CHEMISTRY CURRICULUM

B.Sc. (SPECIAL) DEGREE

Department of Chemistry
University of Sri Jayewardenepura

Department of Chemistry

University of Sri Jayewardenepura

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

Revised
2013

B.Sc. (Special) Degree Course Units – Course Contents (Third Year)

- Core Courses
* - Optional Courses

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B.Sc. (Special) Degree Course Units – Course Contents (Fourth Year)

- Core Courses
* - Optional Courses

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Course Title	**:** Advanced Analytical Chemistry
Course Code	**:** CHE 378 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Dr. C. D. Jayaweera

Objectives:

- To give an understanding of the importance of performance characteristics of instruments, calibration methods, signal and noise.
- To demonstrate how the chemical and physical properties of molecules and atoms are utilized in different instrumental techniques.
- To give a fundamental understanding of the theoretical basis of analytical spectroscopic processes.
- To give an understanding of the function, the requirements and the behavior of the components of instruments for optical spectroscopy employing UV- visible, IR and X ray radiation for atoms and molecules.
- To give a fundamental understanding of the theoretical basis and instrumentation of thermal methods.

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Course Content:

1. Introduction
   Types of instrumental methods, what is an instrument? performance characteristics of instruments (sensitivity, detection limit, dynamic range, selectivity), calibration methods, signals and noise.
   (3 hours)
2. Spectroscopic methods of analysis
   Fundamental principles and instrumentation of Molecular spectroscopy in the UV, Visible region.
   (2 hours)

   Molecular spectroscopy in the IR region
   (2 hours)

   Molecular fluorescence spectroscopy
   (2 hours)

   Atomic absorption spectroscopy
   (2 hours)

   Atomic emission spectroscopy
   (2 hours)
3. Thermal Methods
   Thermogravimetry (TG), Differential Thermal Analysis (DTA), Differential Scanning calorimetry (DSC).
   (2 hours)

Method of Assessment:

End of semester 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.
- Describe and explain the theoretical principles behind spectroscopic techniques.
- Describe and explain the instrumental components present in spectroscopic techniques.
- 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).

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Course Title	**: Spectroscopic Methods in Inorganic Chemistry**
Course Code	**:** CHE 352 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Dr. N. T. Perera

Objectives:

- Understand the theory behind spectroscopic techniques and apply them to solve problems involving inorganic metal complexes.

Course Content:

1. Introduction to various types of spectroscopic methods that can be used to elucidate structure of inorganic complexes, a feel of their energy range, etc.
   (1 hour)
2. Vibrational spectroscopy to determine metal ligand interactions.
   (1 hour)
3. Application of NMR in structure determination of inorganic complexes - resonance, labeling spin systems, spin dilute systems, magnetic vs spin equivalence, non-spin half systems, exchange processes, relaxation processes.
   (5 hours)
4. ESR spectra of transition metal complexes - selection criteria, zero field splitting, Cramer's degeneracy and applications of ESR spectroscopy with special mention of biological systems.
   (5 hours)

5. Nuclear Quadrapolar Resonance and its applications - Uses and principles of Mossbauer spectroscopy, its instrumentation, effect of nuclear quadropole.
(3 hours)

Method of Assessment:

End of course 1 hour theory paper.

Learning Outcomes:
Students will be able to,

- Explain the principles behind IR, NMR, ESR and Mossbauer spectroscopy.
- Evaluate the most suitable spectroscopic method to characterize any given inorganic complex.

Recommended Text Books:

1. Inorganic Spectroscopic Methods, Alan K. Brisdon

Course Title	**:** Structural Chemistry
Course Code	**:** CHE 353 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Dr. P. K. D. M. C. Karunaratne

Objectives:

- Understand the arrangement of chemical bonds between atoms, geometry, and electronic structure of molecules and molecular clusters of *p*- and *d*-block elements, their synthesis, physical and chemical properties, chemical stability, reactivity, and structure-property relationships.

Course Content:

1. Introduction
   Introduction to group 13-15 of the *p*-block and common structural moieties, allotropy, polymorphism, cluster, deltahedron, common types of deltahedra.
   (1 hour)
2. Chemistry of boron, electron deficiency in boron compounds, boranes (boron hydrides), different types (*closo, nido, arachno, hypho, and conjuncto*) of boranes, nomenclature, molecular orbital picture of three center two electron bonds, structural interrelationships, *styx* numbering scheme, Polyhedral skeletal electron pair theory (*PSEPT*) or Wade's rules, corboranes, synthesis of boranes and carboranes, chemistry of small boranes and their anions, boranes as a ligand, metalloboranes.
   (6 hours)
3. Nitrogen compounds, N_2 as a ligand, nitrogen in high energy density materials.
   (1 hour)
4. Phosphorus allotropes, reactions of P_4, P_4 as a ligand.
   (1 hour)

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5. Electronic structure of metal-cyclopentadienyl compounds, structural variations of cyclopentadienyl compounds of main group elements, stereochemically active lone pair.
(1 hour)
6. Metal-metal multiple bonds, MO diagram of M-M quadruple bond.
(1 hour)
7. Metal carbonyl complexes, coordination modes of CO, 18-electron rule, bi-, tri-, tetra-nuclear, and higher metal carbonyl clusters, Isolobal principle and application of Wade's rules for metal carbonyl compounds, capping principle.
(2 hours)
8. Polyatomic Zintl anions of the post-transition elements, laboratory synthesis and chemistry of Zintl ions, geometry and electronic structure, functionalization, heteroatomic deltahedral Zintl ions, application of Wade's rules for Zintl ions.
(2 hours)

Method of Assessment:

End of semester 1 hour exam, essay type.

Learning Outcomes:

- Students will know the different types of bonding and structural entities (clusters) generated and stabilized under different states of electronic and special arrangements of certain elements in the periodic table.

- Students will also learn molecular orbital as well as other empirical and schematic approaches adopted to understand, describe, and predict the structural entities that do not completely describable by classical bonding schemes.

Recommended Text Books:

1. Advanced Inorganic Chemistry, 5th 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, 4th Edition, Lee, J. D.; Chapman & Hall Ltd., London (1991).
4. Metal-Metal Bonded Carbonyl Dimers and Clusters, Housecroft, C. E. Oxford University Press Inc., New York (1996).
5. Cluster Molecules of the p-block Elements, Housecroft, C. E. Oxford University Press Inc., New York (1994).

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Course Title	**:** Inorganic Reaction Mechanisms
Course code	**:** CHE 354 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Prof. S. P. Deraniyagala

Objectives:

- To introduce kinetic and mechanistic aspects of reactions related to inorganic complexes

Course Content:

1. Introduction
   Kinetics, mechanism, reactivity (thermodynamic / kinetic context: stable, unstable, inert, labile), classification of inorganic reactions, ligand substitution reactions, classification of mechanisms (A, D, I_a, I_d), operational tests for mechanisms.
   (3 hours)
2. Substitution at four coordinate square planar metal complexes.
   Introduction, rate law, mechanism of square planar substitution, factors affecting the reactivity of four coordinate square planar complexes: nature of entering group, nature of leaving group, steric factors, nature of metal, nature of solvent, nature of other ligands (trans ligand, trans influence and cis ligands)
   (3 hours)
3. Substitution at six coordinate octahedral metal centers
   Introduction, types of substitution reactions: water exchange, Hydrolysis or aquation (acid/ base hydrolysis) and anation, stereochemical changes in octahedral complexes.
   (5 hours)
4. Electron transfer reactions between octahedral complexes.
   Inner sphere and outer sphere mechanisms, Frank-Condon principle, Marcus equation, rate laws governing outer and inner sphere mechanisms, two electron transfer.
   (4 hours)

Method of Assessment:

One hour structured type, open book examination with 10 minutes reading time.

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

- Write rate laws and identify mechanisms involved in square planar substitution reactions and octahedral substitution reactions.
- Comment on the factors that affect rates of substitution reactions as well as the steoreochemical changes that take place during octahedral substitution reactions.
- Write rate laws and predict mechanism for outer sphere and inner sphere reactions that occur between octahedral complexes.

Recommended Text Books:

1. Concepts and Models of Inorganic Chemistry**,** B. Douglas, D. McDaniel, J. Alexander, 3rd Edition.

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Course Title	: Natural Products Chemistry
Course Code	: CHE 357 2.0
Number of Lecture Hours	: 30
Number of Tutorial Hours	: 06
Lecturer in Charge	: Prof. S. I. Samarasinghe

Objectives:

- To understand the range of structures found in plant secondary metabolites.
- To study the methods of synthesis of the major classes of plant secondary metabolites.
- To study the biosynthetic routes to the major classes of plant secondary metabolites.
- To study the biological significance of selected plant secondary metabolites.

Course Content:

1. Classification, structure determination, laboratory synthesis, biosynthesis, and biological significance of terpenes.
   (6 hours)
2. Classification, structure determination, laboratory synthesis, biosynthesis, and biological significance of steroids.
   (6 hours)
3. Classification, structure determination, laboratory synthesis, biosynthesis, and biological significance of triterpenoids.
   (6 hours)
4. Classification, structure determination, laboratory synthesis, biosynthesis, and biological significance of alkaloids.
   (6 hours)
5. Classification, structure determination, laboratory synthesis, biosynthesis, and biological significance of flavonoids.
   (6 hours)

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Method of Assessment:

End of course two hour theory paper.

Learning Outcomes:
Should be able to,

- Write down and explain the rationale behind synthetic routes to selected terpenes, steroids, triterpenoids, alkaloids, and flavonoids.
- Write down the biosynthetic routes to terpenes, steroids, triterpenoids, alkaloids, and flavonoids.
- Deduce molecular structures from experimental data from degradation and synthetic studies and spectroscopic data.
- Describe the biological activities of selected plant secondary metabolites.

Recommended Text Books:

1. Organic Chemistry (Vol 2), I. L. Finar.
2. Organic Chemistry of Secondary Plant Metabolites, T. A. Geissmann and D. H. D. Crout.
3. Natural Products. Their Chemistry and Biological Significance., J. Mann, R. S. Davidson, J. B. Hobbs, D. V. Banthrope, J. B. Harborne.

Course Title	**: Advanced Organic Spectroscopy**
Course Code	**:** CHE 358 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Dr. M. G. C. Padumadasa

Objectives:

- To provide general understanding on NMR (^{1}H and ^{13}C), UV-Visible, and IR spectroscopy and mass spectrometry.
- To use above mentioned instrumental methods to determine the molecular structure of an unknown organic compound.

