CHEMISTRY CURRICULUM

B.Sc. (GENERAL) DEGREE

Department of Chemistry

University of Sri Jayewardenepura

http://science.sjp.ac.lk/che/

Revised
2013

B.Sc. (General) Degree – Course Contents

- Core Courses

* - Optional Courses

GENERAL DEGREE - FIRST YEAR

Course Title	**:** Concepts in Inorganic Chemistry I
Course Code	**:** CHE 110 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Prof. S. P. Deraniyagala

Objectives:

- To introduce quantum theory and hydrogen atom and the basic concepts of chemical bonding including Valence Bond Theory (VBT).

Course Content:

1. Quantum theory and the hydrogen atom
   Electromagnetic radiation and spectra, quantum theory of radiation, Planck's Law, the spectrum of hydrogen including Rydberg equation, the wave behavior of matter, de Broglie equation, the uncertainty principle, wave mechanics and atomic orbitals including quantum numbers.
   (3 hours)
2. Chemical bonding
   Introduction to chemical bonding, Lewis symbols, Hund's rule, octet rule, ionic lattices, lattice energy, covalent bond, drawing Lewis structures for ionic and covalent molecules, formal charge, concept of resonance, electronegativity, exceptions to the octet rule, dipole moment, polar and non polar covalent bonds, polarization and Fajan's rules.
   (4 hours)
3. Molecular shapes (VSEPR theory), molecular distortion and Valence Bond Theory to predict nature of chemical bonds (will introduce overlap of orbitals, hybridization (sp, sp^2, sp^3, dsp^2, dsp^3, d^2sp^3), electron promotion.
   (5 hours)
4. Lattice energy
   Definitions of lattice energy and heat of formation of an ionic compound Different type of interactions taking place between ions in M^{z+}, X^{Z-}) ionic crystals, Born-Lande equation to determine the lattice energy of an ionic solid, factors affecting the magnitude of lattice energy of ionic solids.
   (3 hours)

Method of Assessment:

End of semester examination 1 hour structured type, open book examination with 10 minutes reading time.

Learning Outcomes:

At the end of the course, student should be able to,

- Calculate the frequency of electromagnetic radiation from its wavelength and vice versa, list the region of the electro magnetic spectrum in order of increasing frequency, distinguish between a continuous spectrum and line spectrum, distinguish between an emission spectrum and absorption spectrum.

- Comment on the quantum theory of radiation including photoelectric effect and black body radiation, the spectrum of hydrogen, Bohr atom and limitations of the Bohr Theory.
- Calculate i) the excited and ground state energies for the hydrogen electron given the quantum number n, ii) the energy, frequency and wavelength of a photon emitted or absorbed during an electron transition in the hydrogen atom.
- Identify the electron transition that gives rise to the Lyman and Balmer series of spectral lines.
- Calculate the de Broglie wavelength associates with a beam of moving particles and state how the Broglie wavelength varies with increasing particle mass and speed.
- State the Heisenberg Uncertainty Principle and explain why we cannot predict the précis path or orbits for very small particles such as electrons.
- Write symbols for the orbital and spin quantum numbers and give their range of values.
- State the number of orbital in each shell and in each subshell, the total number of states available to an electron in each shell or subshell, describe the incidence for electron spin.
- Sketch the pictures for s, p, d orbitals, distinguish between p_x, p_y and p_z, distinguish between electron density and radial electron density.
- State how the most probable distance of an electron from the nuclear varies with increasing n, and within a shell, with increasing l.
- Describe the principal types of chemical bonds.
- Write Lewis symbols for the main group atoms.
- Use Lewis dot symbol and electronic configuration to represent the formation of monoatomic ions and ionic bonds.
- Describe how Lattice energy varies with increasing ionic charge and decreasing ionic radii.
- Diagram Born-Haber Cycle for the formation of an ionic solid and use it to calculate Lattice energies from experiments.
- Calculate Lattice Energy using Born-Lande equation.
- Comment on polarization of ions and Fajan's rules.
- Draw acceptable Lewis structures for covalent bonded molecules and ions.
- Find the formal charges on each atom in a Lewis structure.
- Write resonance structures for molecules and ions and draw the hybrid based on stable structures. Formal charge is used to determine which resonance structures make the greatest contribution to the resonance hybrid.
- State which elements can exhibit octet expansion and which elements are likely to have incomplete octets and draw Lewis structures for molecules containing these elements.
- Give examples of inorganic free radicals and draw their Lewis structures.
- Give examples of polar and non polar molecules.
- State how electronegativities vary across a period and down a group.
- Derive Pauling's equation related to electronegativity.
- Use eletronegativities to predict whether a bond will be ionic, polar covalent or non polar.
- Give examples of molecules with and without dipole moment.
- Calculate dipole moment of covalent bonds.

- Use VSEPR method to determine the shape around each central atoms and comment on molecular distortion.
- Predict the hybridization of the central atom in a molecule/ion.
- Use Valence Bond Theory (VBT) to describe the sigma bonded framework and π bonds in diatomic and polyatomic molecules.

Recommended Text Books:

1. Chemistry, The Central Science, T. L. Brown, H. E. Le May and B. E. Bursten 12th Edition, Prentice Hall.
2. Chemistry, J. McMurray and R. C. Fay 4th Edition, Prentice Hall.
3. Concise Inorganic Chemistry, J. D. Lee 5th Edition, ELBS with Chapman and Hall.
4. Inorganic Chemistry - Structure and Reactivity. E. Huheey 5th Edition, Harper and Row.

Course Title	: Chemical Thermodynamics
Course Code	: CHE103 1.0
Number of Lecture Hours	: 15
Number of Tutorial Hours	: 03
Lecturer in Charge	: Dr. N. M S Sirimuthu

Objectives:

- To introduce macroscopic properties of matter and to understand processes in terms of thermodynamics.

Course Content:

1. Zeroth Law of Thermodynamics, Forms of energy, principles of conservation of energy, heat and work.
   (2 hours)
2. First Law of Thermodynamics, intensive and extensive properties, state functions. Reversible and irreversible processes, isochoric and isobaric processes, heat capacity and enthalpy.
   (4 hours)
3. Qualitative idea about entropy, Second Law of Thermodynamics, entropy as a criterion for spontaneity and equilibrium.
   (3 hours)
4. Clausius Inequality, Carnot Cycle, calculation of entropy changes for reversible and irreversible processes.
   (3 hours)
5. Free energy functions - variation of free energy with temperature and pressure, Maxwell relations.
   (2 hours)
6. Third law of thermodynamics and its applications.
   (1 hour)

Method of Assessment:

End of semester examination 1 hour theory paper.

Learning Outcomes:
By following this course students should be able to,

- Explain the concepts of energy conservation.
- Identify properties of thermodynamic functions.
- Review the concept of entropy as a measure of randomness and spontaneity.
- Express the meaning of free energy.
- Relate thermodynamic functions to different processes.
- Use thermodynamic principles and functions to analyze simple chemical systems.

Recommended Text Books:

1. Four Laws that Drive the Universe by Peter Atkins, Oxford University Press.
2. Physical Chemistry, P. W. Atkins, Julio de Paula and Peter Atkins (10^{th} Edition, 2006, W. H. Freeman and Company).

Course Title	**:** Introduction to Analytical Chemistry and Nuclear Chemistry
Course Code	**:** CHE 111 2.0
Number of Lecture Hours	**:** 30
Number of Tutorial Hours	**:** 06
Lecturer in Charge	**:** Dr. C. D. Jayaweera

Objectives:

- To give an understanding of the analytical process, the role/ importance of errors in analytical chemistry and how to calculate and report typical analytical data with associated errors and the way statistics help to understand analytical data.
- To identify key aspects of titration and gravimetric analysis.
- To give an understanding to what happens when a molecule interacts with UV, Visible radiation.
- To identify key aspects of chromatographic separation.
- To introduce the topic of nuclear chemistry and to give a basic understanding of the applications of nuclear chemistry.

Course Content:

1. Introduction
   What is analytical chemistry? importance, the various stages involved in analysis and skills that needed to be known by an analyst, types of analysis, scale of operation, classification of analytical techniques, factors affecting the choice of an analytical method.

   (2 hours)

2. Evaluation of analytical data
   Absolute and relative error, classification of errors, repeated measurements and estimation of errors, statistical evaluation, significant figures.

   (7 hours)

3. Titrimetric methods of analysis
   Overview of titrimetry, titrations based on acid base, complexation, redox and precipitation reactions.
   (8 hours)
4. Gravimetry
   Particle size, super saturation, precipitate formation, contamination of precipitates.
   (2 hours)
5. Introduction to spectroscopy
   Electromagnetic radiation, what happens to a molecule when it absorbs light, Beer Lambert law and its applications, calculation of absorbance and transmittance, deviations from linearity.
   (3 hours)
6. Introduction to chromatography
   Introduction, classification of chromatographic methods, paper and thin layer chromatography.
   (1 hour)
7. Introduction to radioactivity
   (1 hour)
8. Introduction to nuclides (structural of atomic nucleus)
   Binding energy, nuclear mass and stability, neutron to proton ratio, orbital electron capture (k capture) and X-rays, α, β, γ emission and decay law, other sub particles.
   (1 hour)
9. Nuclear chemistry
   Nuclear energy, nuclear fission, critical mass, fissile and fertile nuclides, nuclear fusion, sun burning, He burning and CNO cycle, particle accelerators nuclear reactions (power plant) nuclear power and nuclear weapons.
   (2 hours)
10. Radioactivity
    Natural and artificial radioactivity, radioactivity equilibrium detections and measurement techniques, counters, cosmic rays cosmogenic and primodial radionuclides.
    (2 hours)
11. Irradiation (radiation effect on matter) irradiation techniques, water, food, (special mention of potatoes), salts (formation of colour centers and new salts) and milk irradiation, advantage of nuclear irradiation over conventional methods, D10 value effect on microbial load (pathogen fungi, etc).
    (1 hour)

Method of Assessment:

End of semester examination 2 hours theory paper.

Learning Outcomes:
At the end of the course the student should be able to,

- Distinguish between quantitative and qualitative methods
- Outline the steps involved in performing an analysis.
- Name and give examples of different techniques employed in quantitative analysis.
- Discuss the factors affecting the choice of an analytical method.

