomic orbitals, introduction to symmetry adapted linear combination of atomic orbitals (SALC) and ligand group orbitals (LGOs), symmetry labels of LGOs and metal atomic orbitals, formation of bonding, antibonding and nonbonding molecular orbitals from LGOs and metal orbitals.

Construction of molecular orbital energy level diagrams for metal-ligand boding: Oh transition metal complexes having (i) M-L sigma bonding only (ii) M-L π-bonding involving (a) π-donor ligands (b) π-acceptor ligands; filling electrons, colours of selected examples. Electronic spectra of octahedral and tetrahedral transition metal complexes:
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Multi electron systems; Russel Saunders coupling, Microstates, construction of a table of microstates. Introduction to Term symbols, determination of term symbols and the Ground state terms

2. Electronic spectra of octahedral and tetrahedral transition metal complexes (6 h)

Electronic spectral features of 1st row transition metal complexes, Types of transitions, Spin and Laporte selection rules; Energy level diagram for (i) d^1 ion in an oh field (ii) d^2, d^3, d^7 and d^8 ions (high spin) in octahedral field; Orgel diagrams, assigning of possible electronic transitions in electronic spectra using Orgel diagrams; Racah parameters, Calculation of Racah parameters, Tanabe Sugano diagrams; Evidence for M-L covalent bonding: Nephelauxetic effect,

3. Kinetics and Mechanisms of reactions of coordination complexes (10 h)

Stoichiometric and intimate mechanisms related to substitution reactions of square planar and octahedral complexes (A, D, Ia, Id), kinetic and thermodynamic aspects of reactivity of complexes; Activation parameters.

Substitution reactions of square planar complexes: General rate law, intimate mechanisms, factors affecting rates of square planar substitution reaction.

4. Substitution reactions of octahedral complexes (5 h)

Water exchange, acid hydrolysis, base hydrolysis and anation reactions, rate laws and their interpretation, Eigen- Wilkins mechanism, leaving and entering group effects, effects of spectator ligands, steric effects, effect of charge, stereochemical changes in octahedral substitution; Mechanism of isomerization.

5. Electron transfer reactions between octahedral complexes (4 h)

Elementary steps and rate expressions for outer sphere and inner sphere mechanism, Frank Condon principle, Marcus Theory.

Methods of Teaching and Learning

Lectures, tutorials, peer assisted student support sessions and small group discussions.

Recommended Readings

- Drago, R. (2012). Physical Methods in Inorganic Chemistry, East-West Press (Pvt.) Ltd., New York.
- Atkins, P.W.; Overton, T.L.; Rourke, J. P.; Weller, M. T.; Armstrong, F. (2010). Shriver & Atkins Inorganic Chemistry, 5th Edition, W. H. Freeman and Company, New York.
- Garry M. L., Donald A. T., "Inorganic Chemistry" 4th Edition, (2010), Prentice Hall.
- Crabtree R. (2019), Organometallic Chemistry of the Transition Elements, 7th ed. Wiley, 2019.

CHE 32052 -
Advanced Topics in Physical Chemistry I

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Course Unit Code	CHE 32052			
Course Unit Name	Advanced Topics in Physical Chemistry I			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 21022			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	To provide knowledge on advanced concepts in electrochemistry, thermodynamics and statistical thermodynamics.			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: interpret electrochemical systems using fundamental theories;

ILO 2: demonstrate the formation of electric double layer; apply rules of electron transfer to electrode reactions.

ILO 3: apply thermodynamics to predict spontaneity of reactions and calculate various thermodynamic parameters.

ILO 4: apply Lagrange's method of undetermined multipliers to derive partition function.

ILO 5: derive thermodynamic properties using statistical mechanics.

Course Content

1. Advanced electrochemistry (10 h)

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

2. Advanced thermodynamics (10h)

Free energy functions: Helmholtz free energy A and Gibbs free energy G; Spontaneity and reversibility; The four fundamental thermodynamic equations; Temperature, volume and pressure coefficients of ΔA and ΔG; Maxwell relationships; Thermodynamic equation of state; Gibbs-Helmholtz equation; Standard free energies; Univariant phase transformations: Clapeyron and Clausius-Clapeyron equation; Colligative properties: Ebullioscopy and cryoscopy; Derivation of equation for free energy changes in general chemical reactions in terms of activity/fugacity; Relationship between standard free energy change and equilibrium constant, influence of temperature on equilibrium constant.

3. Statistical thermodynamics (10h)

Introduction to statistical thermodynamics, quantum mechanical picture of a system of non-interacting particles, configuration, weight of a configuration, Lagrange's method of undetermined multipliers to find the most probable distribution, molecular partition function, Boltzmann Factor, molecular partition function, translational and vibrational partition functions, distinguishable and indistinguishable particles, concept of ensemble, canonical ensemble, systems partition function, statistical entropy, calculation of thermodynamic parameters. Definitions of micro-canonical and grand–canonical ensembles.

Methods of Teaching and Learning

Lectures, tutorial discussions

Recommended Readings

- Atkins, P.; de Paula, J. (2014). Physical Chemistry, 9th Edition, W H Freeman.
- Levine, I.N. (2007). Physical Chemistry, 5th Edition, Tata McGraw-Hill.
- Ott, J. B.; Goates, J. B. (2000). Chemical Thermodynamics Principles and Applications, 1st Edition, Academic Press.
- Terrell L. Hill. Introduction to Statistical Thermodynamics, Dover Publications.
- Advanced Chemical Thermodynamics, CHU 3030, Open University of Sri Lanka.
- Seddon, J.M. and Gale,J.D. (2004). Thermodynamics and Statistical Mechanics. RSC Publications.