Course Content:

1. NMR Spectroscopy
   NMR instrumentation, Fourier transform NMR
   ^{1}H NMR spectroscopy
   a) Nuclear spin and resonance, chemical shifts, factors that influence chemical shifts, spin-spin coupling, coupling patterns and resonance multiplicities, chemical and magnetic equivalence, spin-spin couplings and chemical structure (germinal, vicinal and long range couplings).
   ^{13}C NMR spectroscopy
   (Characteristics of ^{13}C NMR spectra, ^{13}C chemical shifts, factors that affect ^{13}C chemical shifts)
   Broadband developing, OFF-resonance decoupling
   (5 hours)
2. Special pulse techniques
   APT, DEPT, 2D – COSY, HETCOR, HOM 2DJ, HET 2DJ, INADEQUATE and NOE
   (2 hours)
3. UV-Visible Spectroscopy
   Introduction to UV-Visible light absorption
   a) Electronic Transitions
   b) Beer-Lambert Law
   Terms frequently used in UV-Visible spectroscopy
   Solvent effects
   Characteristic UV-Visible absorptions of organic compounds
   (3 hours)
4. IR Spectroscopy
   Introduction to IR spectroscopy
   a) Vibrational modes
   b) Hooke's Law
   Characteristic IR absorptions of organic compounds
   (2 hours)
5. Mass Spectrometry
   Fundamentals of mass spectrometry
   Methods of ionization
   Fragmentation patterns in mass spectrometry
   (2 hours)

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Method of Assessment:

End of course one hour theory paper.

Learning Outcomes:
Should be able to,

- Determine the molecular structure of an unknown organic compound using NMR, UV-Visible and IR spectroscopy and Mass spectrometry.
- Predict the NMR, UV-Visible, IR and Mass spectra for a given unknown organic compound.

Recommended Text Books:

1. Spectrometric Identification of Organic compounds, Silverstein.
2. Organic Chemistry, F. A. Carey.

Course Title	**: Symmetry and Group Theory**
Course Code	**:** CHE 359 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Dr. P. K. D. M. C. Karunaratne

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Objectives:

- Provide a systematic description of symmetry in the nature and in molecules.
- Elucidation of the classes, combinations and mathematical aspect of symmetry.
- Describe point groups of the molecules and their systematic determination.
- Development of group theory based on symmetry and as a way to solve or simplify physical problems of chemical interest.
- Discussion of the application of symmetry and group theory in theoretical descriptions of chemical bonding (VBT, MOT), vibration and electronic spectroscopy.

Course Content:

1. Symmetry elements, symmetry operations, and generation of symmetry operations: Identity operation (E), Rotation operation (C_n), Mirror plane (σ), Center of symmetry (i), Improper rotation axis of symmetry (S_n).
   (3 hours)
2. The algebra of symmetry operations (Product of symmetry operations, Inverse of symmetry operations, Associative Law of combination), Classes of symmetry operations, Combinations of symmetry elements.
   (2 hours)
3. Properties of a mathematical group, Point groups:
   C groups (C_1, C_s, C_i, C_n, C_{nv}, C_{nh}), D groups (D_{nh}, D_{nd}, D_n), Special point groups (T_d, O_h, $C_{\infty v}$, $D_{\infty h}$), Systematic determination of the point group of a molecule.
   (3 hours)
4. Distinct symmetry operations, Character tables, and Properties of character tables.
   (2 hours)

5. Reducible representations, Reduction formula, and Orbital applications of symmetry operations.

(1 hour)

6. Application of symmetry in chemical bonding (Valence bond theory, Molecular orbital theory), Vibration and electronic spectroscopy.

(4 hours)

Method of Assessment:

End of semester 1 hour exam, essay type

Learning Outcomes:

- Students will know various chemical applications of molecular symmetry.
- They will also realize how the various geometries of molecules arises based on contributing atomic orbital symmetries and how the symmetry requirement of the atomic orbitals is fulfilled for linear combination of atomic orbitals.
- They will also realize the meaning of Mulliken symbols of symmetry.
- Ultimately they will acquire sufficient knowledge to follow Diffraction Technique in Inorganic Chemistry, Advanced Coordination Chemistry, and Advanced Molecular Spectroscopy.

Recommended Text Books:

1. Molecular Symmetry and Group Theory, Carter, R. L. John Wily & Sons, Inc., 1998.
2. Shriver & Atkins Inorganic Chemistry, Atkins, P.; Overton, T.; Rourke, J.; Weller, M.; Armstrong, F. 4th Edition, W. H. Freeman and Company, 2006.
3. Symmetry and Spectroscopy: An Introduction to Vibrational and Electronic Spectroscopy, Harris, D. C.; Bertolucci, M. D. Dover Publications, 1989.
4. Inorganic Chemistry, Miessler, G. L.; Tarr, D. A. 3rd Edition, Prentice Hall, 2003.

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Course Title	**:** Advanced Electrochemistry

Course Code : CHE 360 1.0
Number of Lecture Hours : 15
Number of Tutorial Hours : 03
Lecturer in Charge : Prof. W. D. W. Jayatilaka

Objectives:

- To give a broader knowledge on the principles of electrochemistry in terms of the structure and properties of electrochemical systems.
- Use of principles of electrochemistry in electroanalytical techniques.

Course Content:

1. Nature of electrolytes and electrolyte solutions
   Free ion model, Ion-solvent interactions, Ionic atmosphere potential energy, Charge density.
   (1 hour)
2. Related theoretical concepts
   Debye-Huckle theory of interionic interactions, Poisson-Boltzman equation, Potential energy contribution in the ionic atmosphere, Thickness of the ionic atmosphere, Chemical potential, Ideal solutions, Debye-Huckle law, Huckle Equation, Application and the Debye-Huckle equation.
   (2 hours)
3. Electrode processes
   Ideal and non-ideal polarized electrodes, Determination of anode and cathode potentials, Over potential, Application of over potential Method for determination of over potential, Tafel Equation, Type of over potential, Kinetics of electrode processes. Exchange current density, Butler-Volmet equation.
   (3 hours)
4. Theory and Applications of Electroanalytical methods
   Conductimetry, Potentiometry, Amperometry, Voltammetry; Polarography, Cyclic voltammetrty, coulometry, electrogravimetry, Sensors.
   (3 hours)
5. Conductivity of solutions, Migration properties of electrolyte solutions, Diffusion coefficient.
   (3 hours)
6. Metal–electrolyte interface, Models for metal–electrolyte interface. Electrokinetic phenomena, Zeta potential, Lipmann electrometer. Electrocapillary curves.
   (3 hours)

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Method of Assessment:

1 hour essay type end of semester examination.

Learning Outcomes:

- Describes the properties of an electrolyte solution in terms of the structure.
- States the quantitative relationships among physical properties of electrochemical systems.
- Gives mathematical and theoretical interpretations for various properties of electrochemical systems.

- Describes various electroanalytical methods and their applications in terms of principles of electrochemistry.

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: 1969.

Course Title	**:** Advanced Chemical Kinetics
Course Code	**:** CHE 361 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Prof. P. M. Jayaweera

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Objectives:

- Provide the students in depth knowledge in theories and some practical aspects of chemical kinetics.

Course Content:

1. Introduction, potential energy surfaces, the kinetic theory of collision, relationship between critical energy and the activation energy, probability factor.
(2 hours)
2. Activated complex and transition state theory, vibrational mode along the reaction coordinate, thermodynamic interpretation of the overall rate constant, Free energy, enthalpy and entropy change of activation, energized state, application of activated complex theory.
(2 hours)
3. Theories of unimolecular reactions, Lindermann theory, the $[M]_{1/2}$ value of the unimolecular reactions, weaknesses of Lindermann theory, calculation of k_1 value from Hinshelwood method k_{1H}, the treatment of Rice-Ramsperger and Kassel, energized complex.
(3 hours)
4. Slater's treatment, Rice-Ramsperger-Kassel-Marcus theory.
(1 hour)
5. Liquid phase reactions, theory of diffusion-controlled reactions, the theory of absolute reaction rates, influence of solvent in liquid phase reactions, single and double sphere models.
(3 hours)
6. Influence of ionic strength and pressure on reactions in solutions.
(1 hour)

7. Experimental methods in reaction kinetics, plug and stirred flow methods, stopped-flow and continuous flow methods, contact time, pressure and temperature jump methods, shockwave tube, relaxation techniques, pulse radiolysis.
(2 hours)
8. Molecular dynamics, macroscopic and microscopic kinetics, molecular beam apparatus.
(1 hour)

Method of Assessment:

End of semester theory examination.

Learning Outcomes:

- Students should be able to understand the fundamental aspects theories behind the chemical kinetics both in gas and solution phase. Also theoretical and experimental aspects of fast reactions under equilibrium condition.

Recommended Text Books:

1. Chemical Kinetics (3rd Edition), Keith J. Laidler.
2. Unimolecular Reactions: A Concise Introduction, Wendell Fors.
3. Chemical Kinetics and Reaction Mechanisms, (Mcgraw-Hill Series in Advanced Chemistry) by James H. Espenson.

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Course Title	**:** Advanced Quantum Chemistry
Course Code	**:** CHE 362.1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Dr. R. S. Jayakody

Objectives:

The primary focus of this course is to provide the students with the understanding of the quantum mechanical description of atoms and molecules. Particular interest is paid to the operators and vectors in the beginning to ensure students' understanding of quantum theory. Application of quantum theory to H atom is discussed in detail. Application of quantum theory is extended to more complex systems and arising problems such as electronic correlation is discussed. The principles of approximation methods and their applications are introduced. Overall, the course is aimed at providing the correct quantum mechanical background required for other courses such as molecular modeling, molecular spectroscopy.

Course Content:

1. Postulates and general principles of quantum chemistry
Postulates 1-5, Hermitian operators, Harmonic oscillator, Rigid rotor.
(3 hours)
2. Shrodinger equation for the Hydrogen atom
Detailed mathematical approach - wave functions, energies, effect of magnetic field on H atom energy levels.

(3 hours)

3. Schrodinger equation for many electron atoms
   Approximation methods - perturbation theory and variation theory secular determinant.
   (3 hours)
4. Application of Schrodinger equation to He atom
   Hatree-Fock equations and self consistent field method.
   (2 hours)
5. Schrodinger equation for molecules, Born-Oppenheimer approximation, valance bond theory, molecular orbital theory, applications to diatomics.
   (2 hours)
6. SCF-LCAO-MO method, molecular term symbols, Huckel molecular orbital theory.
   (2 hours)

Method of Assessment:

End of course 1 hour exam.

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Learning Outcomes:

- Recognize the significance of the basic postulates of quantum mechanics.
- To identify the Hermitian operators and their importance in Quantum mechanics.
- To describe H atom quantum mechanically.
- Demonstrate the ability to construct 3D QM systems from 1D systems.
- Recognize that He atom Schrodinger equation cannot be solve exactly and therefore, identify the need of approximate methods.
- Demonstrate ability to apply approximate methods to simple systems such as He atom.
- Demonstrate ability to apply various methods to many electron molecules.