- Report the concentration in units of molarity, molality, weight/weight percent, weight/volume percent, volume/volume percent, ppm, ppb, pX.
- Recognize different types of errors in experimental results.
- Report the data of an analysis scientifically.
- Calculate the amount or concentration of an analyte based on a titration analysis.
- Differentiate between the end point and equivalence point of a titration.
- Describe the key features of a reaction suitable to be used in a titration.
- Describe the key features of a primary standard.
- Calculate the pH at key points during a titration of monoprotic acids and bases.
- State reasons why EDTA is used for many metal analyses.
- State why EDTA titrations are carried out at constant known pH.
- Calculate the EDTA – metal conditional formation constant at a given pH and use it in calculation of pM during a EDTA titration.
- Calculate the concentration or the amount of a metal ion (pM) in a sample based on either a direct EDTA or a back titration.
- Describe methods for making an EDTA titration selective.
- Sketch titration curves for simple redox titrations based on electrode potential.
- Give examples and describe the action of the different indicators used in acid-base/ complexometric/ redox titrations.
- Describe the properties of precipitates.
- Identify qualitatively the different regions of the electromagnetic radiation.
- Recognize what happens to a molecule when it absorbs light.
- Define absorption and transmission.
- Calculate absorbance and transmittance and to interconvert one value to the other.
- Define Beer lambert law and its application to mixtures and what causes deviations from linearity as predicted.
- Recognize types of chromatographic methods.
- Understand how chromatography is used for qualitative analysis.
- Compare different types and levels of radiation related to its function/uses.
- Demonstrate a basic understanding of nuclear chemistry.
- Discuss measurement techniques related to radiochemistry.
- Discuss different types of nuclear energy with special reference to fusion and fission reactions.

Recommended Textbooks:

1. Fundamentals of Analytical Chemistry, D. A. Skoog, D. M. West and F. J. Holler, Saunders College Publishing (Sixth Edition).
2. A Textbook of Quantitative Inorganic Analysis, A. I. Vogel, ELBS (Fifth edition).
3. Quantitative Chemical analysis, Daniel C. Harris, W. H. Freeman and Company (Eighth edition).
4. Principles and Practice of Analytical Chemistry, F. W. Fifield and D. Kealey, International Textbook Company Limited.
5. Chemistry of the Elements, N. N. Greenwood and A. Earnshaw.
6. Inorganic Chemistry**,** Structure and Reactivity, J. E. Huheey, 5th Edition, Harper and Row.

Course Title	**:** Main Group and Transition Elements
Course Code	**:** CHE 105 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Prof. Sudantha Liyanage

Objectives:

- The objectives of this course are to provide an understanding of the chemistry of all elements in the modern periodic table.

Course Content:

1. Introduction to modern periodic table
   s, *p*, *d* and *f* block elements, electronegativity, selected topics in *s* and *p* block elements, anomalous behavior of beryllium and diagonal relationship.
   (1 hour)
2. Interpair effect and the variable valency, Hybridization and shapes, outer sphere and inner sphere complexes.
   (2 hours)
3. Chemistry of Boron
   Boron hydride, 3 center 2 electron bonds borazine and related B-N polymer.
   (2 hours)
4. Introduction of intercalation compounds, chemistry of silicon, silicon oxides, siloxanes and silicones.
   (2 hours)
5. Chemistry of phosphorous, acids of nitrogen and phosphorous, catenation effect of sulphur and allotropic forms of sulphur.
   (2 hours)
6. Halogens and inter halogen compounds, compounds containing noble gases and ions.
   (1 hour)
7. Chemistry of *d*-elements
   Electron configuration, electronegativity, acidic-basic nature of oxides, formation of coordination complexes, occurrence of colored complexes.
   (2 hours)
8. Chemistry of *f*-elements
   Introduction to *f*-elements-configurations, electronegativity, acidic-basic nature of oxides and hydroxides, colors of *f*-elements.
   (2 hours)
9. Major difference between actinides and lanthanides.
   (1 hour)

Method of Assessment:

End of semester examination 1 hour theory paper.

Learning Outcomes:

At the end of this course students should be able to,

- Discuss the trends of the main group elements in the rows and groups of the periodic table and compare their properties and reactivities.

- Identify the oxidation states and electronic configuration of transition elements in coordination complexes.
- Identify the oxidation states and electronic configuration of inner transition elements in coordination complexes.

Recommended Text Books:

1. Chemistry of the Elements, N. N. Greenwood and A. Earnshaw.
2. Inorganic Chemistry, Shriver and Atkins.
3. Concise Inorganic Chemistry, J. D. Lee 5th Edition, ELBS with Chapman and Hall.
4. Inorganic Chemistry Structure and Reactivity, J. E. Huheey, 5th Edition, Harper and Row.

Course Title	**: Structure and Properties of Matter**
Course Code	: CHE 106 1.0
Number of Lecture Hours	: 15
Number of Tutorial Hours	: 03
Lecturer in Charge	: Prof. W. D. W. Jayatilaka

Objectives:

- Identify the constituent particles and states of matter.
- Study the interaction between particles in different states.
- Study the relationship between the structure and properties of different matter.

Course Content:

1. Introduction
   Classification of matter, transition between states, intermolecular attraction terms, dipole moment, polarizability, London attraction forces.
   (1 hour)
2. Gaseous State
   Real gasses, ideal gas and ideal gas equation, kinetic theory of gases, distribution of velocities, mean velocities, derivation of the equation $PV = 1/3mNc^2$ and calculations.
   (3 hours)
   Deviation from ideal gas behavior, limiting densities of gasses and Vanderwalls equation, critical state, principle of corresponding states, liquefaction of gasses, mean free path, collision frequency, diffusion of gasses.
   (2 hours)
3. Solid state
   Different types of lattices, lattice parameters, Miller indices, crystal states.
   (2 hours)
   X - ray diffraction and Bragg equation, calculation of lattice energies using properties of particles in an ionic lattice, amorphous state.
   (2 hours)
4. Liquid state and solutions

Properties of liquids, surface tension, viscosity, vapor pressure, miscible and immiscible liquids, intermolecular attraction.

(1 hour)

Ideal solutions and Raoult law, deviation from the Raoult law, coligative properties, osmotic pressure, elevation of boiling point, depression of freezing point, determination of molar mass using coligative properties, modern concepts on liquid state.

(3 hours)

Method of Assessment:

End of semester examination 1 hour theory paper.

Recommended Text Books:

1. Alberty R. A., Silbey R. J., Physical chemistry, John Wily & Sons Inc., 1995.
2. Fried V., Atkins P.W., Physical chemistry, Oxford University Press, 1998.
3. Hamika H. F., Blukis U., Physical chemistry, Macmillan publishing company, New York, 1977.
4. Ladd M., Introduction to Physical chemistry, Chambridge University press, 1999.
5. Rathakrishann E., Fundamentals of Engineering Thermodynamics, Prentice – Hall of India, New Delhi, 2000.
6. Atkins P.W., Physical chemistry, 6th Edition, Oxford University press, Tokyo, 1998.

Course Title : Organic Chemistry I

Course Code : CHE 108 1.0

Number of Lecture Hours : 15

Number of Tutorial Hours : 03

Lecturer in Charge : Dr. K. C. P. Mahathanthila / Dr. Isurika Fernando

Objectives:

- Gain knowledge about basic concepts of structure, stereochemistry and mechanisms of organic reactions.
- Introduce the basic concepts of structure, stereochemistry, and mechanisms as a prerequisite for CHE 109 1.0.

Course Content:

1. Structural theory

   Bonding in organic compounds, polarity of bonds and molecules, relationship of structure to physical properties (melting points, boiling points, solubility, acidity and basicity), delocalized bonding, resonance theory, aromaticity and Huckel's rule.

   (3 hours)

2. Isomerism and stereochemistry

   Structural isomerism and stereoisomerism, diastereomers and enatiomers, tetrahedral carbon, chirality, optical activity, R/S nomenclature, 2-D representations of 3-D structures (Fischer, Newman, and Saw-Horse representations), compounds with more than one chiral carbon atom, plane of symmetry, meso compounds, conformational analysis (ethane, butane, cyclohexane, chair and boat conformations).

(8 hours)

3. Structure and Nomenclature
   Structure and nomenclature of different classes of organic compounds.

   (2 hours)

4. Introduction to the mechanism
   Classifications of organic reactions, concept of a reaction mechanism, rates and equilibria, reaction profile, kinetic and thermodynamic control (illustrated by free radical reactions of alkanes).

   (2 hours)

Method of Assessment:

End of semester examination 1 hour theory paper.

Learning Outcomes:

- To be able to correlate structure of organic compound with their physical properties.
- To understand the 3- D structure of organic molecules.
- To understand the basic concepts involved in the study of the mechanism.

Recommended Text Books:

1. Organic chemistry - Morrison and Boyd.
2. Organic chemistry vol.1 - I. L. Finar.
3. Organic chemistry - Cram and Hammond.
4. A guide book to mechanisms in Organic chemistry - Peter Sykes.

Course Title	**:** Organic Chemistry II
Course Code	**:** CHE 109 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Dr. K. C. P. Mahathanthila / Dr. Isurika Fernando

Objectives:

- Use the knowledge of principles and facts (in CHE 108 1.0) to explain and predict chemical behavior.

Course Content:

1. Structure, Reactions & Mechanisms
   Description of the reactions listed under each class of compound and their associated mechanisms, influence of steric & electronic factors and the solvent on reaction mechanisms, use of kinetic & stereo chemical data and isotopes to elucidating reaction mechanisms 1, 2 nucleophilic rearrangements (Carbenium ions, Holfmann, Beckmann etc.), stereo specificity, stero selectivity and regioselectivity, influence of substituents on reactivity and regioselectivity in monosubstituted benzene.

2. Alkenes
   Electrophilic addition of halogen acids, water and halogens, radical addition of hydrobromic acid, catalytic addition of hydrogen, epoxidation reations with cold alkaline permanganate, osmium tetroxide - sodium bisulphate, diborane - hydrogen peroxide, cleavage reactions: ozonolysis reactions with potassium permanganate and periodic acid, cycloaddition to dienes (Diels – Alder reaction).
   (2 hours)
3. Alkynes
   Reduction with sodium and liquid ammonia, catalytic reduction, addition of halogen, halogen acids, water and ozone, acidity of terminal alkynes.
   (2 hours)
4. Aromatic compounds
   Electrophillic substitution: nitration, sulphonation, halogenations, Friedel - Crafts alkylation and acylation, Effects of substitution on reactivity and orientation, Acidity of Phenol, basicity of aniline, Reimer – Tiemann reaction.
   (2 hours)
5. Alkyl halides
   Nucleophilic substitution and elimination reactions with hydroxyl and alkoxide ions, formation of organometallic compounds, Grignard reactions, lithium dialkyl cuprates, scope of S_N reactions including reactions with carbon nucleophiles.
   (2.5 hours)
6. Alcohols
   Cleavage of carbon oxygen bond; reaction with hydrogen halides and phosphorus halides, dehydration, cleavage of oxygen hydrogen bond, formation of alkoxide ions, alcohols as nucleophiles, reaction with carbonyl compounds and carboxylic acid derivatives, oxidation.
   (2 hours)
7. Ethers
   Cleavage by acids.
   (2.5 hours)
8. Carbonyl compounds
   Nucleophilic addition reactions, reactions with Grignard reagents, cyanide, alcohols, derivatives of ammonia, lithium aluminium hydride and sodium borohydride. Beckmann rearrangement of oximes, Reaction involving acidity of alpha-H, Aldol type reactions, Wittig reaction, Clemmenson and Wolf Kishner reductions.
   a) Carboxylic acids and their derivatives- Acidity of carboxylic acids, nucleophyllic substitution, Claisen condensation of esters, use of ethyl acetoacetate in synthesis, Hoffmann rearrangement of amides.
   b) Amines- Basicity of amines, amines as nucleophiles, reactions with nitrous acids, Aromatic diazonium salt as electrophiles.
   (2 hours)

Method of Assessment:

End of semester examination 1 hour theory paper.