CHE 32062 -
Advanced Chromatography

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Course Unit Code	CHE 32062			
Course Unit Name	Advanced Chromatography			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 21032			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	4	100
Objective of the Course Unit	To provide a fundamental understanding of chromatographic instrumental analysis, related hyphenated techniques and methods of preparative chemical separation for chromatographic analysis.			
Evaluation Method	Mid-Semester Assessment 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: appraise principles, instrumentation, and operation and troubleshooting of gas chromatography and high-performance liquid chromatography

ILO 2: compare different mass analyzers, detectors and different operations of mass spectrometry

ILO 3: appraise hyphenated chromatographic techniques in analysis

ILO 4: compare extraction and cleanup techniques for different residues

ILO 5: propose and justify analytical methodologies to determine an analyte in a given matrix

ILO 6: describe basic instrumentation of basic mass spectrometry

ILO 7: Explain the principles of thermal analytical method

Course Content

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

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

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

2. Other chromatographic methods (2 h)

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

3. Molecular mass spectrometry (6 h)

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

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

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

6. Introductory Thermal analysis (4 h)

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

Methods of Teaching and Learning

Classroom teaching, demonstrations, visual aids and small group discussions.

Recommended Readings

- Christian, G. D.; Dasgupta, P. K.; Schug, K. A. Analytical Chemistry; Wiley, 2013
- Skoog, D. A.; Holler, F. J.; Crouch, S. R. Principles of Instrumental Analysis; Cengage Learning, 2017
- Harris, D. C.; Lucy, C. A. Quantitative Chemical Analysis; W. H. Freeman, 2019
- Bruno, T. J.; Robinson, J. W.; Frame, G. M.; Frame, E. M. S. Undergraduate Instrumental Analysis; CRC Press, 2023

CHE 32072 -
Advanced Organic Chemistry Laboratory

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Course Unit Code	CHE 32072			
Course Unit Name	Advanced Organic Chemistry Laboratory			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 11022			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	-	90	4	100
Objective of the Course Unit	To develop advanced practical skills in organic chemistry.			
Evaluation Method	Attendance 10 % Mid-term Assessment 20%		Lab Reports 10% Final Assessment 60%	

Intended Learning Outcomes (ILO)

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

ILO 1: synthesize heterocyclic compounds and carry out a photochemical reaction

ILO 2: identify natural products using chromatographic and spectroscopic techniques

ILO 3: apply environmental friendly methodologies in the organic synthesis

ILO 4: present results of the group assignments based on natural products

ILO 5: prepare a report and a presentation on the chemical processes involved in the manufacture of products of a particular industry

Course Content

Experiments

Multi step synthesis. Synthesis heterocyclic compounds. Photochemical reactions in organic synthesis.

Extraction methods and purification methods, soxhlet extraction, cold finger, column chromatography and preparative plate chromatography. Distillation, steam distillation and fractional distillation, microwave assisted synthesis of organic compounds.

Phytochemical screening for classes of natural products (alkaloids, steroids, terpenoids, flavonoids and saponins).

Visits to chemical based and natural product industries; Group assignment based on visits.
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Methods of Teaching and Learning

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

Recommended Readings

- Schoffstall, A. M.; Barbara, B. A.; Gaddis, A.; Druelinger, M.L.; Schoffstall, A.; Gaddis, B.; Druelinger, M. (2004). Microscale and Miniscale Organic Chemistry Laboratory Experiments, 2nd Edition, Mc- Grawhill.
- Pavia, D.L.; Lampman, G.L.; Kriz, G.S.; Engel, R.G. (1999). Introduction to Organic Laboratory Techniques: A Microscale Approach, 3rd Edition, Brooks/Cole.
- Moting, J. R.; Mofrrill, T. C.; Hammond, C. N.; Neckers, D. C. (1999). Experimental Organic Chemistry, Freeman.
- Williamson, K.L. (1994). Macroscale and Microscale Organic Experiments, 2nd Edition, Heath and Company.

CHE 32081 -
Biochemistry Laboratory

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Course Unit Code	CHE 32081			
Course Unit Name	Biochemistry Laboratory			
Credit value	1			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 11051, CHE 12031			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	-	45	10	50
Objective of the Course Unit	To develop basic practical skills in Biochemical analysis and biological sample processing			
Evaluation Method	Attendance 10 % Mid-term Assessment 20%		Lab Reports 10% Final Assessment 60%	

Intended Learning Outcomes (ILO)

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

ILO 1: Apply biochemical analytical techniques such as titrimetric, colorimetric, and spectrophotometric methods to quantitatively estimate carbohydrates, proteins, lipids, and nucleic acids in biological samples

ILO 2: Demonstrate competency in qualitative and quantitative separation techniques

ILO 3: Interpret experimental results by comparing standard curves, calculating concentrations, and analyzing biochemical properties

ILO 4: Relate biochemical principles to biological samples by evaluating the composition of real specimens such as milk and urine for their sugar, protein, and metabolite content.

ILO 5: Develop laboratory skills and good practices including accurate pipetting, preparation of reagents, handling of biomolecules, and safe use of equipment.

ILO 6: Integrate knowledge of biochemical assays with physiological and clinical contexts by assessing diagnostic parameters relevant to health and disease.

Course Content

Experiments

Estimation of Carbohydrates (Total and Reducing Sugars, Sucrose and Starch by Ferricyanide Method)

Quantitative Estimation of Reducing Sugars: Using the DNS (dinitro salicylic acid) method or
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Fehling's solution to determine reducing sugar concentration

Estimation of Glucose by the Glucose Oxidase Method: A spectrophotometric assay to measure glucose levels.

Estimate the Protein Quantitatively in the given sample By Lowry'S Method.

Determination of the acid value of the given fats or oil sample and determine of saponification value of the given fats or oil sample.

Separation and identification of amino acids by ascending paper chromatography Separation and thin layer chromatography.

Quantification of DNA by UV Spectrophotometry; Measure DNA concentration using absorbance at 260 nm Agarose Gel Electrophoresis experiment.

Estimation of sugar and protein content in a milk sample; dialysis practical for proteins and small molecules; Sephadex gel chromatography for separation of proteins; quantification of urease activity using a microplate reader; and analysis of a urine sample for proteins, sugars, and ketone bodies.

Methods of Teaching and Learning

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

Recommended Readings

- Varley's Practical Clinical Biochemistry. 6th Edition by Allen H Gowenlock (2006) CBS Publication and Distributors (Indian Reprint)
- Williamson, K.L. (1994). Macroscale and Microscale Organic Experiments, 2nd Edition, Heath and Company.