Recommended Text Books:

1. Physical Chemistry, P. W. Atkins.
2. Physical Chemistry, A Molecular Approach - Donald A. McQuarrie.
3. Quantum Chemistry, Donald A. McQuarrie.

Course Title	**:** Statistical Thermodynamics
Course Code	**:** CHE 363 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Dr. R. S. Jayakody

Objectives:
This introductory Statistical TD course deals with principles of theory and application of statistical thermodynamics for chemistry special students. The course includes principles of kinetic theory, relation between classical and statistical thermodynamics, and fundamentals of quantum statistical mechanics. Furthermore, applications of statistical thermodynamics to ideal gas are introduced.

Course Content:

1. Introduction to statistical thermodynamics
   Microstates Vs Macro states, the distribution of molecular states, configurations and weights.
   (1 hour)
2. The Statistical definition of entropy
   Statistical entropy, microstates, calculating the entropy
   (1 hour)
3. Connecting microscopic and macroscopic properties
   Ensembles, Ensemble averages, postulates of statistical thermodynamics, Ergodic hypothesis, what is the preferred state of a system? The Boltzmann distribution.
   (2 hours)
4. The Partition function
   Definition of the Partition Function, the internal energy, the Helmholtz Free Energy, the entropy, the pressure, the Isochoric Heat Capacity.
   (2 hours)
5. An ideal gas of atoms
   The ideal gas, the Molecular Partition Function, the Translational Partition Function, the Internal Energy of a monatomic ideal gas.
   (2 hours)
6. The heat capacity of a monatomic ideal gas, the pressure of a monatomic ideal gas, the entropy of a monatomic ideal gas.
   (2 hours)
7. An ideal gas of diatomic molecules
   The Rotational Partition Function, Rotation and Symmetry, properties of a Rigid Rotor, the Harmonic Oscillator, thermodynamic properties of the Harmonic Oscillator, the Electronic Partition Function.
   (3 hours)
8. Statistical Mechanics and Equilibrium
   Thermodynamics of gaseous molecules, the Gibbs Free Energy, the Standard Gibbs Free Energy, the Equilibrium Constant (Kp)
   (2 hours)

Method of Assessment:

1 hour end semester exam.

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

- Basic Assumptions of Statistical Mechanics Basic Assumptions
- The Canonical Ensemble
- Partition Functions and its significance
- Microscopic basis of thermodynamics
- Statistical Definition of Entropy
- the difference between BE -FD statistics & Boltzmann statistics
- The students must also know how to relate quantum mechanical and spectroscopic data to macroscopic thermodynamic properties.

Recommended Text Books:

1. Thermodynamics and Statistical Mechanics, Jhon M. Seddon, RCS Publishing, 2001.
2. Physical Chemistry, P. W. Atkins.

Course Title	**:** Diffraction Methods in Chemistry
Course Code	**:** CHE 365 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Dr. N. Kottegoda

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Course Content:

1. Space symmetry, space group, equivalent point generation.
   (2 hours)
2. Theory of diffraction, instrumentation, diffraction patterns, systematic absences (general and special), indexing, unit cell parameter determination, Baravais lattice determination, space group determination.
   (3 hours)
3. Intensity, crystal structure determination, atomic scattering factor - structure factor, powder diffraction files.
   (3 hours)
4. Phase problem, electron density maps, Fourier maps, Scherer equation, crystallite size, limitations.
   (2 hours)
5. Case studies on crystal structure determination.
   (2 hours)
6. Neutron diffraction: principles, instrumentation, neutron diffraction pattern, neutron scattering factor, advantages and limitation, neutron diffraction by magnetic materials case studies.
   (2 hours)
7. Electron diffraction: theory, instrumentation, electron diffraction patterns, advantages and limitations.
   (1 hour)

Method of Assessment:

End semester examination.

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

- Explain the two types of space symmetry elements as applied to crystallography.
- Explain the symmetry elements present in space groups.
- Generate symmetry equivalence points.
- Explain the theory behind diffraction ad appreciate its use as a material characterization tool.
- Explain the use basic instrumentation for single crystal and powder X-ray diffraction experiments.
- Interpret and analyze a diffraction pattern.
- Index a diffraction pattern.
- Use systematic absences and peak positions to obtain various structural information such as unit cell parameters, Bravais lattice type, space symmetry, etc.
- Explain the significance of the intensity of diffraction peaks in crystal structure determination.
- Explain the terms structure factor and the atomic scattering as applied to diffraction experiments.
- Deduce the structure factor for given crystalline solids.
- Use structure factor in crystal structure determination experiments.
- Deduce crystal structure based on diffraction data for simple crystalline solids.
- Understand and explain the information deduced from the ICDD data base.
- Use ICDD data base to identify unknown crystalline solids.
- Interpret the phase problem as applied to X-ray diffraction experiments.
- Explain the methods used to overcome the phase problem.
- Explain the Fourier method in detail.
- Use Scherer equation to calculate the crystallite size.
- Explain the limitations of X-ray diffraction methods in characterizing crystalline solids.
- Describe the principles behind neutron diffraction experiments
- Explain the instrumentation for neutron diffraction experiments.
- Explain the significance of neutron scattering factor.
- Understand the advantages and limitations of neutron diffraction methods over other diffraction techniques.
- Use neutron diffraction patterns for interpretation of magnetic properties.
- Compare the differences between X-ray diffraction and neutron diffraction patterns.
- Explain basic concepts behind electron diffraction pattern.
- Compare the basic features of an electron diffraction pattern with those of an X-ray diffraction pattern.

Recommended Text Books:

1. C. Hammond, The Basics of Crystallography and Diffraction, Oxford University Press Inc., New York, 2001, Second Edition.
2. A. R. West, Basic Solid State Chemistry, John Wiley and Sons Ltd, Chichester, 1996, Second Edition.

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3. B. D. Cullity and S. R. Stock, Elements of X-ray Diffraction, Prentice Hall Press, 2001, Third Edition.
4. M. T. Weller, Inorganic Materials Chemistry, Oxford University Press, Oxford, 1994, Edition.
5. W. Clegg, Crystal Structure Determination, Oxford University Press, New York, 1998, First Edition.

Course Title	**:** Organotransition Metal Chemistry
Course Code	**:** CHE 366 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Prof. S. P. Deraniyagala

Objectives:
To introduce principles of organometallic chemistry, metal-ligand bonding, fundamental reactions of organometallic systems and Homogeneous catalysis.

Course Content:

1. Introduction
   Classification of ligands according to the number of electrons donated; the 18 and 16 electron rule, coordinative unsaturation, oxidative state formalism, hapticity, geometry of transition metal complexes vs. coordination number and electron configuration (d^n), ligand field splitting for various geometries.
   (3 hours)
2. Metal – ligand bonding
   Ligands include carbon monoxide, dinitrogen, olefnes, acetylenes, nitric oxide, group VB donors, isocyanides, carbenes, carbynes, H_2, CS.
   (4 hours)
3. Reactivity patterns
   Oxidative addition (d^7, d^8, d^{10} systems), insertion reactions (migratory insertion migrations to carbon monoxides, thiocarbonyl, carbenes, olefins), reductive elimination (mononuclear systems, reactions forming C-C bonds and C-H bonds), association, dissociation, substitution, elimination (γ, β, α, δ, ε) and oxidative coupling.
   (4 hours)
4. Homogeneous Catalysts
   General Remarks: olefin isomerization, olefin hydrogenation, hydroformylation reactions, Monsanto acetic acid synthesis, water gas shift reaction, hydrosilation and hydrocyanation of unsaturated compounds, hydration of alkenes, polymerization of olefins, alkene metathesis, Heck reaction.
   (4 hours)

Method of Assessment:

One hour structured type, open book examination with 10 minutes reading time.

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

- Determine NVE based on 16 and 18 electron rule, formal oxidation state of the metal, true d^n configuration and shape of organometallic compounds.
- Explain the metal-ligand bonding with examples for ligands such as CO, N_2, RNC, CS, NO, PR_3, AsR_3, carbenes, 20arbines, $H_2C{=}CH_2$ or alkenes, H-C=C-H or alkynes, H_2, etc.
- Identify a given organometallic reaction into categories commonly encountered in organometallic chemistry – oxidative addition, reductive elimination, insertion, elimination (γ, β, α, δ, ε), association, dissociation, substitution, and oxidative coupling.
- Apply areas learnt in 1, 2, 3 to write catalytic cycles for commercially important processes using organometallic compounds.

Recommended Text Books:

1. The Organometallic Chemistry of the Transition Metals, Robert F. Crabtree, 4th Edition, John Wiley and Sons.

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Course Title	**:** Advanced Coordination Chemistry
Course Code	**:** CHE 367 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Dr. P. K. D. M. C. Karunaratne

Objectives:

- To provide an understanding of the structure and magnetic properties of inorganic complexes.

Course Content:

1. Electronic spectra of transition metal complexes: Number and intensities of d-d bands, charge transfer bands in electronic spectra.
   (3 hours)
2. Construction of Orgel diagrams.
   (3 hours)
3. Nephelauxetic ratios, term symbols and energies for d^n ions.
   (4 hours)
4. Derivation of ligand field theory from group theoretical considerations, Tanabe Sunabe diagrams.
   (5 hours)

Method of Assessment:

End of semester 1 hour theory paper.

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

- Determine the structure of transition metal complexes through UV-visible spectrometry.
- Determine magnetic properties of transition metal complexes.

Recommended Text Books:

1. Inorganic Chemistry, by D. F. Atkins and P. W. Atkins and C. H. Langford, 1994, Oxford University Press, 2nd Edition.
2. Principles and Applications of Metal Chelation, by C. F. Bell, 1997, Oxford University Press, Oxford.
3. Electronic Spectra of Coordination Compounds in Coordination Chemistry, D. S. McClure and P. J. Stephens, 1971.
4. Concise Inorganic Chemistry, J. D. Lee, 5th Edition, Blackwell Science.
5. Advanced Chemistry, Philip Matthews, 2003, First Edition, Cambridge University Press.

Course Title : Bioinorganic Chemistry
Course Code : CHE 368 1.0
Number of Lecture Hours : 15
Number of Tutorial Hours : 03
Lecturer in Charge : Dr. N. T. Perera

Objectives:

- To recognize the importance of inorganic compounds in biological systems.
- To give students an exposure to do research on their own in terms of understanding, explaining, and writing on given topic within the course content given below.
- To expose students to current literature on bio-inorganic chemistry by discussing research papers in class and having group discussions.
- To create awareness of current trends in metallopharmaceuticals.