Learning Outcomes:

- To be able to correlate structures of organic compounds with their chemical properties.
- To be able to evaluate evidence for and postulate mechanism for organic reactions.

Recommended Text Books

1. Organic chemistry - Morrison and Boyd.
2. Organic chemistry vol.1- I. L. Finar.
3. Organic chemistry - Cram and Hammond.
4. A guide book to mechanisms in Organic chemistry - Peter Sykes.

Course Title : Chemistry Practical Unit
Course Code : CHE 107 2.0
Number of Practical Hours : 90
Lecturer in Charge : Dr. K. C. P. Mahathanthila/ Dr. S. D. M. Chinthaka/ Dr. N. T. Perera

Laboratory Orientation (3 days)

- Laboratory safety and precautions.
- Familiarizing (identification and handling) with the laboratory glassware, equipments.
- Laboratory chemicals: chemical labels, MSDS and handling.
- Waste disposal protocol.
- The Bunsen burner and glass blowing.
- Significant figures, data, regression analysis, and error calculations (use of excel worksheets).
- How to write a lab report.

Organic Chemistry

Objectives:

- Gain experience to identify the elements and functional groups present in an unknown organic compound.

Course Content:

1. Identification of the nature and the elements in organic compounds:
   Beilstein test, Lassaigne sodium test.

2. Test for functional groups in organic compounds:
   Alcohols, aldehydes, ketones, carboxylic acids, phenols, ammonium salts, amides, and amines, test for unsaturated compounds.

3. Identification of the elements and functional groups present in an unknown organic compounds.

Method of Assessment:

End of course 90 minutes practical examination.

Learning Outcomes:

1. Gain experience to identify the elements in an organic compound.
2. Gain experience to identify functional groups present in an unknown organic compound.
3. Gain knowledge to confirm the elements, and functional groups present in an unknown organic compound.

Recommended Text Books:
1. Practical Organic Chemistry: F. G. Mann and B. C. Saunders.
2. Practical Organic Chemistry: A. I. Vogel.

Inorganic Chemistry

Objectives:
- Instill proper laboratory skills, etiquette and safety practices.
- Guide students to understand the fundamental concepts behind each experiment detailed below.
- Be able to analyze a given sample qualitatively for its components.
- Understand the different types of chemical reactions and take careful observations of changes and how to record and report such observations.

Course Content:
1. Identification of periodic trends within group 2 cations (Mg^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}) and group 7 anions (Cl^-, Br^-, I^-).

2. Execution and identification of different types of chemical reactions:
   Addition: Cyclohexene + Br_2, $Mg_{(s)}$ + $O_{2(g)}$, $CuSO_{4(s)}$ + $H_2O_{(l)}$
   Decomposition: Sugar + H_2SO_4, $H_2O_{2(aq)}$ + $MnO_{2(s)}$, decomposition of $NaHCO_3$
   Single displacement: $Cu_{(s)}$ + $AgNO_{3(aq)}$, $Zn_{(s)}$ + $CuSO_{4(aq)}$
   Double displacement: $HCl_{(aq)}$ + $NaOH_{(aq)}$, Reactions between $PbNO_3$, $AgNO_3$, NaCl, $CuSO_4$, K_2CrO_4

3. Flame test (Li, Na, K, Ca, Sr, Ba) and borax bead test for cations (Cu, Fe, Cr, Mn, Co).

4. Test for anions using original mixture and by using sodium carbonate extract (Cl^-, Br^-, I^-, NO_3^-, NO_2^-, SO_4^{2-}, CO_3^{2-}, PO_4^{3-}, BO_3^{3-}).

5. Test for cations of group I and II, and group III excluding use of H_2S.

6. Cycle of copper reactions.

7. Preparation of hexaaminecopper(II) complex.

Method of Assessment:

End of course 2 hour practical examination (70%)
3 in-class quizzes (15%)

Participation (5%)
Attendance and notebook (10%)

Learning Outcomes:
At the end of this course students will be able to,
- Use and handle properly the glassware and equipment in an inorganic laboratory.
- Categorize reactions into their different types and identify the products.
- Recognize periodic trends of group 2 cations and 17 anions.
- Identify qualitatively the cations and anions present in a given sample.
- Synthesize a given metal complex.

Recommended Text Books:
1. Vogel's Qualitative Inorganic Analysis, Arther Israel Vogel and G. Svehla, Longman 1996.

Physical/Analytical Chemistry

Objectives:
- Introducing theoretical and practical aspects of volumetric analysis.
- Introducing simple laboratory equipments such as pH meter, conductivity meter and colorimeter.

Course Content:
1. Laboratory measurements
   Determination of relative atomic mass of Magnesium.

2. Titrimetric analysis
   Preparation of 0.1 mol dm^{-3} HCl solution and standardization of the prepared HCl solution using secondary standard solution of NaOH.

3. Titrimetric analysis
   Preparation of oxalic acid primary standard solution and standardization of a $KMnO_4$ solution.

4. Titrimetric analysis
   Selection of pH indicators for titrimetric analysis of a carbonate and bicarbonate mixture.

5. pH measurements
   Construction of titration curves for acid base titrations and determination of the end point of the strong acid (HCl) and strong Base (NaOH) titration using pH measurements.

6. Conductimetric titrations
   Determination of end point of a titration of a weak acid (acetic acid) and a weak base (ammonia).

7. Colorimetric measurements (with ferric salicylic experiment)

Exploring Beer Lambert law, calculation of molar absorption coefficient.

Method of Assessment:

End of course 2.5 - 3 hours practical examination.

Learning outcomes:

At the end of this course,

- Students will learn proper reading and recording of laboratory measurements.
- Students will achieve skill level required for theoretical and practical aspects of volumetric analysis.
- Students will handle calculations required for volumetric analysis.

Recommended Text Books:

1. Vogel's Text Book of Quantitative Chemical Analysis, J. Mendham, R. C. Denney, J. D. Barnes, and M. J. K. Thomas, 6th Edition, Pearson Education, 2003.

GENERAL DEGREE - SECOND YEAR

Course Title : Concepts in Inorganic Chemistry II
Course Code : CHE 210 1.0
Number of Lecture Hours : 15
Number of Tutorial Hours : 03
Lecturer in Charge : Prof. S. P. Deraniyagala

Objectives:
To introduce the topics,

- Application of molecular orbital theory to covalent molecules/ions.
- Determination of sizes of atoms and ions.
- Spontaneity of inorganic redox reactions.

Course Content:

1. Molecular orbital theory (MOT)
   LCAO Method (s-s, s-p, p-p, d-p, d-d combinations), Molecular Orbital energy level diagrams of,
   (i) Homodiatomic molecules (H_2, B_2, C_2, N_2, O_2, F_2)
   (2 hours)
   (ii) Heterodiatomic molecules (NO, CO, HCl) and
   (2 hours)
   (iii)Polyatomic inorganic molecules / ions- molecules with σ bonds only ($BeCl_2$,BCl_3) and molecules with σ bonds and delocalized π bonds (NO_2^-, NO_3^-, CO_3^{2-}, SO_3, O_3, CO_2, etc.) and some selected organic molecules such as ethylene, acetylene, allyl ion $(C_3H_5)^-$, butadiene, cyclobutadiene, cyclopentadienyl anion, benzene, formaldehyde. Predicting bond order and magnetism of molecules based on molecular diagrams.
   (4 hours)
2. Sizes of atoms and ions
   Covalent radii, ionic radii, metallic radii, vander waals radii, experimental methods for the determination of ionic radii (Landes and Pauling's methods), bond lengths, screening, Slater rules.
   (4 hours)
3. Inorganic redox reactions
   Oxidation state, assignment of oxidation states of elements in a given compound, Balancing redox reactions in acidic/basic/neutral media using oxidation number method and half reaction method, Electrochemical cells (Galvanic/electrolytic), Standard electrode potential (E^o), Representation of various types of electrodes, determination of cell potentials under standard and non standard conditions (Nernst equation), Determination of ΔG^o and equilibrium constant (K) for redox reactions, Application of the concept of standard electrode potential to predict spontaneity of redox reactions (eg: disproportionate reactions), Factors affecting the magnitude of standard reduction potential.
   (3 hours)

Method of Assessment:

End of semester examination 1 hour structured type, open book examination with 10 minutes reading time.

Learning Outcomes:
At the end of this course students should be able to,

- Draw molecular orbital energy level diagrams of homo and hetero diatomic molecules/ions and calculate their bond order. Should be able to comment on their magnetic behavior.
- Use the molecular orbital theory to describe π electron system in polyatomic molecules/ions.
- Balance redox reaction under acid, base and neutral conditions using oxidation number method and half reaction method.
- Perform stoicheometric calculations that involve redox reactions.
- Define standard electrode potential (E^o).
- Identify the oxidation and reduction based on E^o values.
- Predict the spontaneity of redox reactions by calculating $\Delta G^o = -nFE^o_{cell}$ or $\Delta G = -nFE_{cell}$.
- Calculate i) bond length of covalent bonds using covalent radii, ii) ionic radii using Lande's method and Paulings equation. Concept of shielding and Slater rules to calculate Z_{eff} will be introduced here.

Recommended Text Books:

1. Chemistry, S. R. Radel and M. H. Navidi West Publishing Company (latest edition).
2. Inorganic Chemistry, A. G. Sharp ELBS with Longman.
3. The Importance of Antibonding Orbitals, M. Orchin and H. H. Jaffe Houghton Muffin Company - Boston.
4. Inorganic Chemistry G. L. Miessler and D. A Tarr Prentice Hall, New Jersey.
5. College Chemistry with Qualitative Analysis, Holtzclaw and Robinson Heather Company.
6. Chemistry, Raymond Chang, 9th Edition, McGraw Hill Publication Company.

Course Title	**:** Chemistry of Coordination Compounds
Course Code	**:** CHE 202 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Dr. P. K. D. M. C. Karunaratne

Objectives:

- Build a sound foundation of concepts in coordination chemistry and understand the practicality of available theories of bonding to explain the formation, stability, properties, and reactivity of coordination compounds.

Course Content:

1. Introduction
   Transition metals, types of ligands, Werners theory of coordination compounds, valency, coordination number, geometry, 18 electron rule.
   (2 hours)
2. Nomenclature of coordination compounds.
   (1 hour)
3. Isomerism in coordination compounds.
   (1 hour)
4. Bonding in coordination compounds
   i. Valence Bond theory (VBT): Octahedral (outer and inner orbital), tetrahedral, square planer complexes, strengths and weaknesses of VBT.
   (2 hours)
   ii. Crystal field theory (CFT): d orbital orientation, crystal field splitting of octahedral, tetrahedral, and square planer complexes, spectrochemical series, high spin and low spin complexes, crystal field stabilization energy (CFSE), pairing energy, stability of octahedral Vs tetrahedral complexes, magnetic properties, spin and orbital contribution, Jahn-Teller distortion in octahedral complexes, experimental observations (lattice energy, hydration energy, ionic radii).
   (6 hours)
   iii. Molecular orbital theory (MOT): Octahedral complexes with metal - ligand π bonding.
   (2 hours)
   iv. Colors of transition metal coordination compounds, d-d transitions, selection rules, charge transfer transitions.
   (1 hour)

Method of Assessment:

End of semester examination 1 hour theory paper.