ENH 32091 -
Industrial Training

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Course Unit Code	ENH 32091			
Course Unit Name	Industrial Training			
Credit value	1			
Compulsory/Elective/ Enhancement	Enhancement			
Prerequisites	CHE 31012			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	-	60	40	50
Objective of the Course Unit	To provide a training on industrial process, management and environmental aspects			
Evaluation Method	Industrial supervisor			

Intended Learning Outcomes (ILO)

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

ILO 1: work in industry as a team player or a leader
ILO 2: identify problems in industrial processes
ILO 3: conduct literature survey related to an industrial problem
ILO 4: undertake industrial projects independently
ILO 5: carry out measurements, analyze data and perform statistical treatment and interpret
ILO 6: write reports and present the outcome of industrial project

Course Content

Students must identify an industry, write a brief report on the nature of training and handover to the course coordinator. Once approval is granted, the project must be carried out under a supervisor from industry. The course coordinator will assign an internal supervisor when necessary.

Methods of Teaching and Learning

Working in an industrial setup

Recommended Readings

- Literature relevant to the industrial project
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LEVEL 4

CHE 41012 -
Special Topics in Inorganic Chemistry

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Course Unit Code	CHE 41012			
Course Unit Name	Special Topics in Inorganic Chemistry			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 12012			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	To provide advanced knowledge on Molecular Polyhedra and Bioionorganic Chemistry			
Evaluation Method	Mid-Semester Assessment 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: discuss structural chemistry of boron hydrides

ILO 2: demonstrate structures of condensed materials having chains, rings, sheets, cages, clusters and frameworks

ILO 3: predict geometry, structure and bonding in borane clusters, metal clusters etc.

ILO 4: design synthesis of MOFs based on the requirement

ILO 5: explain role of metals in biological systems

Course Content

1. **Introduction (2 h)**

   Introduction to polyhedron structures; structural groups of silicates, boranes and borates; classification of bonds present in boranes/borates; structural relationships between *closo*, *nido* and *arachno* boranes, IUPAC nomenclature of boranes/borates

2. **Examples for structures of condensed materials having chains, rings, sheets, cages, clusters and frame works (6 h)**

   Chains - silanes, single and double chain silicates; rings - borazines, cyclic silicates; sheets - graphite, graphene and phyllosilicates; cages - boranes and fullerenes; clusters - boron clusters and carboranes, metal carbonyls; frameworks - metal organic frame works

3. **Determination of geometry structure and bonding (7 h)**

   Introduction to quadrupole bond and bridging bonds; bonding in boranes, metalloboranes,
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metal clusters, metal carbonyls; Styx topology, Wades rule, Isolobal analogy, Wades Mingos rules and capping rule; application of Styx number, skeleton electron pairs and capping rule etc. in the determination of geometry, structure and bonding in higher borane clusters and metal clusters, metal carbonyls, metal halides.

4. Metal Organic Frame works (5h)

Classification, synthesis and structures, properties and applications

5. Bioinorganic Chemistry (10 h)

Role of metals in biological systems, speciation and specificity of metal complexes *in vivo*.

Transition metals in biological redox reactions: General mechanism of electron transfer, blue copper proteins, iron sulphur proteins, cytochromes, photosynthetic pathway.

Dioxygen carriers: Dioxygen complexes of transition elements, haemoglobin, nature of haem dioxygen binding, model system; transition metals in biological redox reactions.

Distribution and functions of metals in vivo: Storage and transport of iron, chemistry and biochemistry of nitrogen fixation, Mechanisms & action of zinc, copper, cobalt and molybdenum containing enzymes, enzyme containing vanadium, chromium and nickel.

Methods of Teaching and Learning

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

Recommended Readings

- Cartherine E Housecroft and Alan G Sharpe (2012), Pearson, England, Inorganic chemistry, 4th edition.
- Shriver and Atkins (2010), Inorganic Chemistry, 5th edition

CHE 41022 -
Advanced Topics in Physical Chemistry II

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Course Unit Code	CHE 41022			
Course Unit Name	Advanced Topics in Physical Chemistry II			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 31032			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	To provide advanced knowledge in thermodynamics, statistical thermodynamics and symmetry and group theory.			
Evaluation Method	Continuous Assessment 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: applies transition state theory to reactions

ILO 2: applies Lindemann theory, RRK theory to unimolecular reactions

ILO 3: analyzes molecular and crystal symmetry and elucidate crystal structures using principles of crystallography

ILO 4: applies thermodynamic principles to gases and describe fugacity and chemical potentials of open systems

ILO 5: Calculate third law entropies

Course Content

1. Reaction Dynamics (10 h)

Kinetic theory of collision, relationship between critical energy and the activation energy, probability factor; activated complex theory and its applications, thermodynamic interpretation of the overall rate constant; theories of unimolecular reactions: Lindermann theory, the [M]1/2 value of the unimolecular reactions, weaknesses of Lindermann theory, calculation of k value from Hinshelwood method, treatment of Rice-Ramsperger and Kassel, energized complex, Slater's treatment, Rice –Ramsperger-Kassel-Marcus theory; liquid phase reactions, theories of diffusion- controlled reactions and absolute reaction rates, influence of solvent in liquid phase reactions, single and double sphere models; influence of ionic strength in solutions on reactions.
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2. X-ray crystallography (10 h)

Solids, lattice, crystal planes, miller indices, powder X-ray diffraction, Single crystal X-ray crystallography, space symmetry in a crystal. Approximate solution of structure, intensities to structure factors. Fourier synthesis, phase problem, Patterson synthesis. Heavy atom method, direct method, refinement, R factor, Fourier refinement. Least squares refinement. Estimation of errors. Comparison with neutron and electron diffraction.

3. Chemical thermodynamics (10 h)

The four fundamental Maxwell relations, Open systems: Partial molar properties, Gibbs-Duhem equation; Chemical potential and its variation with temperature and pressure, application of free energy change for a general reaction; Fugacity with special reference to gaseous system: Determination of fugacity in gaseous mixture; Activities and activity coefficients; Third Law of thermodynamics, determination of the third law entropies, Debye T3 Law, comparison of spectroscopic and colorimetric properties, the molecular basis of entropy, Boltzmann Planck equation.