Course Content:

1. Role of metals
   Composition and structure of living systems, metals in biological systems, metals in human health, role of metal ions in biological systems, specialization and specificity of metal complexes in vivo.
   (2 hours)
2. Metalloproteins and metalloenzymes
   Representative metalloenzymes, types and properties of metalloenzymes.
   (2 hours)
3. Dioxygen carriers
   Dioxygen complexes of transition elements, Hemoglobin, Myoglobin, Heamocyanins, Haemovanadins, nature of haemo-dioxygen binding, model systems.
   (3 hours)
4. Transition metals in biological redox reactions
   General mechanism of electron transfer blue copper proteins, iron sulfur proteins (rubredoxins and ferredoxins), cytochromes.

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(2 hours)

5. Distribution and functions of metals in vivo
   Storage and transport of ions, chemistry and biochemistry of nitrogen fixation, mechanism and action of zinc, copper, cobalt and molybdenum containing enzymes, enzymes containing vanadium, chromium, and nickel - topics for presentations/write-ups.
   (2 hours)
6. Environmental bioinorganic chemistry
   Metal induced toxicity and chelation therapy, dietary and environmental aspects.
   (2 hours)
7. Metallopharmaceuticals
   Therapeutic uses of metal complexes, action of drugs like cisplatin, radiopharmaceuticals, ^{99m}Tc radio imaging in diagnosis of diseases.
   (2 hours)

Method of Assessment:

End of semester 1 hour theory paper.

Learning Outcomes:

At the end of the course,

- Students will be able to describe the role of metals in biological systems.
- Students will be able to present on given topics relevant to the syllabus with guidance from the lecturer in charge.
- Develop proper ethical practice in scientific presentations. Stress is given to intolerance of plagiarism in write-ups or presentations while promoting group activity at the same time.
- Review current topics in bio-inorganic chemistry.
- Students should learn to analyze concepts presented in given research papers.

Recommended Text Books:

1. Biocoordination Chemistry, David E. Fenton
2. Inorganic Chemistry in Biology, Patricia and Ralph Wilkins, 5th Edition, 2010
3. Shriver and Atkins' Inorganic Chemistry, P. Atkins, T. Overton, J. Rourke, M. Weller, F. Armstrong and M. Hagerman, 5th Edition, 2010, W. H. Freeman and Company New York – relevant chapter provided as soft copy by lecturer in charge.
4. Metals in Medicine – A Short Course by Roat Malone – pdf provided by lecturer in charge
5. Reliable web sources.

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Course Title	**:** Molecular Photochemistry
Course Code	**:** CHE 369 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Prof. P. M. Jayaweera

Objective:

- Provide the students an understanding about photochemical processes involved in molecular level.

Course Content:

1. Thermal chemistry and photochemistry
   Electromagnetic radiation, Exited states, Spin multiplicity, State diagrams.
   (1 hour)
2. Production and time independent properties
   Absorption and emission of light (Stimulated absorption, Stimulated emission, Spontaneous emission and Einstein coefficients), Radiative lifetimes, the intensities of electronic transitions, Spin and selection rules, Oscillator strengths and forbidden transitions, types of transitions, nomenclature, Charge transfer (CT) transitions (MLCT, LMCT, MMCT, etc.), identification of electronic transitions.
   (2 hours)
3. Method of producing excited states
   Electrical discharges, ionizing radiation, Thermal activation, Chemical activation (Chemiluminesence), Lasers (two, three, and four level systems), Dipole moments, Energies of excited states: Singlet-triplet splitting. Singlets, triplets and biradicals, Solvent effects.
   (3 hours)
4. Production and Time dependent phenomena
   Dissipative pathways, Radiative transitions, Radiationless (non-radiative) transitions, Kinetics, Quantum yields, Quantum efficiencies and lifetimes.
   (2 hours)
5. Radiative transitions
   Fluorescence, delayed fluorescence, resonance fluorescence, and Phosphorescence. Fluorescence vs. Phosphorescence, relation between excitation and emission spectroscopy.
   (2 hours)
6. Properties of excited states
   Geometry, acid base properties, dipole moments. Quenching of excited states: Excimers, Excimer structure and bonding, Exciplexes, the kinetics of quenching, static and dynamic Quenching, Stern–Volmer equation.
   (2 hours)
7. Quenching process and quenching mechanisms
   Electron transfer quenching, heavy atom quenching, quenching by oxygen and paramagnetic species, electronic energy transfer, static and dynamic quenching.
   (2 hours)
8. Quantitative methods of quantum yields and kinetics of quenching
   Detection techniques, stationary state, time resolve.
   (1 hours)

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Method of Assessment:

End of semester theory examination.

Learning Outcomes:

- Students should be able to understand the fundamental aspects like photophysical and photochemical processes behind an excited molecule.

Recommended Text Books:

1. Modern Molecular Photochemistry, Nicholas J. Turro.
2. Photochemistry (Oxford Chemistry Primers), Carol E. Wayne and Richard P. Wayne.
3. Principles of Molecular Photochemistry: An Introduction by Nicholas J. Turro, J. C. Scaiano and V. Ramamurthy.

Course Title	**:** Chemistry of Biological Compounds
Course Code	**:** CHE 379 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Dr. P. Godakumbura

Objectives

- To provide a general understanding on the structure and function of biological compounds (carbohydrates, nucleic acids, lipids, and proteins).
- To understand the relationship among these biological compounds.
- To understand the different types of chemical reactions of these biological compounds and to analyze and identify an unknown biological sample.

Course Content:

1. Chemistry of carbohydrates - structure and function of disaccharides, polysaccharides, glycogen, cellulose, starch and pectin. Sugar derivatives, glycol-proteins, glycol-lipids, purification and analysis of proteins.
(4 hours)
2. Lipids - structure and function of triglycerides, phospholipids, reactions of lipids, analytical methods to evaluate lipids.
(3 hours)
3. Nucleic acids - structure and function of DNA, RNA, different types of DNA, replication of nucleic acid, drugs for prevention of replication, transcription, translation and protein synthesis, mutations in DNA.
(4 hours)
4. Chemistry of amino acids - structure of proteins, purification and analysis of proteins, N-terminal residue analysis, C-terminal residue analysis, peptide analysis by Tandem Mass Spectrometry.
(4 hours)

Method of Assessment:

End of course one hour theory paper.

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Learning Outcomes:

Students should be able to,

- Describe the structure and function of carbohydrates, lipids, nucleic acids and proteins.
- Recognize the relationship among biological compounds.
- Analyze and identify a given unknown biological sample.

Recommended Text Books:

1. Voet D., Voet J. G., Biochemistry, Third edition, volume one, 2004.
2. Biochemistry, A. L. Leninger (any volume).

Course Title	**:** Biochemistry
Course Code	**:** CHE 371 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Dr. P. Godakumbura

Objectives:

- To provide general understanding of enzyme activity, classification, inhibition and its role of enzyme in the body.
- To provide knowledge on determining the kinetic parameters for enzymatic reactions.
- Explore reactions of biochemical pathways and their energy conservation.

Course Content:

1. Enzymes
    - Enzyme characteristics and classification, coenzymes.
    - Enzyme Kinetics by deriving the Michaelis Menten equation.
    - Define the kinetic parameters, K_m, V_{max}, k_{cat}, specificity constant and calculating K_m, V_{max}, k_{cat}, k_{cat}/K_m graphically.
    - Enzyme inhibition and their applications.
    - Factors influencing the enzyme activity.
    - Enzyme regulations.
    - The role of enzyme in the body and their industrial applications.

    (6 hours)
2. Biochemical energetics
    - Define the 1st and 2nd law of thermodynamics and understand the implications of ΔH, ΔS, ΔG relative to the biological system.
    - How ATP act as a power house.
    - Understand the high energy bonds, free energy of hydrolysis.

    (3 hours)
3. Biochemical pathways
    - Glycolysis.
    - The citric acid cycle.
    - Fatty acid as an energy source and beta oxidation.
    - Degradation of amino acids.
    - Oxidative phosphorylation.

    (6 hours)

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Method of Assessment:

End of the course 1 hour theory paper.

Learning Outcomes
Should be able to,

- Graphically determine the Km, Vmax, *kcat, kat/Km* of the enzyme.
- Describe role of the enzyme in the body and their industrial applications.
- Explain the importance of the biochemical pathways.

Recommended Text Books:

1. Lehninger Principles of Biochemistry, 4th Edition, Campbel/Farrell.

Course Title	**:**Heterocyclic Compounds and Polynuclear Aromatic Hydrocarbons
Course Code	**:** CHE 380 2.0
Number of Lecture Hours	**:** 30
Number of Tutorial Hours	**:** 06
Lecturer in Charge	**:** Dr. M. G. C. Padumadasa

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Objectives:

- Provide an unified treatment of the synthesis and properties of common heterocyclic compounds and their derivatives.
- Introduce the structures, syntheses and properties of common polynuclear aromatic hydrocarbons.
- Illustrate the biological importance and industrial applications of classes of compounds and specific compounds discussed in this course with selected examples.

Course Contents:

1. Heterocyclic compounds
   - Compounds containing 6-membered rings with one heteroatom: Pyridines (review), quinolines, isoquinolines, pyrilium salts, pyrones, coumarins, chromones.
   - Compounds containing 5-membered rings with one heteroatom: Indoles, benzofurans.
   - Compounds containing 5-membered rings with two heteroatoms: Pyrazoles, imidazoles, triazoles, oxazoles, thiazoles.
   - Purines and pyrimidines

   (22 hours)
2. Polynuclear aromatic hydrocarbons
   - Biphenyls, Naphthalene, Anthracene, Phenanthrene and Pyrenes.

   (08 hours)

Learning Outcomes:

- The occurrence in nature, industrial applications and significance of selected compounds and compound classes will be discussed at the appropriate points throughout the course.

Method of Assessment:

Two hour theory paper at the end of the course.

Recommended Text Books:

1. Principles of Heterocyclic chemistry, A. R. Katritsky and J. M. Lagowski. Methuen and Company, London.
2. Heterocyclic Chemistry, J. A. Joule and G. F. Smith, Van Nostrand Rheingold, London.
3. Organic Chemistry, Volume 1 - I. L. Finar. Longmans and Green, London.

Course Title	**:** Physical Organic Chemistry
Course Code	**:** CHE 373 2.0
Number of Lecture Hours	**:** 30
Number of Tutorial Hours	**:** 06
Lecturer in Charge	**:** Dr. P. Godakumbura

Objectives:

- Present an overview of the field of physical organic chemistry as the application of physical principles to study the "how and why" of organic reactions.
- Provide a description, rationalization of and evidence for the mechanisms of selected classes of organic transformations.
- Explore structure activity relationships and the effect of the medium on organic phenomena.
- Study methods used to investigate reaction mechanisms.