Learning Outcomes:

- Students will understand the structural, electronic, magnetic, and chemical aspects of coordination compounds. They will be in a strong position to study advanced topics (advanced coordination chemistry, organo-transition metal chemistry, inorganic spectroscopy, etc.) and to apply their knowledge in research.

Recommended Text Books:

1. Advanced Inorganic Chemistry, 5^{th} Edition, Cotton, F. A.; Wilkinson, G. Interscience Publishers, New York (1998).
2. Inorganic Chemistry, Shriver, D. F.; Atkins, P. W.; Langford, C. H. Oxford University Press, Oxford (1990).
3. Concise Inorganic Chemistry, 4^{th} Edition, Lee, J. D.; Chapman & Hall Ltd., London (1991).
4. Concepts and Models of Inorganic Chemistry, 3^{rd} Edition, Douglas, B.; McDaniel, D.; Alexander, J. John Wiley and Sons Inc. (1993).

Course Title	**:** Organic Spectroscopy
Course Code	**:** CHE 203 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Dr. B. A. Perera

Objectives:

- To give an idea about NMR, UV Visible, Mass and IR spectroscopy.
- To interpret spectra in order to identify structures of organic compounds.

Course Content:

1. Introduction
   Electromagnetic spectrum, types of spectroscopic methods used in organic chemistry.
   (1 hour)
2. UV Spectroscopy
   Types of electronic transitions, chromophore, auxochrome, bathochromic shift, the effect of conjugation on the λ_{max}, solvent effect.
   (2 hours)
3. Infrared spectroscopy
   IR absorption process, uses of IR, modes of vibration, bond properties and absorption trends, general survey of functional groups.
   (3 hours)
4. ^{1}H NMR Spectroscopy
   Introduction, nuclear spin state and nuclear magnetic moment, chemical shift and shielding, chemical equivalence, chemical environment around a proton, spin-spin coupling, (n+1) rule and analysis of ^{1}H NMR spectra.
   (3 hours)
5. ^{13}C NMR Spectroscopy
   Coupling and decoupling, off resonance decoupling, DEPT spectra, molecular symmetry, analysis of ^{13}C NMR spectra.
   (2 hours)
6. Mass Spectrometry
   Ionization processes, mass spectral data, examples of common type of fragmentation processes.
   (2 hours)
7. Questions

(2 hours)

Method of Assessment:

End of semester examination 1 hour theory paper.

Learning Outcomes:
Should be able to,

- Describe the theory of NMR, IR, UV spectroscopic and mass spectrometric methods.
- Combine these methods and interpret unknown spectra's to find the structure of molecules.

Recommended Text Books:

1. Spectroscopy - D. R. Browing.
2. Organic Structures from Spectra (any edition) L. D. Field, S. Sternhell, J. R. Kalman.

Course Title	**:** Electrochemistry
Course Code	**:** CHE 204 1.0
Number of lecture hours	**:** 15
Number of tutorial hours	**:** 03
Lecturer in Charge	**:** Dr. D. R. Ratnaweera

Objectives:
To give,

- A basic knowledge on structure and properties of electrochemical systems.
- Practical application of the principles of the ionic mobilities.
- Determination of thermodynamic functions using electrochemical data.
- Theoretical and practical knowledge on electrochemical cells in use.
- Descriptive knowledge on theory and practice on electroplating.

Course Content:

1. Conductance and transference, electronic and ionic conduction, conductance, conductivity.

   (1 hour)

2 Molar conductivity
Experimental determination of molar conductivity of solutions, variation of conductivity and molar conductivity with concentration of various electrolytes, molar conductivity at infinite dilution, Kohlrausch law of independent migration of ions, ionic conductivities.

(2 hours)

3. Onsager equation, interpretation of current in terms of properties of ions in solution, ion mobilities, transference numbers, Hittorf method and moving boundary method for the determination of transference numbers.

   (2 hours)

4. Electrode potentials and electrochemical cells
   Conversion of chemical energy to electrical energy and vice-versa, cells and electrodes, equilibrium electrode reactions, electrode potentials and standard

electrode potentials, standard electrodes and standard cells, variation of electrode potentials will concentration.

(2 hours)

5. Nernst equation, electromotive force (EMF), types of electrochemical cells, variation of EMF with concentration.

(2 hours)

6. pH measurements, liquid junction potential, determination of thermo dynamic functions *ΔG,* ΔH, ΔS) and equilibrium constant using EMF data.

(2 hours)

7. Electrolysis
Polarization, decomposition voltage, discharges potential, overvoltage, Prediction at products of some electrolysis systems.

(2 hours)

8. Application of electrochemistry
Coulometry, electrophoresis, conductometry, potentiometry, amperometry, polarography, determination of activity coefficients using EMF and conductivity data. Primary cell and secondary cells, fuel cells, corrosion and prevention of corrosion, electroplating.

(2 hours)

Method of Assessment:

End of semester examination 1 hour theory paper.

Learning Outcomes:

- Describes the nature of electrolyte systems.
- Calculates thermodynamic data from electrochemical data.
- Calculates the properties of electrochemical system using Nernst equation.
- Identify the chemistry and the other properties of cell and batteries in the market.
- Calculates conductive properties of solutions using relevant equations.
- State and describe the applications of ionic mobilities in practical systems.

Recommended Text Books:

1. Crow, D. R., Principles and Applications of Electrochemistry. Stanley Thornes: 1994.
2. Selley, N. J., Experimental approach to electrochemistry. John Wiley & Sons, Incorporated: 1977.
3. Wang, J., Analytical Electrochemistry, Wiley, 1994.
4. Vogel, A. I.; Bassett, J.; Denney, R. C.; Jeffrey, G. H., Vogel's Text-book of Quantitative Inorganic Analysis: Including Elementary Instrumental Analysis, Longman, 1996.

Course Title	**:** Chemistry of Heterocyclic and Bio-organic compounds
Course Code	**:** CHE 205 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Dr. M. G. C. Padumadasa

Objectives:

- To provide a general understanding of the structure of heterocyclic and bio-organic compounds.
- To provide knowledge on the basic reactivity patterns and reactions of above molecules.

Course Content:

1. Heterocyclic compounds
   Structure, synthesis, properties and reactions of furan, pyrrole, thiophene and pyridine.
   (4 hours)
2. Carbohydrates
   Introduction to carbohydrates, classification, Fischer projections, configurational notations, cyclic forms, mutarotation, and reactions of monosaccharides.
   (6 hours)
3. Amino acids, peptides and proteins
   Introduction to amino acids, peptides and proteins, classification, stereochemistry, properties, synthesis and reactions of amino acids, synthesis of peptides.
   (3 hours)
4. Lipids
   Introduction to fats and oils, introduction, nomenclature, structure, properties and reactions of fatty acids.
   (2 hours)

Method of assessment:

End of semester examination 1 hour theory paper.

Learning outcomes:
Should be able to,

- Describe the structure of heterocyclic and bio-organic compounds.
- Write down the basic reactivity patterns and reactions of above molecules and rationalize in terms of structure reactivity principles.
- State the significance of above molecules in biology, medicine and industry.

Recommended Text Books:

1. Organic Chemistry - Morrison and Boyd.
2. Organic Chemistry (Vol II) - I. L. Finar.
3. Organic Chemistry - Cram and Hammond.

Course Title	**:** Chemical Kinetics
Course Code	**:** CHE 206 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Dr. R. S. Jayakody

Objectives:

- To recall the basics of chemical kinetics and introduce students to some further topics in chemical kinetics such as Arrhenius equation, Eyring equation and steady state approximation.
- To strengthen student's knowledge of reaction mechanisms.

Course Content:

1. Introduction to basic concepts
   Reaction kinetics in chemistry, reaction as a collision process, effects of energy, temperature and concentration on reaction rates, definition of rate of a reaction, elementary reactions, molecularity.
   (3 hours)
2. Rate law
   Rate law and reactant concentrations, half-life and its applications in kinetics.
   (2 hours)
3. Arrhenius equation and activation energy, catalysis, enzyme catalysis, autocatalysis and oscillators.
   (2 hours)
4. Eyring equation and its uses against Arrhenius equation, application of Eyring equation, calculation of entropy of activation.
   (2 hours)
5. Parallel and consecutive reactions, mechanism of reactions, rate determining step.
   (2 hours)
6. First order reversible reactions, first order consecutive reactions, chain reactions.
   (1 hour)
7. Steady state approximation, application of steady sate approximation to produce single rate law from a set of differential equations.
   (2 hours)
8. Introduction to Lindemann mechanism and Transition state theory.
   (1 hour)

Method of Assessment:

End of semester examination 1 hour theory paper.

Learning Outcomes:

- Learn the concept of rate of change associated with chemical change, recognizing that the rate of change and how it can be measured.
- Determine rate law of chemical change based on experimental data.
- Be able to identify the reaction order for a chemical change.
- Apply integrated rate equations to solve for the concentration of chemical species during a reaction of different orders.

- Recall and explain why certain factors such as concentration, temperature, medium and the presence of a catalyst will affect the speed of a chemical change.
- Master the concept of activation energy in the context of the transition state and be able to calculate the activation energy given some experimental data.
- Learn, manipulate and properly employ the Arrhenius Law.
- Learn, manipulate and properly employ Eyring's equation, calculation of change in entropy by using Eyring's equation.
- Explain the function and purpose of a catalyst.
- To be able to distinguish between parallel and consecutive complex reactions.
- Understand the concept of mechanism and using rate law data predict whether or not a proposed mechanism is viable or not.
- Be able to calculate the rate constants of 1^{st} order parallel reactions.
- Be able to calculate the rate constants of consecutive reactions.
- Learn, manipulate and properly employ the steady state approximation.

Recommended Text Books:

1. Atkins, P.; de Paula, J., Elements of Physical Chemistry. W. H. Freeman: 2009.

Course Title	**: Phase Equilibria and Surface Chemistry**
Course Code	**:** CHE 207 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Prof. P. M. Jayaweera

Objectives:

- Define equilibrium: Be able to understand: different variant systems, Construction of phase diagrams and cooling curves, adsorption and desorption phenomena, adsorption isotherms, Brief knowledge about surface reactions.

Course Content:

1. Introduction to Phase Equilibria
   Components, Phases and Degrees of Freedom, Gibbs Phase rule, Phase transitions.
   (2 hours)
2. One-component systems, Clausius-Clapeyron equation, P/T diagrams, triple points, critical points.
   (2 hours)
3. Allotropy, Metastable Equilibria, liquid crystals and anisotropic liquids.
   (1 hours)
4. Two component liquid systems, ideal and real solutions, zeotropic and azeotropic systems, distillation of liquid mixtures, partially and immiscible liquids.
   (2 hours)
5. Two component solid liquid systems, eutectic mixtures, compound formation, congurent and incongurent melts, construction of cooling curves, miscibility in the solid state, two component solid solutions.
   (2 hours)

6. Three component systems, experimental methods for constructing phase diagrams, ternary systems with water and two water soluble salts, systems with more than three components, differential thermal analysis.