Methods of Teaching and Learning

lectures, tutorial discussions

Recommended Readings

- Laidler K.J. (2003) Pearson India.
- Peter Atkins, Julio de Paula, and James Keeler (2022). Physical Chemistry, Oxford University Press.
- Glusker, J.P. Trueblood, K.N., Crystal Structure Analysis
- Giacovazzo, C. (2011) Fundamentals of Crystallography, Oxford University Press.
- Glasser, L.S.D., (1977) X-Ray Crystallography von nostrand Reinhold
- Ott, J. B.; Goates, J. B. (2000). Chemical Thermodynamics Principles and Applications, 1st Edition, Academic Press.
- Advanced Chemical Thermodynamics, CHU 3030, Open University of Sri Lanka.

CHE 41032 -
Advanced Spectroscopic Techniques and Photochemistry

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Course Unit Code	CHE 41032			
Course Unit Name	Advanced Spectroscopic Techniques and Photochemistry			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 21012, CHE 31032			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	To expose students to the necessity of Advanced Spectroscopic method in order to elucidate structure of Organic Molecules; to demonstrate photochemically induced organic reactions			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: elucidate the structure of complex molecules using different pulse sequences in NMR spectroscopy

ILO 2: elucidate the structure of an organic molecule

ILO 3: predict the products of photochemical reactions

Course Content

1. Advanced organic spectroscopy (18 h)

^{1}H NMR: First order spectra, deuterium exchange, isotopic peaks, FID, instrumentation, complex splitting patterns of ^{1}H NMR and J values, NMR of homotopic, enantiotopic and diastereotopic protons, AB, ABC, ABX and AMX spin systems; Non-first order spectra; C NMR: solvent peak, simplification of ^{13}C NMR, proton decoupled spectra, double quantum, single quantum and zero quantum spin relaxations, NOE, population inversion, different types of ^{13}C NMR spectra, NOEDIFF, INEPT, APT, DEPT experiments, 2D NMR; COSY, ROSY, TOCSY, HECTCOR, HSQC, HMBC, NOESY, ROSEY; Mass spectrometry:

Ionization methods, GCMS, LCMS, HRMS, fragmentation patterns of selected classes of organic compounds; Joint application of spectroscopic techniques in structure elucidation of organic molecules.
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2. Photochemistry (12 h)

Selection rules, Jablanski diagram, singlet and triplet excited states, Kinetics of excited state processes such as quenching, energy transfer, triplet sensitization; mechanism of photochemical reactions, secondary reactions, photochemical reactions of carbonyl compounds: Norrish Type I and II reactions, photooxidations, photoreductions, photocycloadditions and photo rearrangements, -di-pi-methane rearrangement, Excited with singlet oxygen; industrial and biological application of photochemical reactions.

Methods of Teaching and Learning

Lectures, Tutorial, discussions

Recommended Readings

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

CHE 41042 -
Molecular Modelling and Molecular Simulations (T & P)

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Course Unit Code	CHE 41042			
Course Unit Name	Molecular Modelling and Molecular Simulations (T & P)			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 31032			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	20	30	-	100
Objective of the Course Unit	To provide theoretical and working knowledge on computational chemistry and applications.			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: apply electronic structure calculation for small molecules to predict their physical properties

ILO 2: describe geometry optimization through energy minimization techniques

ILO 3: simulate macromolecules using molecular dynamics and Monte-Carlo methods

ILO 4: estimate binding free energies of receptor ligand complexes

Course Content

1. Electronic Structure Calculations (8 h)

Computational methods of electronic structure calculations, ab initio and semi empirical calculations; Many electron wave function, antisymmetry of wave function and indistinguishability of electrons, Slater determinants, Hartree-Fock and Density functional theory, atomic orbitals, Slater functions and Gaussian functions, basis-sets. Total energy, geometry optimization, potential energy surfaces.

2. Molecular Mechanics (6 h)

Potential energy functional forms; molecular mechanics force field of a molecular system; geometry optimization: Simplex, Steepest decent, and conjugate gradient methods; Use of optimization in molecular system.

3. Molecular Dynamics & MC simulations (6 h)

Introduction to molecular simulation; Monte Carlo simulation and determining chemical
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and physical properties; molecular dynamics simulation and determining chemical and physical properties; introduction to Coarse grain and multiscale simulations.

5. Experiments in Molecular Modelling (Practical: 30 h)

Numerical differentiation and numerical integration using Microsoft excel or other software; protein visualization and explore the active site using VMD software; homology modeling and BLAST search Molecular docking and virtual screening; Computer aided drug designing, building small molecules using GUIs and Z- matrix with correct symmetry. Geometry optimization and vibrational analysis of small molecules using ab initio, DFT and semi empirical methods; introductory molecular dynamic practical, mini project.

Methods of Teaching and Learning

Lectures, course work, discussions, practical sessions, home assignments, computer assisted learning, mini project

Recommended Readings

- Leach A.R. (2001) Molecular modeling – Principles and applications, Prentice Hall, 2001
- Levine, I.N. (2002) Physical Chemistry, McGraw Hill Company, Fifth edition, 2002.

CHE 41051 -
Advanced Biochemistry - II

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Course Unit Code	CHE 41051			
Course Unit Name	Advanced Biochemistry - II			
Credit value	1			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 12031			
Hourly breakdown	**Theory**	**Tutorial**	**Independent learning**	**Notional learning hours**
	15	2	-	50
Objective of the Course Unit	To provide the students with a basic understanding of the techniques used in Molecular Biology & Biotechnology, applications of Molecular Biology in industry & medicine and separation techniques employed in biochemical research.			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: Describe and ways of isolating and visualization techniques for DNA / RNA

ILO 2: List the Enzymes used in Recombinant DNA work.

ILO 3: Describe making recombinant DNA, plasmids, DNA libraries, hybridization and DNA probes

ILO 4: Describe different DNA/RNA based techniques (eg: blotting, sequencing, PCR etc.) and applications

ILO 5: Describe the methods available for crude extraction and different types of chromatographic separations for different bio molecules

Course Content

1. Introduction to Molecular Biology & Biotechnology, and its applications (9 h)

Brief introduction to the topic, DNA / RNA isolation techniques.Visualization techniques for DNA. Enzymes used in recombinant DNA technology. Creating recombinant DNA. Plasmids used in recombinant DNA technology. DNA libraries. DNA hybridization. DNA probes. Agarose & acrylamide gel electrophoresis. Southern, Northern & Western blotting techniques. Reverse transcription. Transformation techniques. DNA sequencing. PCR technique & applications. Applications in health care, agriculture and industry.
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2. Separation Techniques in Biochemistry (6 h)

Introduction and selection of samples. Homogenization / crude extractions / Centrifugation. Chromatography. Ion-exchange chromatography. Affinity chromatography TLC. High-performance liquid chromatography (HPLC). Gel filtration (size-exclusion) chromatography. Electrophoresis. SDS-PAGE (Sodium Dodecyl Sulfate Polyacrylamide Gel Electrophoresis). Agarose gel electrophoresis. Capillary electrophoresis. Ultrafiltrat ethanol). Dialysis / Crystallization. Liquid-Liquid Extraction.