Course Content:

1. Pericyclic reactions
   Stepwise and concerted reactions. Evidence for concerted reactions. Electrolytic, cycloaddition, sigmatropic reactions. Derivation of selection rules using FMO theory, aromatic transition state theory and the principle of conservation of orbital symmetry. Application of selection rules.
   (8 hours)
2. Rearrangement reactions
   Neighbouring group participation, anchimeric assistance, non – classical ions. Carbon to carbon rearrangements; pinacol–pinacolone, semi pinacol, dienone–phenol, benzyl–benzylic acid, Favoskii, Arndt–Eistert, Fritsch–Buttenberg–Wiechell rearrangements. Carbon to nitrogen rearrangements; Hoffman, Curtius, Schmidt, Beckmann rearrangements. Carbon to oxygen rearrangements; Baeyer–Villiger, Hydroperoxide rearrangements. Aromatic rearrangements; Claisen, benzidene rearrangement, benzyne mechanism in S (Ar) reactions.
   (10 hours)
3. Solvent effects
   Intermolecular interactions, solvation, importance of entropy, classification of solvents, Hughes–Ingold rules, solvent polarity parameters, nucleophilicity, solvent assisted ionization, effect on spectra.
   (6 hours)

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4. Effects of substituent on reactivity:
   Hammett equation, linear free energy relationships, Yukawa–Tsuno equation, Taft equation, use of Hammett equation in the study of reaction mechanisms.
   (6 hours)

Method of Assessment:

End of course 2 hour theory paper.

Learning Outcomes:

- Be able to describe, rationalize and evaluate evidence for the mechanisms of pericyclic and rearrangement reactions.
- Be able to provide mechanism based rationalizations of chemical transformations that involve rearrangements and pericyclic reactions.
- Be able to predict the effect of changes of solvent and of substrate structure on selected chemical transformations.
- Be able to design experiments to test hypotheses regarding mechanisms of selected reactions and to interpret the results obtained.

Recommended Text Books:

1. Physical and mechanistic organic chemistry, R. A. Y. Jones.
2. Organic reactions and orbital symmetry, Gilchrist and Storr.
3. Advanced organic chemistry, J. March.
4. Mechanism and theory in organic chemistry, Lowry and Richardson.

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Course Title	: Inorganic Chemistry Practical Unit
Course Code	: CHE 374 2.0
Number of Practical Hours	: 6 × 10
Lecturer in Charge	: Prof. S. P. Deraniyagala

Objectives:

- One of the purposes of this laboratory is to provide the students an appreciation for the synthesis and characterizations of metal complexes.
- It is also aimed to provide the students high competence in the laboratory skills required for accurate and precise chemical analysis. A special insist on standard laboratory protocols and lab safety measures.

Course Content:

1. Determination of calcium, magnesium and iron in a dolomite sample.
2. Study of factors affecting a colorimetric analysis using ferric thiocyanate complexes.
3. Preparation of cobalt complexes $[Co(NH_3)_5Cl]Cl_2$, $[Co(NH_3)_5(ONO)]Cl_2$, and $[Co(NH_3)_5(NO_2)]Cl_2$.
4. Determination of iron in an unknown sample by solvent extraction.
5. Preparation of ferrocene derivatives.
6. Quantitative analysis of Nitrate (NO_3^-) and Nitrite (NO_2^-) ions in a waste water sample.

7. Quantitative analysis of Ammonium (NH_4^+) ions in a waste water sample.
8. Preparation of lead tetra acetate.
9. Preparation and analysis of potassium tris(oxalate)ferrate(III) trihydrate.

Suggested experiments in place of existing experiment 8

- Determination of the concentration of Oxalate ($C_2O_4^{2-}$) ions by colorimetric method.
- Determination of the concentration of Dichromate ($Cr_2O_7^{2-}$) ions indirectly by colorimetric methods.

Method of Assessment:

End of course 6 hour laboratory exam.

Learning Outcomes:

- Students will develop skills on synthetic and analytical techniques and gain proficiency in the applications of the theory underlying in laboratory applications.

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.
2. The organometallic chemistry of the transition metals, Crabtree, R. H. 5th Edition, John Wiley and Sons, 2009.

Course Title : Organic Chemistry Practical Unit

Course Code : CHE 375 2.0

Number of Practical Hours : 6 × 10

Lecturer in Charge : Prof. S. T. Samarasinghe

Objectives:

- To gain experience in the separation of organic compounds from a mixture using different separation techniques.
- To gain experience in organic synthesis.
- To gain experience in distillation techniques (simple, steam and reduced pressure).
- To gain experience in the extraction and confirmation of phytochemicals.

Course Content:

1. Column and thin layer chromatography.
2. Acetylation of cholesterol and purification of the product by column chromatography.
3. Synthesis of n-butyl bromide.
4. Dehydration of cyclohexanol to cyclohexene.
5. Preparation of cyclohexanone.
6. Synthesis of phthalimide and phthalide.
7. Photochemical reduction of benzophenone to benzopinacol and acid-catalysed rearrangement of benzopinacol to β-benzopinacolone.
8. Phytochemical screening.

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Learning Outcomes:
Should be able to,
- Separate organic compounds from a mixture using different separation techniques.
- Design and carry out organic synthesis.
- Use distillation techniques (simple, steam and reduced pressure).
- Extract and confirm phytochemicals.

Method of Assessment:

End of course 6 hour practical examination.

Recommended Text Books:
1. Organic Experiments, L. F. Fieser and K. L. Williamson.
2. Practical Organic Chemistry: A. I. Vogel.
3. Practical Organic Chemistry: F. G. Mann and B. C. Saunders.

Course Title	**:** Physical Chemistry Practical Unit
Course Code	**:** CHE 376 2.0
Number of Practical Hours	**:** 6 × 10
Lecturer in Charge	**:** Prof. P. M. Jayaweera

Objectives:
To improve the knowledge on,
- Measurements and the accuracy of measurements
- Error calculation and interpretation of experimental results
- Designing of experiments under available laboratory facilities.
- Trial and error method for designing of new experiments.
- Practical use of significant figures in laboratory work.
- Interpretation of results using theories already known.
- Interpretation of results using further references in addition to present knowledge.
- Concept of physical chemistry.
- Punctuality, laboratory disciplines and tidiness.

Course Content:
1. Determination of the variation of the solubility of the following compounds with temperature: KNO_3, $Ca(OH)_2$, Na_2SO_4

2. Acid hydrolysis of methyl acetate.

3. Determination of the kinetics of the following reaction using initial rate method.
   $$HCl_{(aq)} + Na_2S_2O_{3(aq)} = NaCl_{(aq)} + S_{(s)} + H_2O_{(l)} + SO_{2(g)}$$

4. Determination of the activation energy and the order of the reaction between $S_2O_3^{2-}$ and I^-

5. Kinetic studies on the reaction between iodine and acetone in aqueous medium.

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6. Determination of the equilibrium constant for the reaction between Fe^{3+} and thiocyanate ion
7. Determination of the solubility product of calcium hydroxide
8. Instrumentation

Method of Assessment:

Continuous assessment based on day to day work.

Learning Outcomes:

- Studies the general laboratory disciplines and safety.
- Take measurements based on the required accuracy of the final result.
- Variations of physical quantities are correctly represented using graphical methods.
- Controls significant figures in all steps of the calculations.
- Error calculations are done using graphical methods.
- Identify major and minor mistakes done during the experiment.
- Takes necessary actions to rectify the mistakes may happen doing an experiment.
- Use standard data books to obtain necessary data.
- Use standard terminology, units and new concepts when entering experiments.
- Understand the importance of tidiness and punctuality of laboratory work for success.

Recommended Text Books:

1. Findly, Practical Physical Chemistry.
2. Vogel A. I., Quantitative Inorganic Analysis.
3. Practical physical Chemistry.

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Course Title **: Modern Chromatographic Techniques**
Course Code **:** CHE 377.1.0
Number of Lecture Hours **:** 15
Number of Tutorial Hours **:** 03
Lecturer in Charge **:** Dr. S. D. M. Chinthaka

Objectives

- To provide theoretical background of chromatographic separations
- To provide broad aspects of instrumentation in chromatographic separation techniques.
- To provide comprehensive knowledge of sample preparation techniques for chromatographic instruments.
- Introduction of new and emerging developments in chromatographic techniques.

Course Contents:

1. Theoretical consideration of chromatographic separations

Introduction, Family three of chromatographic separations, Zone migrations, Retention, Band broadening, Resolution, Separation time, Plate theory, Van-Deemter equation, Quantification principles, Optimization of column performance.

(6 hours)

2. Gas Chromatography
   Mobile phases, stationary phases, retention and selectivity in GC, Columns in GC.

   (1 hour)
3. Instrumental aspects of GC
   Pneumatic systems, thermal zones, sample handling techniques, Sample inlets, Detectors in GC, Coupled column GC systems, method developments in GC.

   (3 hours)
4. Liquid Chromatography
   Retention mechanisms in LC, Columns in Liquid Chromatography, Liquid chromatographic techniques (HPLC, IC, SEC).

   (1 hour)
5. Instrumental aspects of LC
   Solvent delivery systems, Sample inlets, Guard columns, Detectors.

   (1 hour)
6. Coupling of chromatography with mass spectrometry
   Mass spectrometry as identification and quantification tool, Mass separation techniques, Chromatography-mass spectrometry interfaces, GCMS, LCMS, Tandem mass spectroscopic techniques.

   (2 hours)
7. Sample preparation for chromatographic separations
   Solvent extraction, Solid phase extraction, Solid phase micro extraction, Holofiber micro extraction, Derivatization techniques.

   (2 hours)

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Method of Assessment:

End of semester one hour theory examination.

Learning Outcomes:

- Students must be able to rationalize theoretical aspect of chromatographic separations.
- Be able to describe the effective separation of relatively complex mixtures using column variables and kinetic and thermodynamic parameters.
- Students must be able to calculate column parameters based on the information available on chromatograms and rationalize the effective optimization using these parameters.
- Be able to understand and describe the instrumentation aspects of major chromatographic techniques.
- Be able to gain knowledge about new and classical sample preparation techniques in chromatographic separations.

Recommended Text Books:

1. The Essence of Chromatography, C. F. Poole, 1st edition, Elsevier, New York, 2003.
2. Skoog, D. A, Leary, J. J. Principles of instrumental analysis, 4th Saunders. 1992.
3. Harris, D. C., Quantitative chemical analysis, 7th edition, W.H. Freeman, New York.