   (1 hour)

7. Introduction to surface phenomena
   Adsorption and desorption, comparative description of physisorption and chemisorption.

   (1 hour)

8. Adsorption theories
   Adsorption isotherms, Langmuir adsorption isotherm and its applications, failures of Langmuir model, introduction to multilayer adsorption, B.E.T. theory of multilayer isotherm, calculation of surface area, associative and dissociative adsorptions.

   (3 hours)

9. Kinetics of unimolecular surface reactions, Langmuir-Hinshelwood mechanism.

   (1 hour)

Method of Assessment:

End of semester examination 1 hour theory paper.

Learning Outcomes:

1. Phase Equilibria Section:

   On completion of course unit students will be able to understand,

   - The thermodynamic aspects of phase equilibria and to calculate the number of components, phases and degrees of freedom. Use of phase rule to understand the P/T curves.
   - Liquid/Liquid, Liquid/Solid, Liquid/Vapor and Solid/Solid systems and must be able to explain the phase diagrams and construct the cooling curves.
   - Fractional distillation, Steam distillation and fractional crystallization.
   - Liquid ternary systems with different pairs of miscibility. The effect of temperature of phase diagrams.

2. Surface Chemistry Section:

   On completion of course unit students will be able to understand,

   - Fundamentals of surface phenomena, chemisorption and physisorption, adsorption/desorption processes and heat of adsorption associative and dissosiative adsorption, Langmuir, Freundlich and BET isotherms. Mechanism of surface reactions and kinetics of unimolecular surface reactions, Langmuir-Hinshelwood mechanism.

Recommended Text Books:

1. Phase Diagrams: Understanding the Basics by F. C. Campbell.
2. The phase rule and its applications by Alexander Findlay.
3. Intermolecular and Surface Forces by Jacob N. Israelachvili.
4. Gas Adsorption Equilibria: Experimental Methods and Adsorptive Isotherms by Jürgen U. Keller and Reiner Staudt.

Course Title	**:** Quantum Chemistry

Course Code **:** CHE 208 1.0
Number of Lecture Hours **:** 15
Number of Tutorial Hours **:** 03
Lecturer in Charge **:** Dr. S. D. M. Chinthaka

Objectives:

- To introduce the basic concepts of quantum theory.
- To understand that the quantum theory is to describe the dynamic of microscopic particles only.
- To compare the classical mechanics with quantum mechanics and to understand the failure of classic mechanics when applied to microscopic particles.
- To understand that the Schrödinger equation and wave function are the central equations in quantum mechanics.
- Learn how to use of model systems to understand the application of quantum mechanics to describe the atomic structure**.**
- Learn how to interpret the wave function to describe atomic properties such as quantum numbers, energy levels, electron density, degeneracy in single electron systems.

Course Content:

1. Introduction
   Behavior of macroscopic and microscopic particles under applied force, failure of classical mechanics when applied to the transfer of very small energy in very small particles, mathematical description of wave, properties of wave, common sine wave equation, frequency, period, angular frequency, wavelength, amplitude, and the energy of a wave, electromagnetic wave and spectrum, wave particle duality, de Broglie relationship, the Heisenberg uncertainly principle.
   (3 hours)
2. Background knowledge for understanding quantum chemistry
   Wave function and its properties, complex function, Operators, Eigen function and Eigen value equation, interpretation of wave function - normalization: normalized and normalizable wave functions, probability density of particle, probability of finding particle in given space, postulates of quantum mechanics.
   (3 hours)
3. Schrödinger equation
   One dimensional time independent Schrödinger equation, kinetic energy and potential energy operators in Schrödinger equation.
   (1 hour)
4. Model systems for applying Schrödinger equation
   Particle in one dimensional box, solving Schrödinger equation for Particle in one dimensional box, boundary conditions for finding the wave function and the energy for particle in one dimensional box model, Quantization (quantum number) of energy in Particle in one dimensional box model, probability density and probability of finding a particle in one dimensional box model, motion in two dimensions, degeneracy and degenerate wave functions.
   (4 hours)
5. Structure and spectra of single electron systems (hydrogen like atoms)

Balmer, Lyman and Paschen series, Rutherford nuclear model, introduction of spherical coordinates, separation of radial and angular variables, wave function of hydrogen like atoms-atomic orbitals, relationship of *n*, *l* and *ml* quantum numbers and identification of these numbers in atomic orbital wave functions.
Interpretation of atomic orbital: radial electron and probability density of atomic orbitals, angular momentum, nodes, behavior of single electronic systems in applied external magnetic field.

(3 hours)

6. Spin of the electrons
   Origin of electronic spin, Stern-Gerlarch experiment, spin angular momentum quantum number, available spin states, fermions, bosons, Pauli Exclusion Principle, requirement of four quantum numbers to describe atoms.

(1 hour)

Method of Assessment:

End of semester examination 1 hour theory paper.

Learning Outcomes:

- Students will learn some background knowledge for the better understanding of quantum mechanics/chemistry.
- Student must be able to understand the failure of classical mechanics when applied to microscopic particles.
- Student must be able to explain the failure of classical mechanics when applied to microscopic particles through scientific experiments.
- Students will learn the importance of Schrödinger equation and its solutions for energy and the dynamics for simple model systems.
- Students will learn the use of the solution of Schrödinger equation to explain the energy levels and orbitals of single electron systems.

Recommended Text Books:

1. Physical Chemistry: P. W. Atkins, 9th edition, Freeman, 2010.
2. Any general chemistry book that contains a quantum chemistry chapter.

Course Title : Chemistry Practical Unit

Course Code : CHE 209 2.0
Number of Practical Hours : 90
Lecturer in Charge : Prof. L. Karunanayake/ Dr. B. A. Perera/ Dr. P. Godakumbura

Inorganic Chemistry

Objectives:

- To improve laboratory skills and safety practices.
- Guide students to understand the fundamental concepts behind each experiment detailed below.
- To give a practical experience to analyze compounds using different methods (Titrations, Gravimetric methods).
- To give an experience to analyze household chemicals and other compounds.
- Understand the different types of chemical reactions and take careful observations of changes and how to record and report such observations.

Course Content:

1. Determination of Zinc, Nickel, and total hardness of water by complexometric titration using EDTA.

2. Standardization of a sodium thiosulphate solution and determination of the concentration of a given iodine solution by titrimetric analysis.

3. Redox titration of Vanadium (IV) and Vanadium (II) with potassium permanganate.

4. Determination of calcium by precipitation from homogeneous solution by titrimetric analysis.

5. Analysis of Vitamin C using Iodine by Iodometry.

6. Analysis of active ingredients in a commercial tablet: Asprin.

7. Analysis of vinegar and fruit juices.

8. Determination of phosphate by precipitation as $Mg(NH_4)PO_4.6H_2O$ and back titration with EDTA.

Method of Assessment:

End of course 2 hours practical examination.

Learning Outcomes:
Student should be able to,

- Use and handle properly the glassware and equipment in an inorganic laboratory.
- Apply complexometric titrations, redox titrations to analyze samples.
- Apply precipitation methods to find out unknown concentrations of the samples.
- Use these methods to find out active ingredients of common household chemicals.

Recommended Text Books:

1. Vogel's Qualitative Inorganic Analysis, Arther Israel Vogel and G. Svehla, Longman 1996.

<u>Organic Chemistry</u>

Objectives:

- To give practical experience of synthesis, purification techniques, preparation of dyes and applications.
- Reactions of organic compounds and identification of unknown compound by determining melting points.
- Calculating percent recovery, percent yield.
- Familiarizing and mastering techniques such as reflux, recrystallization, distillation and separation of an organic compound from a mixture.

Course Content:

1. Preparation of solid organic derivates of phenolic compounds by Schotten-Baumann reaction and identification of the parent compound; Product verification and confirmation of purity by determining the melting point, melting point depression of a mixture of organic solids and identification of the unknown compound (Mixed melting point concept), calculating the percentage yield and the percent recovery.

2. Preparation of solid derivates (2, 4 –dinitrophenylhydrozone and semicarbazones) of carbonyl compound (aldehydes and ketones) and identification of the parent compound by determining the melting point and calculating the percent yield, recrystalizing organic solid using mixed solvents.

3. Preparation of solid organic derivate and identification of the parent compound of primary aromatic amines (acetylation reaction) and calculating percent yield.

4. Nitration of acetanilide and conformation of the purity of the product by determining the melting point.

5. Preparation and separation of ethyl acetate by azeotropic mixture (use of distillation apparatus).

6. Benzoic acid synthesis by hydrolysis of Benzamide and conformation of the purity; calculating percent yield.

7. Preparation of azo dyes (Para red and Methyl Orange) and applications.

8. Separation of mixtures containing two organic compounds (acidic, basic and neutral compounds).

Method of Assessment:

End of the course 120 min exam: 70%

Lab recordings:	10%	
Attendance:	10%	(80% attendance is required)
Viva and the Technique:	10%	

Learning Outcomes:

By following this course, student should be able to,

- Determine the melting point of an organic solid and product identification, confirmation of purity.
- Synthesize organic compound and calculating percent yield and percent recovery.
- Gain experience to perform the techniques such as reflux, recrystalization and distillation.
- Separate organic compound from a mixture.

Recommended Text Books:

1. Practical Organic Chemistry: A. I. Vogel.
2. Organic Chemistry laboratory: C. E. Bell.
3. Practical Organic Chemistry: F. G. Mann and B. C. Saunders.

Physical Chemistry

Objectives:

- To apply the principles of thermodynamics, kinetics and some spectroscopic techniques in illustrative experiments.
- To gain experience with a variety of physico-chemical measurement techniques.

Course Content:

1. Determination of partition coefficient of NH_3 between $CHCl_3$ and water using titrimetric method. Calculate the enthalpy change of the above process and coordination no of $[Cu(NH_3)]_4$ complex.

2. Determination of endpoint of acid-base titrations using conductance measurement and to obtain composition of a mixture of strong (HCl) and weak (HAc) acids.

3. Preparation of buffer solutions of $CH_3COOH/CH_3COO^-Na^+$ and NH_4OH/NH_4Cl investigation of their properties.

4. Determination of the reaction order and the rate constant (at 30 ^oC) for the acid catalyzed hydrolysis of methyl acetate using titrimetric method.

5. Use conductivity measurements,
    a. To calculate the dissociation constant of a week acid (Acetic acid).
    b. To calculate the solubility product of a partially soluble salt (Lead sulphate).

6. Determine the rate constant and activation energy for the ethyl acetate and sodium hydroxide reaction using titrimetric analysis.