Methods of Teaching and Learning

Lectures, tutorial discussions

Recommended Readings

- Abali, E. E.; Cline, S. D.; Franklin, D. S.; Viselli, S. M. Lippincott® Illustrated Reviews: Biochemistry; Lippincott Williams & Wilkins, 2024.
- Rodwell, V. W.; Bender, D. A.; Botham, K. M.; Kennelly, P. J.; Weil, P. A. Harper's Illustrated Biochemistry 31E; 2018.
- Devlin, T. M. Textbook of Biochemistry with Clinical Correlations; Wiley-Liss, 2002
- Nelson, D. L.; Lehninger, A. L.; Cox, M. M. Lehninger Principles of Biochemistry; Macmillan, 2008.

CHE 41062 -
Material Science

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Course Unit Code	CHE 41062			
Course Unit Name	Material Science			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 21032, CHE 22032, CHE 31032			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	To provide foundational knowledge and practical insight into the synthesis, properties, characterization and applications of materials			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: provide an overview of different nanomaterials and their uses

ILO 2: explain physicochemical characteristics of nanomaterials

ILO 3: describe different preparation methods of nanomaterials and identify suitable techniques to characterize them

ILO 4: Describe applications of sonochemistry.

ILO 5: identify the characteristics of liquid crystals for different applications.

Course Content

1. Molecular Orbital Theory (MOT) for Transition Metal Complexes (5 h)

Limitations of Crystal Field Theory; requirements for effective overlapping of atomic orbitals, introduction to symmetry adapted linear combination of atomic orbitals (SALC) and ligand group orbitals (LGOs), symmetry labels of LGOs and metal atomic orbitals, formation of bonding, antibonding and nonbonding molecular orbitals from LGOs and metal orbitals.

Construction of molecular orbital energy level diagrams for metal-ligand boding: Oh transition metal complexes having (i) M-L sigma bonding only (ii) M-L π-bonding involving (a) π-donor ligands (b) π-acceptor ligands; filling electrons, colours of selected examples. Electronic spectra of octahedral and tetrahedral transition metal complexes: Multi electron systems; Russel Saunders coupling, Microstates, construction of a table of microstates. Introduction to Term symbols, determination of term symbols and the 4.
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Methods of Teaching and Learning

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

Recommended Readings

- Varley's Practical Clinical Biochemistry. 6th Edition by Allen H Gowenlock (2006) CBS Publication and Distributors (Indian Reprint)
- Williamson, K.L. (1994). Macroscale and Microscale Organic Experiments, 2nd Edition, Heath and Company.

CHE 41072 -
Generative AI for Chemistry and Chemical Industry

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Course Unit Code	CHE 41072			
Course Unit Name	Generative AI for Chemistry and Chemical Industry			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 31012			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	15	30	55	100
Objective of the Course Unit	This course unit is designed to provide students with an understanding of generative artificial intelligence and its applications in the chemistry and chemical industry. It focuses on how generative AI can aid in molecule design, reaction optimization, and material discovery, providing students with the skills to apply AI tools effectively in chemical research and industrial contexts.			
Evaluation Method	Continuous Assessments 30%		Final Assessment 70%	

Intended Learning Outcomes (ILO)

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

ILO 1: Explain the principles of generative AI and their applications in chemistry

ILO 2: Utilize AI algorithms for data generation and molecule synthesis

ILO 3: Analyze case studies on the use of generative AI in chemical and pharmaceutical industries

ILO 4: Develop basic generative AI models tailored to chemistry-related problems

Course Content

1. **Introduction to Generative AI in Chemistry (Theory 5 h: Practical 10 h)**

   Basics of generative AI and deep learning. Importance and impact in chemical and pharmaceutical industries.

2. **AI Tools for Molecular Design and Reaction Prediction (Theory 5 h: Practical 10 h)**

   Applications of AI in molecule generation and synthesis, AI-driven reaction prediction models.
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3. Practical Applications and Case Studies (Theory 5 h: Practical 10 h)

AI in drug discovery and material science. Case studies on industry implementations.

Methods of Teaching and Learning

Lectures, Laboratory classes using AI modeling software, Group projects and presentations, Case studies.

Recommended Readings

- Smith, J., & Brown, A. Artificial Intelligence in Chemistry: A Practical Guide
- Chen, R., et al. Applications of Generative Models in Molecular Science

APM 41082 -
Innovation and New Product Development

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Course Unit Code	APM 41082			
Course Unit Name	Innovation and New Product Development			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	None			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	To equip students with the knowledge and skills to manage the innovation process, integrate marketing and technology perspectives, and successfully develop and launch new products.			
Evaluation Method	Final Assessment 100%			

Intended Learning Outcomes (ILO)

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

ILO 1: identify importance of new product development to organizational performance

ILO 2: describe the marketing and technology interface in the process of innovation

ILO 3: demonstrate the ability to apply the methods of generating, evaluating and testing the product ideas and bringing them into the market.

Course Content

1. **Fundamentals of innovation and product development (10 h)**
   Types of new products, new products and the product life cycle, product platforms, the innovation process, market creation, market disruption, stage-gate process, and assessing market potential.

2. **From idea to market launch (20 h)**
   Idea generation methods, concept development, product positioning, industrial design, product architecture, prototyping, product and market testing, and product launch.

Methods of Teaching and Learning

Lectures, assignments, case studies, mini-projects
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Recommended Readings

- Paul, T (2010), Innovation Management and New Product Development, 4th Edition, Pearson.
- Ettlie, J E (2010), Managing Innovation: New technology, new products and new services on a global economy, 2nd Edition, Butterworth-Heinemann.
- Material provided in CAL.