Course Title	**:** Inorganic Materials
Course Code	**:** CHE 451 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Prof. Sudantha Liyanage

Objectives:

- To provide an understanding of silicates and inorganic polymers

Course Content:

1. Comparison between organic and inorganic polymers.
   (1 hour)
2. Synthesis, properties and usages of sililcates, alumino-sililcates with special reference to zeolite, chemistry and applications of silicones.
   (8 hours)

   Fullerenes and high temperature super conductance.
   (2 hours)

   Inorganic polymers containing boron, sulphur and phosphorous, high temperature super-conductors
   (2 hours)
3. Brief introduction to coordination and conducting polymers.
   (2 hours)

Method of Assessment:

End Semester 1 hour theory paper.

Learning Outcomes:

At the end of the course, students should,

- Understand deifferent behaviour of organic polymers and inorganic polymers.
- Understand the importance and thermal stability of silicon based materials.
- Know how to synthesize materials with zero resistivity using inorganic compounds.

Recommended Text books:

1. Concise Inorganic Chemistry, J. D. Lee, 5^{th} Edition, Blackwell Science.
2. Chemistry of the Elements, N. N. Greenwood and A. Earnshaw.
3. Advanced Inorganic Chemistry, 5^{th} Edition, Cotton, F. A., Wilkinson, G. Interscience Publishers, New York (1998).
4. Silicones, Sudantha Liyanage, Institute of Chemistry Monograph.

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Course Title	**:** Medicinal Chemistry
Course Code	**:** CHE 454 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Prof. A. M. Abeysekera

Objectives:

- Develop knowledge and understanding of the principles of drug design and synthesis.

Course Content:

1. Introduction to drug targets - receptors, enzymes, transport proteins, RNA, DNA.
(2 hours)
2. Overview of the process of drug design and development - from selection of lead compound to marketing of drug.
(2 hours)
3. Design strategies to optimize pharmacodynamic and pharmacokinetic characteristics of drugs. (eg. Variation of substituent, extension of structure, ring variation, simplification, rigidification) and reactions and mechanisms involved in associated molecular transformations. Examples should be chosen from the literature (eg. Antibacterial agents, opioid analgesics, antiulcer agents, steroidal anti-inflammatory agents) to illustrate and explain the following concepts/themes. Drug target interactions, Structure activity relationships and identification of pharmacophore, prodrug, drug metabolism, importance of hydrophilic/hydrophobic balance, selectivity and toxicity.
(11 hours)

Method of Assessment:

A written examination of 1 hour duration at the end of the semester.

Learning Outcomes:

- Recognize the relationship between molecular structure and the different factors affecting the action of drugs.
- Identify structure activity relationship based on experimental data and relate these to drug - target interactions.
- Propose pathways for selected chemical transformations in the synthesis of drugs.

Recommended Text Books:

1. An Introduction to Medicinal Chemistry, Graham L. Patrick.
2. Medicinal Chemistry: An Introduction, Gareth Thomas.
3. Progress in Medicinal Chemistry, G. Lawton and D. R. Witty.

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Course Title : Polymer Chemistry
Course Code : CHE 456 1.0
Number of Lecture Hours : 15
Number of Tutorial Hours : 03
Lecturer in Charge : Dr. K. M. T. D. Gunasekera

Objectives:

- Introduce basic science behind polymer chemistry.
- Introduce the basic concepts: Polymer molecular weight, Nomenclature, thermal transitions and mechanical properties.
- Fundamentals of polymerization: Radical polymerization and Step-growth polymerization.

Course Contents:

1. Introduction
   What are polymers? Historical background, classification of polymers: by source, by polymerization reaction, by composition, by skeletal Structure, by application, and by thermal Behavior, Nomenclature, molecular weight, thermal transition, polymer stereochemistry.
   (3 hours)
2. Step growth polymerization
   Type of monomers, polymerization reaction, molecular weight and molecular weight distribution, kinetics.
   (3 hours)
3. Addition polymerization
   Structural arrangement of monomer units, initiators, reaction mechanism (propagation and termination), molecular weight and molecular weight distribution, kinetics.
   (3 hours)
4. Ionic Polymerization
   Comparison of Free Radical and Ionic Polymerizations, Cationic Polymerization, Anionic Polymerization, Carbonyl Polymerization.
   (3 hours)
5. Ring Opening Polymerization
   Introduction to Ring Opening Polymerization, Ionic Mechanisms of Ring Opening Polymerization, examples of Ring Opening Polymerization.
   (3 hours)

Method of Assessment:

End of semester one hour theory examination.

Learning Outcomes:

- Students would identify the important of polymers science
- Students would understand the basics concepts of polymer chemistry

Recommended Text Books:

1. Principles of polymerization, George Odian, Principles of polymerization by P. G. Flory.
2. Polymer Processing Fundamentals, Tim A. Osswald, Hanser.
3. Polymers: Chemistry and Physics of Modern Materials, J. M. G. Cowie.

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Course Title	**:** Molecular Spectroscopy

Course Code : CHE 457 1.0
Number of Lecture Hours : 15
Number of Tutorial Hours : 03
Lecturer in Charge : Dr. N. Kottegoda

Course Content:

1. **Microwave (Rotational) spectroscopy**:
   Rotation of molecules, moment of inertia, symmetric top molecules, spherical top molecules, asymmetric top molecules, rigid rotor model, rotational spectra, rotational energy, selection rules, intensity of spectral lines, diatomic and polyatomic molecules, isotopic substitution.
   (3 hours)
2. Modification of rigid rotor model to account for non-rigid of molecules, applications of microwave spectroscopy.
   (2 hours)
3. Effect of nuclear quadrapole on rotational spectra, Stark effect.
   (2 hours)
4. Vibrational Spectroscopy - Vibrating diatomic molecules, simple harmonic oscillator model, selection rules, energy, isotopic substitution, anharmonic oscillator, appearance of overtones and hot bands, bond dissociation, vibration-rotation spectrum, breakdown of Born-Oppenheimer principle, interactions between rotations and vibrations, rotational-vibrational energy, rotational-vibrational spectra of polyatomic molecules.
   (3 hours)
5. Raman Spectroscopy - Raman effect, pure rotational Raman spectra, vibrational Raman spectra, selection rules, energy, polarizability ellipsoid, structure determination using Raman and IR spectra.
   (3 hours)
6. Electronic spectra - electronic spectroscopy of molecules, intensity of vibrational-electronic spectra, Frank Condon principle, rotational structure of electronic-vibrational spectra, electronic structure of diatomic molecules.
   (2 hours)

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Method Assessment:

End semester examination.

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

- Explain the fundamental principle behind the appearance of rotational spectra of molecules.
- Calculate moment of inertia for symmetric top molecules, spherical top molecules and asymmetric top molecules.
- Explain the rigid rotor model as applied to rotational spectroscopy.
- Derive expressions for spectral positions arising from energy differences.
- State the selection rules associated with rotational spectroscopy.
- Derive expression for intensity of rotational peaks.
- Calculate the transition associated with maximum intensity.

- Appreciate the deviations from rigid rotor model.
- Explain the rotational spectra of diatomic and poly atomic molecules.
- Calculate the rotational constants.
- Calculate the atomic mass of using rotational spectra.
- Modify the rigid rotor model to account for the flexibility of molecules.
- Apply the non-rigid rotor model for real molecules.
- Explain the effect of isotopic substitution on the rotational spectra.
- Use the details obtained from the rotational spectra to calculate the unknown bond lengths and atomic masses.
- Modify the selection rules and spectral positions to account for the effects of nuclear quadrapole effect.
- Modify the rotational spectra to account for the stark effect.
- Express the selection rules in the presence of Stark effect.
- Calculate the shifts of spectral positions in the presence of applied electric field.
- Design experiments to calculate the moment of inertia, reduced mass and atomic masses.
- Explain the vibrations of molecules referring to simple harmonic oscillator model.
- Derive the expression for spectral positions of vibrational sprectra.
- Explain the isotopic substitution on the vibrational spectra.
- Explain the appearance of overtones and hot bands.
- Explain the bond dissociation.
- Modify the expressions to account for anharmonocity of molecules.
- Derive expressions for spectral positions in arising from the anharmonic oscillator model.
- Calculate the vibrational energy level at which the bond dissociation occur.
- Derive expressions for spectral positions arising from vibrational rotational transitions.
- Explain the effect of rotational vibrational interactions leading to break down of Born-Oppenheimer principle.
- Derive expressions for P, Q and R bands arising in rotational-vibrational spectra.
- Modify the energy and spectral position expressions to account for the rotational and vibrational interactions.
- Explain the theory of Raman effect.
- Derive spectral positions, energy terms and selection rules for pure rotational Raman spectra.
- Explain the effect of polarizability on the appearance of Raman lines.
- Draw polarisability ellipsoid for simple molecules.
- Explain the vibrational modes of different molecules.
- Sketch the polarisability change vs displacement graphs
- Explain the nonexistence of certain Raman modes in the Raman spectra.
- Use the Raman and IR data to determine the structure of molecules.

Recommended Text Books:

1. C. N. Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy, Tata McGraw Hill, New Delhi, 2010, Fourth Edition.
2. P. W. Atkins, Physical Chemistry, Oxford University Press, Oxford, Sixth Edition.

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Course Title	: Advanced Surface Chemistry
Course Code	: CHE 458 1.0
Number of Lecture Hours	: 15
Number of Tutorial Hours	: 03
Lecturer in Charge	: Dr. D. R. Ratnaweera

Objective:

- To provide an introduction to the experimental and theoretical aspects of surface and interface science

Course Content:

1. Introduction
   Failure of the Langmuir model, factors affecting the variation of the heat of adsorption with coverage, BET isotherm and multiplayer physical adsorption, determination of surface area from adsorption data.
   (2 hour)
2. Surface excess and Gibbs absorption isotherm.
   (1 hour)
3. Surface tension, surface free energy, contact angle, Young's law, surface tension as an interfacial property, capillary effect, Interfacial potential, effect of solutes and temperature on surface tension, surface pressure.
   (2 hour)
4. Kinetic of surface reactions, Langmuir – Hinshelwood mechanism.
   (2 hour)
5. Experimental aspects of surface Chemistry.
   Monolayer & multi-layer preparation from Langmuir Blodgett trough.
   (1 hour)
6. Molecular flow gases: Knudsen number.
   (1 hour)
7. Surface tension measurements – capillary rice, sessile drop, pendant drop and tethered bubbles and pullout methods.
   (2 hour)
8. Accurate measurement of small doses of gas by calibrated volume and calibrated leak methods.
   (1 hour)
9. Determination of heats of adsorption using isosteric, calorimetric (film and filament calorimetry) and desorption energy methods, Lennard - Jones potential energy diagrams.
   (2 hour)
10. Characterizing surfaces using scattering techniques (using X-ray, neutron and light sources)
    (1 hour)

Prerequisites:

CHE 210 1.0 Phase Equilibria and Surface Chemistry

Method of Assessment:

One hour theory paper at the end of the semester.