7. Determine the freezing point depression constant of naphthalene and to obtain the molar mass of an unknown solute.

8. Colorimetric determination of unknown solution concentrations of $NiSO_4$, $Co(CH_3COO)_2$ and $CuSO_4$ systems.

Method of Assessment:

- Lab Reports 40%
- Three hours practical examination 60%

Learning Outcomes:

- Students should be able to understand the connection between the laboratory experiment and underlying physical chemistry phenomenon.
- Develop the skill sets required in scientific report writing and interpretation of results.

Recommended Text Books:

1. Practical Physical Chemistry, Findlay Alexander, Jan 2013, Hard Press Publishing.

GENERAL DEGREE - THIRD YEAR

Course Title	**:** Industrial Utilization of Plant Materials
Course Code	**:** CHE 302 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Dr. M. G. C. Padumadasa

Objectives:

- To identify plants as a source of industrially important compounds.
- To provide a general understanding of the chemistry, composition, extraction, refining and chemical and physical tests of plant oils.
- To provide a general understanding of the chemistry, composition, extraction, and industrial uses of essential oils.
- To provide knowledge on medicinal compounds present in plants and their chemistry, extraction and industrial uses.

Course Content:

1. Introduction to plant metabolites
   Primary metabolites and secondary metabolites.
   (2 hours)
2. Fixed oils
   Chemistry of fixed oils, extraction of fixed oils (mechanical and solvent extraction), refining and quality tests, industrial uses (soap and biodiesel production).
   (5 hours)
3. Essential oils
   Chemistry of essential oils, Extraction of essential oils (distillation, solvent extraction, expression and enfleurage), industrial uses.
   (3 hours)
4. Medicinal compounds
   Chemistry of medicinal compounds (alkaloids, phenolics and terpenoids), extraction of medicinal compounds, industrial uses (modern pharmaceuticals and herbal products).
   (5 hours)

Method of Assessment:

End of semester examination 1 hour theory paper.

Learning Outcomes:
Be able to,

- Describe the chemistry, composition, extraction, refining and chemical and physical tests of plant oils.
- Describe the chemistry, composition, extraction, and industrial uses of essential oils.
- Describe the medicinal compounds present in plants and their chemistry, extraction and industrial uses.

Recommended Text Books:

1. Industrial Utilization of Renewable Resources – H. Harry Szmant.

2. A manual on the essential oil industry - K. Tuley De Silva.
3. Spices and Essential Oils - OUSL publication.

Course Title	**:** Photochemical Aspects of Solar Energy Conversion
Course Code	**:** CHE 340 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Dr. D. R. Ratnaweera

Objective:

- Deliver the knowledge of fundamental principles behind photochemistry.
- Introduce major solar energy conversion methods with relevant theoretical models.

Course Content:

1. Introduction
    a. Interaction of electromagnetic radiation with mater, quantized energy levels of molecules.
    (1 hour)
    b. Absorption, excited states, fluorescence, phosphorescence, vibronic coupling, relaxation phenomena, solvent effects, quantum yield, Boltzmann distribution.
    (2 hours)
2. Rotational spectra of simple molecules, selection rules, degeneracy and intensity of rotational transitions, effect of isotopic substitution.
    (2 hours)
3. Simple harmonic vibrations, selection rules, vibration energy levels, vibration of simple polyatomic molecules, effect of isotopic substitution on vibrational spectra.
    (2.5 hours)
4. Photocurrent conversion efficiency and action spectra.
    (1 hour)
5. Solar energy conversion
    a. Nature of the solar irradiation, thermodynamic efficiency and restrictions in solar energy conversion.
    (1 hour)
    b. Solar thermal energy conversion
        i. Conversion of heat to electricity - thermoelectric devices
        (1 hour)
        ii. Conversion of heat to mechanical energy
        (0.5 hours)
    c. Solar photonic process
        i. Photochemical process
        (1 hour)
        ii. Semiconductor systems
            1. Silicon solar cells, Dye sensitized solar cells
            (1 hour)
            2. Polymer based and quantum dot sensitized solar cells
            (1 hour)

iii. Photo-biological process

(1 hour)

Method of Assessment:

End of semester examination 1 hour theory paper.

Learning Outcomes:
Students should be able to describe,

- The common photochemical and photophysical processes and their mechanisms with relevant models.
- The principles behind rotational and vibrational spectra.
- The solar energy conversion and storage mechanisms.

Recommended Text Books:

1. Principles of Molecular Photochemistry: An Introduction, Nicholas J. Turro, V. Ramamurthy, Juan C. Scaiano, University Science Books, 2009, 1^{st} edition, ISBN-10: 1891389572.
2. Photochemistry, Carol E. Wayne and Richard P. Wayne, Oxford Chemistry Primers, 1996, 1^{st} edition, ISBN-10: 0198558864.

Course Title	**:** Environmental Chemistry
Course Code	**:** CHE 309 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Dr. S. D. M. Chinthaka

Objectives:

- To obtain Chemistry related knowledge about our environment and apply that knowledge for the remediation of polluted environment.
- To study basic environmental processes, pollution streams, remediation methods and chemical analysis of environmentally important chemical species.

Course Contents:

1. Chemical knowledge required for studying environmental chemistry.
(2 hours)
2. Water pollution (by hydrocarbons, heavy metals, PCBs, PAHs, pesticides, soap and detergents.
(3 hours)
3. Fate and removal water pollutants.
(3 hours)
4. Atmospheric chemistry.
(2 hours)
5. CFCs in the atmosphere, effect of CFCs to O_3 layer.
(1 hour)
6. Particles in the atmosphere.
(1 hour)

7. Photochemical smog.

(1 hour)

8. Acid rain and global warming.

(2 hours)

Method of Assessment:

End of semester examination 1 hour theory paper.

Learning outcomes:

- Students must be able to describe chemical aspect of basic environment processes, polluting streams and fate of the environmental pollutants.
- He will describe how to remove and how to reduce the amount of discharge of polluting species based on chemistry knowledge.
- Students must be able to describe the atmospheric chemical processes and the effects of anthropogenic impact on these processes.
- Students will describe the chemical aspects of major global environmental issues.

Recommended Text Books:

1. S. M. Manahan, Environmental Chemistry, 9th edition, CRC press, 2009.
2. Des W. Connell, Basic concepts of Environmental chemistry, Lewis publication, USA.

Course Title : Basic Chemical Engineering
Course Code : CHE 312 1.0
Number of Lecture Hours : 15
Number of Tutorial Hours : 03
Lecturer in Charge : Prof. W. D. W. Jayatilaka

Objectives:

- Use of principles of chemistry and physics for industrial applications.
- Introduction of the difference between the laboratory scale and industrial scale production of materials.
- Chemical processes and unit operations in chemical industry.

Course Content:

1. Introduction
   What is chemical engineering?

(1 hour)

2. Chemical Reactors
   Batch reactor, Semi-batch reactor, Continuous stirred tank reactor, Tubular reactor, Chemical reaction rate, Fractional conversion, Generalized design equation, Residence time, Choice of reactors.

(2 hours)

3. Theory of Heat Transfer

Heat transfer through a simple slab and a composite slab, Overall heat transfer coefficient, Heat transfer through a reactor wall, Heat transfer methods.

(2 hours)

4. Mixing and Agitation
   Reasons for mixing, Art of mixing, Equipment type mixers, Mixing liquids in tanks, configurations of common type mechanical mixers and agitators.

   (2 hours)

5. Solid particles and Size Reduction
   Properties of solid particles, Particle size and size separation, Distribution of particle size, Sphericity, Hardness, Density, Crushing efficiency, Work index, Crushers and grinders.

   (2 hours)

6. Fluid flow Phenomena and Hydraulics
   Viscosity of fluids, Newtonian and non- Newtonian liquids, Flow patterns, Reynolds number, Bernoulli Equation, Calculations in simple pipeline systems.

   (3 hours)

7. Filtration and Drying

   (1 hour)

8. Distillation

   (1 hour)

9. Energy supply and Flames

   (1 hour)

Method of Assessment:

End of semester examination 1 hour theory paper.

Recommended Text Books:

1. Perry, R. H.; Chilton, C. H.; Perry, J. H., Chemical engineers' handbook. McGraw-Hill: 1973.
2. Coulson, J. M.; Sinnott, R. K.; Richardson, J. F.; Backhurst, J. R.; Harker, J. H., Coulson & Richardson's Chemical Engineering: Chemical Engineering Design. 3rd ed. Butterworth-Heinemann: 1999. (Vol 1 – Vol 6).

Course Title	**:** Metal Complexes in Catalysis
Course Code	**:** CHE 319 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Dr. P. K. D. M. C. Karunaratne

Objectives:

- Provide the students with in depth knowledge on transition metal organometallic compounds and their catalytic action in homogeneous systems.

Course Content:

1. Introduction to organometallic chemistry
   Transition metals, Types of ligand (CO, RNC, PR_3, $H_2C{=}CH_2$, H_2, Carbene), Metal-ligand bonding (covalent model) and hapticity, Coordination number and geometry, the 18- and 16-electron rule and limitations to the 18-electron rule, Coordinative unsaturation, Oxidation state formalism.
   (4 hours)
2. Reactivity patterns of organometallic compounds
   Oxidative additions, Reductive eliminations, Migratory insertions, Association, Dissociation, Substitution, Elimination, and Oxidative coupling.
   (4 hours)
3. Homogeneous catalytic reactions
   Isomerization of alkenes, Hydrogenation of alkenes, Hydrocyanation of alkenes, Hydrosilation of alkenes, Hydroformylation of alkenes, Monsanto acetic acid synthesis, Water-gas shift reaction, Oxidation of olefins - Wacker process, Alkene metathesis, Heck reaction.
   (6 hours)
4. Heterogeneous catalytic reactions
   Fischer-Tropsch synthesis, Ziegler-Natta polymerization of olefins.
   (1 hour)

Method of Assessment:

End of semester examination 1 hour theory paper.

Learning Outcomes:

- Students will know the types of reactions organometallic compounds undergo in relation to the metal-ligand systems and use them to describe common homogeneous catalytic processes as well as new catalytic cycles.

Recommended Text Books:

1. The organometallic chemistry of the transition metals, Crabtree, R. H., 5th Edition, John Wiley and Sons, 2009.
2. Organometallic Chemistry and Catalysis, Astruc, D. Springer Berlin Heidelberg, New York (2007).
3. Organotransition Metal Chemistry: From Bonding to Catalysis, 1st edition, Hartwig J., University Science books (2009).

Course Title	: Food Chemistry
Course Code	: CHE 320 1.0
Number of Lecture Hours	: 15
Number of Tutorial Hours	: 03
Lecturer in Charge	: Prof. S. I. Samarasinghe

Objectives:

- To provide a general understanding of the major and minor components that occurs in food.
- To provide knowledge of the chemical and physical properties of food components.