CHE 42022 -
Chemical and Process Engineering for Chemical Industry

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Course Unit Code	CHE 42022			
Course Unit Name	Chemical and Process Engineering for Chemical Industry			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	CHE 22032			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	To provide students a foundational understanding of the principles and applications of process engineering, focusing on key aspects of mass and energy transfer, fluid dynamics, and reactor design.			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: Apply material and energy balance for a given system

ILO 2: Understand basic principles of heat and mass transfer

ILO 3: Describe principles, applications, equipment related to unit operations, such as distillation, absorption, extraction, mixing and drying

ILO 4: Apply the basic equations for fluid flow

ILO 5: Identify reactor types, applications and perform size calculations for simple reactor.

Course Content

1. **Introduction (3 h)**

   Concept of process development, steady and unsteady processes, batch and continuous processes, introduction to unit operations, mass and energy balance, Introduction to Flow sheeting.

2. **Mass transfer theory (3 h)**

   Introduction to mass transfer, Fick's law and two film theory with applications, concept of mass transfer coefficient.

3. **Heat transfer (6 h)**

   Modes of heat transfer (conduction, convection and radiation) with applications. Types of heat exchangers, concept of heat transfer coefficient and Heat exchanger calculations.
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4. Mass Transfer Operations (6 h)

Distillation: Introduction to binary and multicomponent distillation, Principle of binary distillation; Flash distillation calculations, Introduction to column distillation, Tray and packed columns, Concept of equilibrium staged separations. Extraction: Liquid-liquid extraction, modes of extraction, Phase equilibrium for partially miscible systems, single stage extraction calculations, solvents used and their selection, solid-liquid extraction, extraction equipment. Absorption and stripping: Gas-liquid equilibrium, Introduction to absorption and stripping, principle, equipment and applications. Drying: Drying theory, use of psychrometry, calculation of drying time, drying equipment.

5. Fluid dynamics (5 h)

Introduction to fluid dynamics: Characteristics of fluid flow, Flow classification, Bernoulli's equation and its applications, flow through pipes, selection of pumps for a given application.

6. Mixing and agitation (3 h)

Liquid mixing, Types of mixing, mixing mechanisms equipment used.

7. Reactor Engineering (4 h)

Introduction to reactor engineering and applications of industrial reactors. Definition to reaction rate. Mole balances for Batch reactors, Continuous Stirred Tank Reactor (CSTR) and continuous flow reactors such as PFR and Packed bed reactors. Design Equations for batch, CSTR and continuous flow reactors. Overview of use of catalysts in industrial reactors.

Methods of Teaching and Learning

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

Recommended Readings

- J. F. Richardson, J. H. Harker, J. R. Backhurst, "Coulson & Richardson's Chemical Engineering, Volume 1, 2 3 and 6, Butterworth- Heinemann.
- K.G. Denbigh and J.C.R Turner, Chemical Reactor Theory.
- A W Nienow , M F Edwards, N. Harnby, Mixing in the process industry, Butterworth-Heinemann

CHE 42051 -
Mineral Resources and Processing

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Course Unit Code	CHE 42051			
Course Unit Name	Mineral Resources and Processing			
Credit value	1			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	-			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	15	-	-	50
Objective of the Course Unit	Provide knowledge on mineral resources and associated industries in Sri Lanka			
Evaluation Method	Continuous Assessments 30% Final Assessment 70%			

Intended Learning Outcomes (ILO)

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

ILO 1: identify the difference between rocks and minerals

ILO 2: discuss geological formations in Sri Lanka

ILO 3: classify minerals in Sri Lanka

ILO 4: discuss possible industries based on mineral resources and value addition in Sri Lanka.

Course Content

1. **Rocks and minerals (5 h)**

   Difference between rocks and minerals, geological formations in Sri Lanka, igneous sedimentary and metamorphic rocks.

2. **Classification of minerals (2 h)**

   Classification as ferroalloy group, nonferrous group and non-metallic group.

3. **Industries based on mineral deposits in Sri Lanka (8 h)**

   Mineral deposits in Sri Lanka and chemical composition of those minerals, chemistry relevant to industries based on some selected minerals - clay, quartz, calcareous materials, beach mineral sands, apatite, gem stones, graphite; Value addition and aspects of value addition: Potential industries.
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Methods of Teaching and Learning

Lectures, tutorials, self-studying, industrial visits

Recommended Readings

- Sri Lankan Mineral and Industries: Resources, Potentialities and current issues (2003),
- M.M.J.W. Hearth Geological survey and mines bureau.
- Silica based industries – Future Prospectus (1999), Proceedings of a seminar, Natural Resources, Energy and Science Authority of Sri Lanka.
- Mineral resources of Sri Lanka (1980), J. W. Herath, Geological survey Department.

CHE 43016 -
Research Project

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Course Unit Code	CHE 43016			
Course Unit Name	Research Project			
Credit value	6 (during the sem-1 and 2 of the Level 4)			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	ENH 22101			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	-	180	20	-
Objective of the Course Unit	To provide basic skills in planning and executing a research project in chemistry or a related area in chemistry and present & defend findings to a scientific community			
Evaluation Method	Research presentation		Thesis	Viva

Intended Learning Outcomes (ILO)

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

ILO 1: identify a research problem

ILO 2: conduct a comprehensive literature survey related to the research problem

ILO 3: design and conduct suitable experiments following scientific methods

ILO 4: critically analyze the results

ILO 5: write a dissertation covering a comprehensive literature survey, experimental procedure, analysis of results and discussion

ILO 6: effectively communicate the findings and defend the work in a professional manner

Course Content

Literature survey, proposal writing, laboratory and/or field work, data analysis and interpretation, writing dissertation and Presentation

Methods of Teaching and Learning

Each student will carry out a research project during the Level-4 under the supervision of an assigned supervisor (s).