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Learning Outcomes:
Students should be able to describe,

- Models for monolayer and multilayer adsorption and their limitations
- Major experimental aspects of surface chemistry
- Methods of making monolayers and multi-layers on interfaces
- Principles of surface energy measuring techniques

Recommended Text Books:

1. Introduction to Colloid and Surface Chemistry, Duncan Shaw, Butterworth-Heinemann, 1992.
2. Principles of colloidal and surface chemistry, Paul C. Hiemenz, Raj Rajagopalan, 1997.

Course Title	**:** Advanced Chemical Thermodynamics
Course Code	**:** CHE 459 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Dr. R. S. Jayakody

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Objectives:

- Provide a rigorous and advanced knowledge in certain topics of thermodynamics suitable for chemistry special students.
- To learn various methods of determining partial molar properties. To learn the concept of fugacity of gases and to learn about determining fugacity of a real gas and gaseous mixtures.
- To learn the concept of activities and activity coefficient To study the experimental evidence leading to the third law.
- To understand the molecular basis of entropy.

Course Content:

1. Review of the basic thermodynamic principles, definition of Standard states Thermodynamic description of mixtures, partial molar quantities: partial molar volume, partial molar Gibbs energies, introduction of the fundamental equation of thermodynamics.
   (2 hours)
2. Significance of the chemical potential, Gibbs-Dunhem equation, TD interpretation of the colligative properties, Thermodynamics of mixing: Gibbs energy of mixing of perfect gases, introduction of standard chemical potential, enthalpy of mixing.
   (2 hours)
3. Determination of partial molar properties direct method, apparent molar property method, methods of intercept.
   (2 hours)
4. Chemical potential, its variation with temperature and pressure, application of TD to determine the free energy for a general reaction in equilibrium in terms of activities of reactants and products, the solvent activity, the solute activity, ideal-dilute solutions,

real solutes, activities of regular solutions, activity of ions in solutions, mean activity coefficients, the Debye-Huckel limiting law.

(3 hours)

5. Fugacity of gases, fugacity diagrams, reduced variables, variation of fugacity with temperature and pressure, determination of fugacity of a real gas and a real gas in a gaseous mixture.

(2 hours)

6. Experimental evidence leading to the third law. Third law of thermodynamics. Debye T3 law, determination of third law entropies. Comparison of spectroscopic and calorimetric entropies.

(3 hours)

Method of Assessment:

End of semester 1 hour exam, essay type.

Learning Outcomes:

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

- Describe and recognize partial molar properties.
- Use, manipulate and apply Gibbs-Dunhem equation.
- Recognize the methods of determining partial molar properties.
- Apply the concept of chemical potential and activity.
- Recognize, define and the fugacity of gases and know how to determine the fugacity of a real gas.
- Recognize and identify the evidences leading to the third law of thermodynamics.

Recommended Text Books:

1. Physical Chemistry, P. W. Atkins, W. H. Freeman & Co, 6th edition of above.

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Course Title	: Industrial Management
Course Code	: 460 1.0
Number of Lecture Hours	: 15
Number of Tutorial Hours	: 03
Lecturer in Charge	: Ms. Peumi

Objectives:

- Prepare and shape students to managerial post to cater current industrial needs.
- Enhance the practical, technical as well as the theoretical knowledge in managing people with specialized skills.
- Enhance the problem solving skills in relation to the company survival, growth and development.
- Increase the demand in graduates to the research and development field in industry.

Course Content:

1. What is management?
    - Managerial roles, managerial levels.
    - Characteristics of a good manager.
    - Evolution of management theory.
    - Management functions.

    (5 hours)
2. Human Resources Management
    - Staffing, Benefits of human resources planning,
    - The process of staffing
    - Job analysis, Job description, Job specification, Recruitment and Retention
    - Career planning, Performance appraisal
    - Employee training and development
    - Training techniques

    (3 hours)
3. Marketing Management
    - Introduction to Marketing: core concept, marketing philosophies
    - Marketing environment, MIS and marketing research
    - STP strategies: Segmentation, Target, Positioning
    - Marketing mix strategies (4P's/7P's)

    (3 hours)
4. Production / Operation Management
    - Introduction to operation management;

      Input $\longrightarrow$ Process $\longrightarrow$ Output
    - Operations function;
    - Facility weation, layout, quality management, work-study, Capacity management, Purchasing/Materials Management, Inventory control
    - Challenges faced by operation managers

    (3 hours)
5. SWOT analysis, 5S and KASM concepts.

    (1 hour)

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Method of Assignments:

SWOT Analysis: written and Oral presenting (5 to 7 min) 5S concept and KSAM: Industrial visit and written document.

Method of Assessments:

Assessment 1: 15%

Market search, documentation.

Market search design:

Identify and study about a market product thoroughly.
Collect information/data by consulting managers and consumers.
Process information and analyze the current situation.
Predict future trends based on collected data.
Provide outcomes, benefits and recommendation for the predicted product.

Assessment 2: 10%

Present your findings from market search (5 to 7 min talk without a PPT)

Assessment 3:

Final exam: 75% with
Condition: Two Assessments must be completed to sit the final exam

Learning Outcomes:

- Able to understand and practice principles of Management, Human Resource Management, Marketing and 5S concept.
- Able to understand Industrial management process and enter into managerial position in the chosen field.
- Be able to identify market share of given product

Recommended Text Books:

1. Management (sixth edition), James A. F. Stoner.
2. Management Theory and Practice, J. S. Chandan.
3. Fundamentals of Management, (core concepts and applications), Ricky W. Griffin.
4. Operations Management, Russel and Taylor.
5. Marketing Management, Philip Kottler, 2013.
6. Principles of Marketing, Philip Kottler.

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Course Title	**:** Basic Chemical Engineering
Course Code	**:** CHE 461 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.
   (2hours)
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.

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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	**:** Food Chemistry
Course Code	**:** CHE 462 2.0
Number of Lecture Hours	**:** 30
Number of Tutorial Hours	**:** 06
Lecturer in Charge	**:** Prof. S. I. Samarasinghe

Objective:

- To provide an in depth understanding of the chemistry and interaction of food components.
- To provide knowledge of the fundamentals of food analysis.

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Course Content:

1. Carbohydrates
    - Chemistry of monosaccharide, disaccharides and polysaccharides- Gelatinisation of starch, application of pectins in the food industry.
    - Interaction of sugars with amino acids (Maillard Browning), Caramelisation reactions.

    (10 hours)
2. Lipids
    - Chemistry of saturated and unsaturated fatty acids present in food, chemistry of hydrolytic rancidity and oxidative rancidity, prevention of rancidity and the mechanism of action of antioxidants. Determination of Saponification value, Acid value, Peroxide value, Iodine number and the significance of these parameters in fatty foods.

    (8 hours)
3. Proteins
    - Chemistry of amino acids, peptides and proteins with reference to proteins in milk, meat, eggs and wheat.
    - Effect of the denaturation of proteins on the properties of food. Determination of proteins in food.

    (6 hours)
4. Vitamins and minerals in food
    - Occurrence, functions and chemistry of fat soluble and water soluble vitamins in food and their stability.
    - Major and trace elements present in food, methods used and the principles involved in the determination of minerals in food.

    (3 hours)
5. Sensory properties of food

- Chemistry of anthocyanins, flavanoids, carotenoids and porphyrins present in food. Properties of volatile constituents in food with reference to terpenes, essential oils present in food, colors and flavors produced during processing of food, black tea manufacture, processing of meat.

(3 hours)

Method of Assessment:

2 hour end of unit theory examination.

Learning Outcomes:

- To be able to describe the reactions of monosaccharide, disaccharides (maltose, lactose, sucrose), pectin and starch in food systems. To be able to describe the types of browning that occurs in food systems.
- To be able to describe the composition and reactions 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 structure and properties of amino acids, peptides and the different proteins present in food, the nature of proteins and the factors that cause their denaturation.
- To be able to describe the structure of vitamins and the effect of processing conditions on the structure.
- To be able to describe the importance of sensory properties of food based on the properties of flavor compounds and pigments present in food in relation to their structural features.

Recommended Textbooks:

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. Conetate, T. P. Royal Society of Chemistry Publications (1984).

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Course Title : Food Technology

Course Code : CHE 463 2.0
Number of Lecture Hours : 30
Number of Tutorial Hours : 06
Lecturer in Charge : Dr. S. Weerasinghe

Objectives:

- To understand the chemical properties of various food commodities such as fruits and vegetables, meat, and milk
- To understand numerous chemical/biochemical changes that occur in food matrices during food product manufacture
- To understand the principles of processing and preservation of fruits and vegetables, meats and dairy products

Course Content:

1. Introduction to food and nutrients, intrinsic and extrinsic factors affecting characteristics of foods, climacteric and non-climacteric fruits, respiration patterns of fruits and vegetables, chemistry of fruit ripening, effects of processing on fruits and vegetables, and fermentation.
(10 hours)
2. Introduction to meat science, muscle chemistry, muscle structure, ultimate pH of meat, post mortem glycolysis and rigor mortis stage of meat, development of sensory qualities in meat, meat processing and processed meat products.
(10 hours)
3. Introduction to dairy science, composition of milk, chemistry of milk components, heat-induced changes in milk, dairy product process technology.
(10 hours)

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Learning Outcomes:

- Acquire a general knowledge of the structure and chemical composition of fruits and vegetables, meats, and dairy products
- Get an in-depth understanding of factors that influence the manufacturing process and overall quality of food products (fruits and vegetables/ dairy/ meat).
- Apply the obtained knowledge to:
  - Reduce the rate of deterioration in fresh fruits and vegetables and their finished products during handling, processing and storage
  - Improve quality of processed meats and dairy products

Recommended Text Books:

1. Handbook of Food Science, Technology, and Engineering (04 volumes).
Editor(s): Y. H. Hui, Frank Sherkat.
   Volume 1: Food Science: Properties and Products
   Volume 2: Food Science: Ingredients, Health, and Safety
   Volume 3: Food Engineering and Food Processing
   Volume 4: Food Technology and Food Processing
2. Food Chemistry (3^{rd} Edition), Owen R. Fennema (Ed).
3. Handbook of Meat Processing, Fidel Toldrá (Ed), Blackwell Publishing (2010); ISBN: 978-0-8138-2182-5.
4. Dairy Chemistry and Biochemistry, P. F. Fox and P. L. H. McSweeney.