Course Content:

1. Carbohydrates
   Monosaccharides, disaccharides and polysaccharides, their occurrence in food, chemical and physical properties. Alcoholic fermentation of sugars.
   (5 hours)
2. Lipids
   Fats and oils present in food, autoxidation of fats and oils, development of rancidity in food, prevention of rancidity and the mechanism of action of antioxidants. Saponification value, acid value, peroxide value, iodine number and the significance of these parameters in fatty foods.
   (3 hours)
3. Proteins:
   Essential amino acids, iso electric point, denaturation of proteins, principles involved in lactic acid fermentation, yoghurt, curd and cheese manufacture. Classification of proteins, color changes associated with meat.
   (2 hours)
4. Browning reactions in food
   Non enzymatic browning - Maillard browning, caramelisation of sugars.
   Enzymatic browning - browning of fruits and vegetables.
   Controlling browning in food.
   (1 hour)
5. Vitamins and minerals in food
   Fat soluble and water soluble vitamins, occurrence in food, importance of vitamins in the diet, effect of processing and storage on vitamins, major and trace elements present in food, principles involved in the determination of minerals in food.
   (2 hours)
6. Sensory properties of food
   Flavor compounds and pigments present in food.
   (2 hours)

Method of Assessment:

End of semester examination 1 hour theory paper.

Learning Outcomes:

- To be able to describe the nature of simple sugars, disaccharides (maltose, lactose, sucrose), pectin and starch and their uses in the food industry.
- To be able to describe the properties of fats and oils and how they deteriorate.

- To be able to describe the methods of prevention of adverse effects, and the parameters that determine the quality of fats and oils.
- To be able to describe the different proteins present in food, the nature of proteins and the factors that cause their denaturation.
- To be able to describe the factors causing browning of food, the changes undergone by food components during browning effect of browning on quality.
- To be ale to describe the changes undergone by vitamins during processing and storage of food, and the importance of minimizing such changes.
- To be able to describe the importance of sensory properties of food based on the properties of flavor compounds and pigments present in food.

Recommended Text Books:

1. Integrated Food Science and Technology for the tropics. Ihakoronye, A. I; Ngoddy, P. O. (1985) MacMillan Publishers. ISBN 0-333-3883-6
2. Food, the Chemistry of its Components. Coultate, T. P Royal Society of Chemistry Publications(1984).

Course Title	**:** Food Spoilage, Preservation and Analysis
Course code	**:** CHE 339 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Mr. E. G. Somapala

Objectives:

- To provide a general understanding of the principles of food spoilage and preservation.
- To provide knowledge on the analysis of important food constituents.

Course Content:

1. Modes of food spoilage
   a. Microbial
   b. Chemical
   c. Enzymatic

(2 hours)

2. Principles and methods of food preservation
   a. Cold Preservation (effect of low temperatures on enzymes and microorganisms, types of freezing systems, ice crystal formation, effects of freezing on food quality).
   b. Heat Preservation (sterilization, pasturization, blanching).
   c. Fermentation and fermentation products (lactic acid fermentations, ethanol fermentations).
   d. Preservation by concentration and dehydration (water activity, pickling, evaporation, air drying, curing, smoking, freeze concentration, freeze drying).
   e. Irradiation, high-pressure, pulsed electric field.

(6 hours)

3. Chemical preservatives

(1 hour)

4. Food Packaging

(1 hour)

5. Food Analysis
    a. Moisture analysis
    b. Mineral/ash analysis
    c. Lipid analysis
    d. Protein analysis
    e. Carbohydrate analysis

(5 hours)

Method of Assessment:

End of semester examination 1 hour theory paper.

Learning Outcomes:

Should be able to,

- Describe the modes of food spoilage.
- Explain the principles of food preservation.
- Describe the main techniques of food preservation.
- Describe the methods and physiochemical principles involved in the analysis of major food constituents.

Recommended Text Books:

1. Elements of Food Spoilage and Preservation (2nd edition) - J. A. Awan.
2. Food Analysis - Nielsen, S. Suzanne (Ed.).

Course Title	: Instrumental Analysis I
Course Code	**:** CHE 337 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Dr. C. D. Jayaweera/ Dr. B. A. Perera

Objectives:

- To give an understanding of the importance of performance characteristics of instruments, calibration methods, signal and noise.
- To give a fundamental understanding of the theoretical basis for chromatography and instrumentation of Gas Chromatography and High Performance Liquid Chromatography.
- To give a fundamental understanding of the theoretical basis and instrumentation of thermal methods.

Course Content:

1. Introduction
   Types of instrumental methods, what is an instrument? Performance characteristics of instruments (sensitivity, detection limit, dynamic range, selectivity), calibration of instrumental methods, signals and noise.
   (3 hours)
2. Chromatography
   Elution chromatography on columns, sorption isotherms, sorption mechanisms, migration rates of solutes, chromatograms, retention time, capacity factor, selectivity factor, resolution, and efficiency.
   (3 hours)

   Instrumentation of GC
   (3 hours)

   Instrumentation of HPLC
   (2 hours)
3. Thermal Methods
   Thermogravimetry (TG), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC), Microthermal analysis, thermal titrations.
   (3 hours)

Method of Assessment:

End of semester examination 1 hour theory paper.

Learning Outcomes:

At the end of the course the student should be able to,

- Understand performance characteristics, calibration methods, signal and noise of instruments.
- Understand the basic theoretical principles of elution chromatography.
- Know the basic components of GC and HPLC.
- Discuss and interpret the chromatograms derived from GC and HPLC.
- Understand the basic theoretical principles of thermal analysis.
- Discuss and interpret the thermograms derived from the Thermogravimetry, Differential Thermal Analysis and Differential Scanning Calorimetry.

Recommended Text Books:

1. Fundamentals of Analytical Chemistry – D. A. Skoog, D. M. West and F. J. Holler., Saunders College Publishing, (Sixth Edition).
2. Instrumental Analysis, D. A. Skoog, F. J. Holler and S. R. Crouch, Brooks/Cole, a part of college learning (Eleventh Edition).
3. Quantitative Chemical Analysis – Daniel C. Harris, W. H. Freeman and Company (Eighth edition).
4. Chemical Analysis (Modern Instrumentation Methods and Techniques), F. Rouessac and A. Rouessac, John Wiley and Sons Ltd., (Sixth edition).

Course Title	: Instrumental Analysis II
Course Code	: CHE 338 1.0
Number of Lecture Hours	: 15
Number of Tutorial Hours	: 03
Lecturer in Charge	: Dr. C. D. Jayaweera/ Dr. B. A. Perera

Objectives:

- To give an idea about different types of analytical methods which are used to identify compounds.
- To understand the theory, instruments used and applications of these methods.

Course Content:

1. Introduction to spectroscopic methods
   Molecular absorption spectrometry, UV Visible and IR instrument, sources, wave length selectors, detectors, signal to noise ratio, photometric titrations and applications.
   (4 hours)
2. Molecular Fluorescence Spectroscopy
   Theory, effect of concentration on fluorescence intensity, fluorescence instruments, fluorescent species and application, phosphorescence.
   (3 hours)
3. Atomic Spectroscopy
   Origin of atomic species, production of atoms and ions, plasma, Flame hydride and Electro thermal atomizer, interferences in plasma and flame, Atomic Emission Spectrometry, Atomic Absorption Spectrometry, Atomic Florescence Spectrometry and application of Atomic Spectrometry.
   (4 hours)
4. Mass Spectrometry
   Principles, ionization, mass analyzers, interpretation, Tandem Mass Spectrometry.
   (4 hours)

Method of Assessment:

End of semester examination 1 hour theory paper essay type.

Learning outcomes:
Students should be able to,

- Explain the theory of molecular absorption spectroscopy.
- Recognize different types of errors in experimental results.
- Explain and apply the principles of fluorescence, phosphoresonance, Atomic Spectroscopy and Mass spectrometry.

Recommended Text Books:

1. Skoog D. A, West D. M., Holler F. J, Crounch S. R, Fundamentals of analytical chemistry, 8^{th} edition, Brooks/ cole, 2004.
2. Charles K. Mann, Thomas J. Vickers, Wilson M. Gulick Instrumental Analysis.

Course Title	**:** Structure and Functions of Biomolecules
Course code	**:** CHE 330 1.0
Number of lecture hours	**:** 15
Number of tutorial hours	**:** 03
Lecturer in Charge	**:** Dr. P. Godakumbura

Objectives:

- Present an overview of the field of biomolecules and their structures and functions.
- To provide knowledge on how to determine the kinetic parameters for the enzymatic reactions graphically.
- Explore the industrial applications of PCR reaction, proteins and enzymes.

Course Content:

1. Proteins
   Primary, secondary, tertiary and quaternary structure of proteins, protein purification and detection, factors causing denaturation of proteins, applications of proteins (biologically active proteins and their functions, research in proteins).
   (4 hours)
2. Enzymes
   Enzyme characteristics and classification, coenzymes, enzyme kinetics and graphically determination of Km, Vmax, Kcat, Kcat/Km, enzyme inhibitors and their applications, enzyme regulation by allosteric modification, the role of enzymes in the body, industrial applications of enzymes.
   (6 hours)
3. Nucleic acid
   Structure and functions of nucleic acid, DNA, RNA central Dogma, protein biosynthesis, isolation of DNA, separation and identification of DNA fragments, denaturation and mutations in DNA, polymerase chain reaction and its application.
   (5 hours)

Method of Assessment:

End of semester examination 1 hour theory paper.

Learning Outcomes:
Should be able to,

- Explain the structures and functions of biomolecules.
- Graphically determine the Km, Vmax, Kcat, Kcat/Km for an enzyme.
- Describe the importance of the biomolecules in the body and their applications.

Recommended Text Books:

1. Lehninger, Principles of Biochemistry.
2. Biochemistry, 4^{th} Edition, Campbel/Farrell.

Course Title	**: Quality Control and Assurance**
Course Code	**:** CHE 333 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Mr. Ushantha Jayalath

Objectives:

- To learn and understand the ISO 9001:2008 & ISO 14001:2004 standards, quality policy, quality manuals, standard operating procedures, operational or technical guidelines, technical documentation, validation and verification, system audits, sustainability of the system.
- Explore and learn quality management system (QMS) and the organizational structure, quality management frame work, Total quality management system (TQM), quality control systems and how to establish parameters.
- Provide a description, rationalization of the sampling techniques, Lean management, 5 S practices, PDCA cycles, process mapping and waste elimination.

Course Content:

1. ISO 9001:2008
   (3 hours)
2. ISO 14001:2004
   (3 hours)
3. Standards, quality policy, quality manuals, standard operating procedures, operational or technical guidelines, technical documentation, validation and verification, system audits, sustainability of the system.
   (3 hours)
4. Quality management system (QMS) application and the organizational structure.
   (1 hour)
5. Quality management frame work, total quality management system (TQM).
   (2 hours)
6. Quality control systems and how to establish parameters, sampling techniques.
   (1 hour)
7. Lean management, 5 S practices, PDCA cycles, process mapping and waste elimination.
   (2 hours)

Method of Assessment:

End of semester examination 1 hour theory paper.

Learning Outcomes:

- Be able to learn and understand ISO 9001:2008 & ISO 14001:2004 standards.
- Be able to explain quality management system (QMS) & quality management frame work related to quality assurance.

Recommended Text Books:

1. The Six SIGMA Handbook: A Complete Guide for Greenbelts, Blackbelts, and Managers at All Levels (Hardcover) by Thomas Pyzdek.
2. The Handbook for Quality Management, Second Edition by Thomas Pyzdek, Paul Keller.