Components: Literature survey, Proposal writing, laboratory and/or field work, data analysis and interpretation, writing a dissertation and presentation

Recommended Readings

- Literature relevant to the title of the research project
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APM 42032 -
Project Management

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Course Unit Code	APM 42032			
Course Unit Name	Project Management			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	None			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	To equip students with the skills to plan, execute, and evaluate projects, manage risks, prevent failures, and adapt practices to various project environments.			
Evaluation Method	Final Assessment 100%			

Intended Learning Outcomes (ILO)

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

ILO 1: explain how to initiate, specify, and prioritize projects and to determine various aspects of feasibility;

ILO 2: explain the foundations of project management, including its definition, scope, and the need for project management in the modern organization;

ILO 3: explain the phases of the project management lifecycle;

ILO 4: assess different issues that lead to project failures and addressing them;

ILO 5: assess the differences between IT/IS projects and general projects.

Course Content

1. **Fundamentals of project management (6 h)**

   Introduction to project management, project management life cycle, organizational structures for projects, and project selection.

2. **Project definition and planning (8 h)**

   Defining a project, estimating project times and costs, developing a project plan, and scheduling of resources.

3. **Project execution, control, and closure (10 h)**

   Risk management, measuring and evaluating project performance, project auditing, and winding up of projects.
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4. Introduction to IT project management (6 h)

Overview of IT project management concepts, approaches, and challenges.

Methods of Teaching and Learning

Lectures, case discussions and computer assisted learning

Recommended Readings

- Kloppenborg, T (2008), Contemporary Project Management, Cengage Learning.
- James, P Cand Jack, G (2008), Effective Project Management, 3rd Edition, Cengage Learning.
- Meredith, J R and Samuel, J M J (2008), Project Management, A Managerial Approach, 5th Edition, John Wiley & Sons, Inc

APM 42042 -
Professional Practices

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Course Unit Code	APM 42042			
Course Unit Name	Professional Practices			
Credit value	2			
Compulsory/Elective/ Enhancement	Compulsory			
Prerequisites	None			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	To develop students' professionalism, ethics, communication, and social intelligence for informed, responsible decision-making.			
Evaluation Method	Final Assessment 100%			

Intended Learning Outcomes (ILO)

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

ILO 1: describe the characteristics of a professional;

ILO 2: communicate at a professional level;

ILO 3: discuss the role of ethics in industry;

ILO 4: appreciate how to accept responsibility and ownership for yourself and other people under your direction;

ILO 5: describe the role of professional associations;

ILO 6: apply own level of social intelligence to his/her own position related to other professionals in the work place and thereby make informed decisions aligned to the professional practice in the industry s/he is involved in.

Course Content

1. **Fundamentals of professionalism (6 h)**

   Characteristics of a professional, professional associations, professionalism in workplace contexts.

2. **Communication and professional relationships (4 h)**

   Communication fundamentals, inter-relationships between communication and professionalism.

3. **Ethics and professional standards (10 h)**

   Ethics, differentiation between law, morals, and ethics, using standards and codes of
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ethics, inter-relationships between professionalism and ethics.

4. Professional judgment and social intelligence (10 h)

Introduction to decision-making in professional contexts, social intelligence and its role in professional success, professional judgment, inter-relationships between ethics and professional judgment, inter-relationships between professional judgment and social intelligence.

Methods of Teaching and Learning

Lectures and case analysis

Recommended Readings

- Bazerman, M H and Moore, D A (2009), Judgment in Managerial Decision Making, 7th Edition, John Wiley.
- Fisher, A (2001), Critical Thinking: an introduction, Cambridge University Press.

CHE 42062 -
Chemical Education

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Course Unit Code	CHE 42062			
Course Unit Name	Chemical Education			
Credit value	2			
Compulsory/Elective/ Enhancement	Elective			
Prerequisites	None			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	To provide knowledge on chemical education			
Evaluation Method	Final Assessment 100%			

Intended Learning Outcomes (ILO)

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

ILO 1: design teaching, learning and assessment activities according to psychological theories in education;

ILO 2: differentiate distinct types of learning and teaching methodologies

ILO 3: plan course modules in line with taxonomies of education

ILO 4: explain fundamental aspects of curriculum design

ILO 5: use historical aspects of chemistry in clearer understanding of chemistry;

ILO 6: demonstrate fundamental teaching techniques in chemistry education.

Course Content

1. Psychological and aspects of science education (8h)

Attention span and forgetting curve, components of critical thinking, Kolb's cycle of experimental Learning, SQ4R (survey, question, read, recite, relate, and review), reading method, Curry's onion model of education, Johari Window (Student and peer evaluation), Covey's time management.

2. Technical aspects of teaching, learning and assessment (8h)

Deep and surface learning; Active and passive learning; Teacher-centred vs. student-centred teaching; Taxonomies of education: Cognitive, affective and psychomotor domains of Bloom's Taxonomy; Solo Taxonomy; Perry Model of cognitive development; Chemistry education in the ICT age.
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3. **Designing curricula (6h)**

   Content-based vs. objective-based teaching; Biggs' constructive alignment; Introduction to Sri Lanka Qualifications Framework (SLQF).

4. **Historical & philosophical development of chemistry (8h)**

   Historical landmarks of chemistry; Inspirational life stories of eminent personalities in chemistry; Industrial revolution and the history of global chemical industry, identifying significant human mistakes in the past and the prediction of future based on history; Basic IQ in roots of chemistry.

5. **Demonstrations in chemical education (15h)**

   Demonstrations in chemistry: Demonstrations to reinforce classroom material, demonstrations to entertain thermochemistry, chemiluminescence, polymers, coloured metal ion complexes, etc. Use of everyday objects in chemical demonstrations; Classroom assessment: Teaching practice and seminar presentations which carries 20% of the marks for the course.

Methods of Teaching and Learning

Lectures, tutorials, class room activities and assignments

Recommended Readings

- Biggs, J.; Tang, C.; Kennedy, G., Teaching for Quality Learning at University 5e. McGraw-Hill Education: 2022.
- Ormrod, J. E., Human Learning. Pearson: 2019.
- Ambrose, S. A.; Bridges, M. W.; DiPietro, M.; Lovett, M. C.; Norman, M. K.; Mayer, R. E., How Learning Works: Seven Research-Based Principles for Smart Teaching. Wiley: 2010.

CHE 42072 -
Pharmaceutical Chemistry

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Course Unit Code	CHE 42072			
Course Unit Name	Pharmaceutical Chemistry			
Credit value	2			
Compulsory/Elective/ Enhancement	Elective			
Prerequisites	None			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	To provide knowledge and skills required in pharmaceutical industry			
Evaluation Method	Final Assessment 100%			

Intended Learning Outcomes (ILO)

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

ILO 1: apply knowledge gained in pharmaceutical chemistry to pharmaceutical technology

ILO 2: explain preparation methods of various pharmaceutical preparations

ILO 3: calculate the strength of pharmaceutical preparations

ILO 4: describe quality control and quality assurance procedures of pharmaceutical preparations

ILO 5: brief on essential components of pharmaceutical industry

Course Content

1. **Introduction (4 h)**

   Importance of pharmaceutical technology; Usage of pharmaceutical products; Classification of dosage forms; method of administration, GMPs.

2. **Preparation aspects (12 h)**

   Theory and preparation of various pharmaceutical products, such as tablets, suspensions, emulsions, ointments, gels, pastes, semisolid preparations, suppositories, powders, inhaled products, veterinary preparations; Problems associated with pharmaceutical preparations; Incompatibility issues.

3. **Quality control and quality assurance (10h)**

   Good laboratory practices, good manufacturing practices, good documentation practices; ISO series; Preservation, packaging and storage procedures; Sampling and application of
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analytical techniques in quantification; Bioequivalence studies; Methods validation.

4. Pharmaceutical industry (4h)

History of pharmaceutical industry, modern pharmaceutical industry and challenges faced; Pharmaceutical unit operations, Optimization and scaling up; Pilot scale considerations

Methods of Teaching and Learning

Lectures, tutorials, industrial visits, computer assisted learning, group work

Recommended Readings

- S.H. Rasheed, Pharmaceutical Technology-I, SIA Publishers and Distributors (P) Ltd., 2015.
- G. Agarwal and A. Kaushik, Pharmaceutical Technology I, CBS Publishers & Distributors Pvt Ltd., 2017.
- Fah, Voigt's Pharmaceutical Technology, J. Wiley & Sons, 2018.
- R.K. Yadav, A Textbook Of Pharmaceutical Technology-I, Vardhans Publishers.

CHE 42082 -
Food Chemistry & Technology

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Course Unit Code	CHE 42082			
Course Unit Name	Food Chemistry & Technology			
Credit value	2			
Compulsory/Elective/ Enhancement	Elective			
Prerequisites	None			
Hourly breakdown	**Theory**	**Practical / Tutorial**	**Independent learning**	**Notional learning hours**
	30	-	-	100
Objective of the Course Unit	To provide knowledge on food industry			
Evaluation Method	Final Assessment 100%			

Intended Learning Outcomes (ILO)

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

ILO 1: describe the nature of food components
ILO 2: explain principles of food preservation
ILO 3: apply technologies used to process and manufacture different food products
ILO 4: describe standards used in the food industry
ILO 5: apply safety regulations and quality management
ILO 6: suggest methods to analyze different food items

Course Content

1. **Carbohydrates, proteins and lipids (3 h)**

   Occurrence of monosaccharides, disaccharides and polysaccharides in food, their properties and industrial uses; Structure and properties of starch, gelatinization of starch, structure and properties of pectins, gel formation in pectins and uses of pectins in food industry; Food gums, Maillard browning and caramelization reactions; Analysis of carbohydrates in food.

   Chemistry of amino acids, peptides and proteins with reference to proteins in milk, meat, fish, eggs and wheat, Iso-electric point and its importance in food manufacture; Denaturation of proteins and its effect on food; Determination of proteins in food (Kjeldhal method, chromatographic methods).

   Occurrence of fats and oils in food, structure and properties of saturated and unsaturated
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fatty acids in food items, deterioration of fats and oils in food, hydrolytic and oxidative rancidity, chemistry of rancidity and role of antioxidants, determination of saponification value, iodine value, acid value, peroxide value and their importance.

2. Vitamins and minerals in food (2 h)

Occurrence, food sources and properties of water soluble and fat-soluble vitamins, stability of vitamins during processing and storage, minerals and trace elements in food; Analysis of vitamin C in food; instrumental methods for the analysis of trace elements present in food.

3. Sensory properties of food (2 h)

Natural pigments and flavour compounds in food - flavor and coloured compounds; Structural features of carotenoids, anthocyanins, porphyrins (chlorophyll and heme) and curcumins, occurrence and changes during cooking and processing.

4. Food additives (2 h)

Preservatives, antioxidants, artificial colours, emulsifiers and stabilizers, flavor enhancers, analysis of food additives; food adulteration.

5. Food spoilage and food preservation (2 h)

Perishability of food related to composition of milk, meat. cereals, nuts, fruits and vegetables, water activity, acidic and non-acidic foods, factors that cause spoilage, chemical and biochemical changes that can occur in food during food manufacturing and processing, methods of controlling spoilage, principles of food preservation, packaging technology.

6. Food quality and safety (2h)

Standards and food quality management, food safety and regulations.

7. Food Technology (7h)

Food processing and preservation technology: Food processing methods – Heat preservation, dehydration, concentration, freezing, refrigeration, minimal processing, chemical preservation Dairy technology, technology of cereals, technology of fish & meat products, technology of fruits and vegetables, Bakery technology, Confectionary technology. Technology of spices, essential oils and flavors: Sri Lankan spices, processing methods, physical and chemical characteristics, unique characteristics, production of essential oils, production of oleoresins, Quality assurance, methods of determinations.

8. Food Chemistry and food technology practical (20 h)

Proximate analysis of food; Determination of reducing sugars in food; Kjeldahl determination of proteins; Determination of saponification value; Acid value and peroxide value of fats and oils; Analysis of Vitamin C in fruits and vegetables; Determination of minerals in food using AAS and UV spectrophotometry; Bakery technology; Fruit and

vegetable technology (Dehydration methods, solar drying).

Methods of Teaching and Learning

Lectures, tutorials, industrial visits, computer assisted learning, laboratory work, group work, Industrial visits

Recommended Readings

- T.Coultate (2009), Food, the chemistry of its components 5th Edition. RSC Publication.
- Nandanie Ediriweera (2016), Food Science & technology Vol 1, S. Godage Bros.
- Nandanie Ediriweera (2016), Food Science & Technology Vol 2, S. Godage Bros.

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