Course Title	: Colloids and Nanochemistry
Course Code	: CHE 341 1.0
Number of Lecture Hours	: 15
Number of Tutorial Hours	: 03
Lecturer in Charge	: Dr. P. K. D. M. C. Karunaratne

Objectives:

- Provide insight into the types, formation, separation, purification, properties, and stability of colloids.
- Identify nano-materials as a transition between atomic/molecular and macroscopic materials.
- Describe the changes of materials properties in the Nano-regime.
- Depict size dependent (size tunable) material properties and how they arise.
- Identify different types of nano-materials.
- Discussion of some major ways of nanofabrication under top down and bottom up approaches.
- Provide an overview on fullerenes and carbon nanotubes: Structure, properties, and fabrication.
- Provide a brief exposure of nanomaterial characterization techniques.

Course Content:

1. What is a colloid? (vs. solution). Types and naming of colloids, formation, separation (electrophoresis), purification (dialysis), and stability of colloids.
   (3 hours)
2. General properties of colloids (light scattering- Tyndal effect). Colloids vs nanomaterials.
   (1 hour)
3. Introduction to nanochemistry.
   (1 hour)
4. Definitions, history, material properties at nano level and classification of nanomaterials.

5. Nanoconcepts: Quantum confinement, metal to insulator transition, surface plasmon resonance.
(2 hours)
6. Structure and growth.
(1 hour)
7. Nanofabrication: Top down and bottom up approaches
Lithography (optical, electron beam, dip-pen, stamp), Block copolymer pattern transfer, Physical vapor deposition (thermal evaporation, E-beam evaporation, sputtering, Laser ablation), Chemical vapor deposition, Atomic layer deposition, Milling, Solution methods, Sol-gel methods, Template based synthesis, Self Assembly (SAM, reverse micelle-, and Dendrimer-assisted methods), VLS mechanism, Encapsulation.
(5 hours)
8. Buckminister fullerenes, Single wall and multi wall carbon nanotubes.
(1 hour)
9. Nanocharacterization
Microscopic imaging (TEM, SEM, AFM, STM), and spectroscopic (EELS, EDX, XPS) techniques.
(2 hours)

Method of Assessment:

End of semester examination 1 hour theory paper.

Learning Outcomes:

- Students will know the different types of colloids and nanomaterials, their unique properties, and characterization techniques available.

Recommended Text Books:

1. Introduction to Nanoscale Science and Technology, Ventra, M.; Evoy, S.; Heflin, J. R. Springer (2004).
2. Introduction to Nanoscience and Nanotechnology, 1^{st} edition, Binns, C. John Wiley and Sons Inc. (2010).

Course Title : Polymer Science and Technology

Course Code : CHE 342 1.0
Number of Lecture Hours : 15
Number of Tutorial Hours : 01
Lecturer in Charge : Prof. L. Karunanayake

Objectives:

- Introduction to the subject of polymer chemistry.
- Introduction to concept of average molar masses and molar mass distributions.
- Study conformations, thermal properties and thermal transitions of polymers.
- Elastomers, plastics and fibers.
- Fundamentals of Step-growth and Chain/addition polymerization.
- Introduction to polymer processing.

Course Contents:

1. Classifications of polymers: Monomers, homo-polymers, co-polymers and ter-polymers.
(1.5 hours)
2. Different average molar masses, their definitions and molar mass distributions.
(1 hour)
3. Polymer conformations, amorphous and semi-crystalline polymers and their molecular structures, thermal behavior of polymers and thermal transitions, graphical depiction of thermal behavior of polymers.
(1.5 hours)
4. Examples of elastomers, plastics and fibers and their properties.
(2 hours)
5. Step-growth polymerization and examples, Carother's equation and kinetics of polymerization, control of molar mass, Schotten-Baumann reaction, salt dehydration reaction, ester interchange reaction and step polyaddition, stoichiometric control of molar mass and the extended Carother's equation, examples, linear (thermoplastic) and non-linear (thermosettings).
(3 hours)
6. Chain/addition polymerization - ionic and free radical polymerization, initiation, propagation and termination.
(2 hours)
7. Plastic processing techniques and equipment, extrusion, injection moulding, calendaring, blow moulding, film forming, fiber spinning and coatings.
(4 hours)

Method of Assessment:

End of semester examination 1 hour theory paper.

Learning Outcomes:

- Students would be comprehended of basics of polymer chemistry.
- Students would learn concept of average molar masses and molar mass distributions.
- Students would learn conformations, thermal properties and thermal transitions of polymers.

- Students would be introduced elastomers, plastics and fibers that are used in the industry.
- Students would learn fundamentals of Step-growth polymerization.
- Students would learn fundamentals of Chain/addition polymerization- ionic and free radical polymerization.
- Basics of polymer processing techniques would be learnt.

Recommended Text Books:

1. Outlines of Polymer Technology: Processing Polymers, R. Sinha, Prentice-Hall India.
2. Polymer Processing Fundamentals, Tim A. Osswald, Hanser.
3. Polymers: Chemistry and Physics of Modern Materials, J. M. G. Cowie.

Course Title : Chemistry Practical Unit
Course Code : CHE 315 2.0
Number of Practical Hours : 90 hours
Lecturer in Charge : Dr. C. D. Jayaweera/ Dr. N. Kottegoda/ Dr. M. G. C. Padumadasa

Organic Chemistry

Objectives:

- To gain experience in the separation of compound mixture using different separation techniques.
- To gain experience in organic synthesis.
- To gain experience in the extraction of phytochemicals.
- To gain experience in the determination of factors influencing enzyme activity.
- To gain experience in polymer synthesis.

Course Content:

1. Synthesis of aspirin.
2. Thin layer chromatographic analysis of over-the-counter analgesics.
3. Paper chromatography for the separation of amino acid mixtures.
4. Column chromatography to separate organic compounds from a mixture.
5. Extraction of vascicine from *Adhathodavassica* using solid-liquid extraction.
6. Extraction of essential oils from plants using steam distillation.
7. Isolation of caffeine from tea leaves.
8. Determining factors influencing the action of polyphenol oxidase.
9. The condensation polymerization of phenol and formaldehyde: Bakelite.

Method of Assessment:

End of course 90 minutes practical examination.

Learning Outcomes:

- Should be able to plan and carry out an organic synthesis.
- Should be able to select a suitable separation technique and separate organic compounds in a mixture.
- Should be able to select a suitable extraction technique and extract phytochemicals from plant materials.
- Should be able to determine factors influencing enzyme activity.
- Should be able to carry out a polymer synthesis.

Recommended Text Books:

1. Practical Organic Chemistry: F. G. Mann and B. C. Saunders.
2. Practical Organic Chemistry: A. I. Vogel.

<u>Inorganic Chemistry</u>

Objectives:

- To enable students to appreciate the scientific method which involves experimentation, accurate observation, recording and interpretation of scientific data.
- To enable students to develop laboratory skills, including awareness of hazards in the laboratory and the safety measures required to prevent them.
- To enable students to master a range instrumental techniques.

Course Content:

1. Preparation of a complex containing only iron, oxalate and water and analysis of the complex for iron, oxalate and deriving an empirical formula for the complex.

2. Experiments with ion exchange resins
   - 2.1 Determination of the exchange capacity of a strongly acidic cation exchanger.
   - 2.2 Application of a strong cation exchanger for water softening.
   - 2.3 Determination of the concentration of a salt solution using a strongly basic anion exchanger.
   - 2.4 Concentration of a metal from a dilute solution using a weakly acidic cation exchanger.
   - 2.5 Separation of a mixture of cobalt & nickel using a strongly basic anion exchanger and quantitative determination of each metal (Ion exchange chromatography).

3. Analytical gas chromatography.

4. Fluorescence spectroscopy in quantitative analysis.

5. UV-visible absorption spectroscopy in quantitative organic analysis.

6. Determination of the iron content in an iron capsule by colorimetry and atomic absorption spectroscopy.

7. Preparation of cis & trans potassium diaquadioxalatochromate(III) and analysis for the percentage of chromium & oxalate.

8. Analysis of a water sample to determine the temperature, pH, conductivity, dissolved oxygen.

Method of Assessment:

End of a session (10 hrs) 2hr exam	30 marks
Attendance	40 marks
Laboratory reports	30 marks

Learning Outcomes:

Students should be able to,

- Interpret a set of instructions and implement them to achieve the stated practical objectives.
- Understand and perform the key practical techniques associated with the analysis.
- Understand how to collect and record data with precision and accuracy, from numerical, graphical and pictorial outputs.
- Have an appreciation of the significance of results, the sources of error relating to them and the management of practical work to minimize error.
- Record experimental work accurately and in a timely fashion in a laboratory report including key observations relating to the experimental work.
- Manage time effectively to ensure successful completion of the practical work, and associated theory, in the time available.
- Use the knowledge of key principles and practice in chemistry in the development of understanding of the theoretical work being undertaken in lecture courses.

Recommended Text Books:

1. A Textbook of Quantitative Inorganic Analysis – A. I. Vogel, ELBS (Fifth edition).
2. Principles of Instrumental Analysis – D. A. Skoog, F. J. Holler and T. A. Nieman, Saunders College publishing (Fifth edition).

<u>Physical Chemistry</u>

Objectives:

- To offer opportunity to improve psychomotor skills of undergraduates within the physical chemistry laboratory environment.
- To offer opportunity to increases the confidence in the laboratory environment to use the knowledge of principles and practice in physical chemistry.
- To enhance the knowledge of a variety of experimental techniques used in 3rd year physical chemistry laboratory.

Course Content:

1. Determination of the distribution coefficient of salicylic acid between water and $CHCl_3$ using conductivity measurements at 25^0C.

2. Determination of the enthalpy change of the reaction. $I_2 + I^- \rightarrow I_3^-$

3. Investigation of the adsorption of oxalic acid from aqueous solution on charcoal.

4. Investigation of solvent effects on the UV spectrum of benzophenone and study of vibrational frequencies of small molecules using FTIR.

5. Determination of enthalpy of fusion of naphthalene and biphenyl using freezing point diagram.

6. Determination of pKa of weak acid using potentiometric titrations.

7. Determination of formula and the equilibrium constant of a complex between Fe^{3+} and salicylic acid using colorimetry.

8. Determination of activation energy of iodination of acetone using initial rate method.

New Topics

9. Conductivity determination of Critical Micells Concentration (CMC) of surfactant system.

10. Thermodynamics parameters of the reaction between Zn and AgCl using EMF measurements.

Method of Assessment:

Lab Reports - (20%)
In-Practical Assessment - (20%)
Three hours practical examination - (60%)

Learning Outcomes:

- Undergraduates in final year should be able to understand the experimental procedure and perform the key practical techniques associated with quantitative analysis in physical chemistry.
- They should be able to design experiments in the purpose of investigational studies or a research project.
- They should be able to report and interpret their results of scientific work in a realistic context.

Recommended Text Books:

1. Physical Laboratory Manual, Department of Chemistry, University of Sri Jayewardenepura.