Course Title	**:** Polymer Technology
Course Code	**:** CHE 464 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
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 one hour theory examination.

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

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- 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	**:** Biophysical Chemistry
Course Code	**:** CHE 465 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Dr. S. D. M. Chinthaka

Objectives:

- To learn about non covalent interactions as key binding patterns that governs the structure and functionality of biomolecules.
- To explore physical parameters, that governs the structure and functionality of biomolecules.
- To learn unique thermodynamic requirements for driving biological reactions.
- To learn proteins as key functional molecules in biological systems and their physical chemistry aspects of structure.
- To explore physical parameters, that governs the structure and functionality of membrane transport and signal transduction of small molecules in biological systems.

Course Contents:

1. Chemical bonding in bio-molecules
   Importance of reversible noncovelent interactions for the functionality of biomolecules. Hydrogen bonding , Ionic interactions, Hydrophilic & hydrophobic interactions , Van der Walls interactions.
   (1 hour)
2. Role of water in bimolecules
   Osmosis as a passive transportation mechanism in biological systems, Buffering action for enzyme activity in biological systems.
   (1 hour)
3. Energy and bioenergetics
   Second law of thermodynamics and its importance for biological reactions. Entropy as major driving force in many biological reactions. ATP as energy currency in biological reactions, Energetic of ATP hydrolysis, Group transfer as energy exchange in isothermal biological systems. Anabolism and catabolism, Separate energy pools in anabolism and catabolism.
   (3 hours)
4. Proteins

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Structure and functionality of proteins, Primary, secondary, tertiary quaternary structure of Proteins, Peptide bond and its structural and conformational properties, protein folding, folding patterns and their structural properties, Structural proteins and their physical properties, Functional proteins and key principles of protein function. Mechanisms of protein function.

(3 hours)

5. Co-operate binding mechanism in carrier proteins, Hill plot, MWC model and Sequential model.

(1 hour)

6. Biological membrane and solute transport across membrane transport, Active and passive transport, thermodynamics of solute transport across biological membranes, physical properties of membrane transporter proteins: Hydropathy plot.

(3 hours)

7. Small molecule transport across biological membranes
Water, carbon dioxide, glucose, Na^+, K^+, Cl^- and their importance for signal transduction.

(3 hours)

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Method of Assessment:

End of the year one hour written examination.

Learning Outcomes:

- Students will explain the importance of intermolecular forces and their strength in cellular functionality.
- Students will be able to do calculations on osmosis based on the levels of cellular and environmental solutes and explain some behavioral changes of animals and plants due to osmosis.
- Students will explain and perform numerical calculations on energy transfer, energy managements in anabolic and catabolic reactions and protein substrate binding using the laws of thermodynamics.
- Students will explain the folding patterns, rotational barriers of proteins and their physical chemistry aspects.
- Student will use the hemoglobin and myoglobin to explain the functionality and binding of proteins with substrates.
- Students will explain functionality and the physical chemistry aspects of cell membrane and use the law of thermodynamics to explain the transport of simple molecules across the cell membrane.

Recommended Text Books:

1. Leninger's principles of bio-chemistry, Nelson and Cox, 5th edition W. H. Freeman.

Course Title	**:** Environmental Chemistry
Course Code	**:** CHE 470 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Dr. S. D. M. Chinthaka

Objectives:

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

Course Contents:

1. Water and water pollution

Aquatic chemistry. Water pollution by hydrocarbons, heavy metals, PCBs, PAHs pesticides, soap and detergents.

(3 hours)

Fate of environmental pollutants. Water and waste water treatments.

(2 hours)

2. Atmospheric chemistry

Stratification of atmosphere, Major chemical species and reactions in the atmosphere, Gaseous inorganic and organic pollutants.

(1 hour)

Interaction of pollutants with solar radiation. Photochemical reactions involving pollutants and major atmospheric radicals. Particles in the atmosphere, Reactions, effect, fate, and removal of atmospheric particulate.

(3 hours)

3. Major pollution related environmental issues

Ozone layer depletion: CFCs in the atmosphere, effect of CFCs to O_3 layer. Fate of CFC, Alternative to CFC. Photochemical smog. Smog forming pollutants, Smog forming process, Toxic chemicals formed in photochemical smog.
Global warming, Green house effect, major green house gases, Origin and fate of green house gases.

(4 hours)

4. Environmental analysis

Analytical methods available for environmental analysis, sampling techniques for environmental analysis, Standard methods for environmental pollutant analysis.

(2 hours)

Method of Assessment:

1 hour end of the semester examination.

Learning Outcomes:

- Students must be able to understand chemical aspect of environment processes, polluting streams and fate of the environmental pollutants.
- He will get the comprehensive chemical knowledge of waste treatments and waste reductions.

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- Students will explain the chemical aspect of major pollution related global environmental issues and suggest solutions for these issues.
- He will also explain and rationalize the current sample preparation and analytical method for the analysis of environmental chemical species.

Recommended Text Books:

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

Course Title	**:** Textile Chemistry and Technology
Course Code	**:** CHE 471 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Visiting Lecturer

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Objectives:

- This lecture series emphasizes the fundamental principles of fiber science, dyeing and finishing technology, dye chemistry, chemistry of textile printing and fiber formation. This program is highly relevant to many of the chemical nature of textile industries.

Course Content:

1. Fiber Science and Technology
   - General introduction about yarn & Fiber
   - Classification of textile fiber
   - Chemical properties of fiber (Chemical structures)
   - Yarn Formation reactions (Polymerization) of synthetic yarn

   (2 hours)
2. Water Treatment Process
   - Process water treatment mechanism & reactions
   - Waste water treatment mechanism & reactions
   - Water quality parameters

   (2 hours)
3. Chemistry of pretreatment technology
   - Bleaching reactions
   - Reactions & mechanism of detergent & Surface active agent
   - Scouring Agent and their reactions
   - Solvent extraction method for fabric scouring
   - Solvent scouring machineries
   - presetting/ heat setting process

   (2 hours)
4. Textile dyeing technology and chemistry
   - Introduction of textile dye
   - Classification of Dye stuff
   - Chemistry of Dyeing
   - Dyeing of textile materials and Dyeing parameters

- Post treatments in dyeing process and their reactions

(4 hours)

5. Textile finishing technology and chemistry
   Introduction of deferent finishing chemicals and properties
   - Mechanism of padding process
   - Eco friendly textile finishers
   - How to improve the chemical fastness property in finishing process

(3 hours)

6. Printing Technology
   - Printing Methods
   - Printing process
   - Chemistry of the printing paste

(1 hour)

7. Anti yellowing treatment

(1 hour)

8. Cold black Treatment (New concept)

9. IR dyeing technology/ Water Free Dyeing (New Technology)

10. Basic Introductions about textile chemical testing (ISO/ AATCC methods)

11. One day Factory Tour
    **field class report: Visit a Synthetic Dyeing and finishing plant, printing plant and water treatment unit (Bothe process water and waste water)

Method of Assessment:

80% for theory paper
20% for field class report

Learning Outcomes:

- Students would learn basics dyeing / Finishing and printing technology &chemistry of both Synthetic and Natural fibers (Nylon, PES and cotton).
- Students would learn about the chemical reaction and structures of the textile dyes and Auxiliary chemicals.
- Students would learn about the very new technologies in Synthetic dyeing process.

Recommended Text Books:

1. Textile coloration and Finishing, Warren S. Perkins, Carolina Academic Press, 1996. Dyestuff.
2. Chemicals for polyamide fibers, Clariant textile application lab hand book, 2012.

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Course Title : Physical Chemistry of Polymers
Course Code : CHE 474 1.0
Number of Lecture Hours : 15
Number of Tutorial Hours : 03
Lecturer in Charge : Dr. M. A. B. Prashantha

Objectives:

- To introduce mathematical approach in molar mass distribution of polymers.
- To introduce the application of colligative properties, light scattering techniques and intrinsic viscosity in molar mass determination.
- To introduce the chemical thermodynamics and statistical approach to the polymer solutions.
- To introduce the crystallization behavior of polymers.
- To introduce mathematical approach to kinetics of polymerization.

Course Contents:

1. Molar mass distribution
   Molar mass distribution, number average molar mass, weight average molar mass , Z-average molar mass distribution, viscosity average molar mass, polydispersity index, chain conformations and end-to-end distance, radius of gyration and degree of polymerization.
   (3 hours)
2. Determination of molar masses of polymers
   End group analysis and use of colligative properties to determine number average molar mass of polymer, Light scattering techniques to determine weight average molar mass, intrinsic viscosity measurements to determine viscosity average molar mass.
   (4 hours)
3. Thermodynamics of polymer solutions
   Solubility of polymers in organic solvents, Flory-Huggins lattice model, solubility parameter and Flory-Huggins interaction parameter.
   (3 hours)
4. Crystallization of polymers
   Structural requirements for crystallinity, introduction to Tg, Tm and Tc, qualitative introduction to the crystallization kinetics.
   (2 hours)
5. Kinetics of polymerization
   Reactivity and molecular size, statistics of linear stepwise polymerization, kinetics of vinyl radical polymerization and kinetic chain length.
   (3 hours)

Method of Assessment:

End of semester one hour theory examination.

Learning Outcomes

- Students would learn to apply the basics of thermodynamics, chemical kinetics and colligative properties to the polymer system.

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Recommended Text Books:

1. Textbook of Polymer Science, Fred W. Billmeyer.
2. Fundamental of Polymer Science, Paul C. Painter and Michael M. Coleman.

Course Title	**: Synthetic Organic Chemistry**
Course Code	**:** CHE 475 2.0
Number of Lecture Hours	**:** 30
Number of Tutorial Hours	**:** 06
Lecturer in Charge	**:** Dr. M. G. C. Padumadasa

Objectives:

- Investigate methods and strategies for designing the synthesis of complex molecules from simpler molecules.

Course Content:

1. Basic concepts in retrosynthetic analysis – disconnection, functional group interconversions, protecting groups, retron, synthon, reagents and polarity inversion. (10 hours)
2. Functional group based strategies – one group disconnections, two group disconnections. (14 hours)
3. Regioselectivity, chemoselectivity, stereospecificity and stereoselectivity. (2 hour)
4. Modern reagents for selected transformations – reactivity and selectivity. (2 hour)
5. Analysis of selected well-known published syntheses. (2 hour)

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Method of Assessment:

End of course two hour theory paper.

Learning Outcomes:

Should be able to,

- Disconnect complex molecules to develop synthetic trees and to evaluate the resultant synthetic pathways.
- Predict possible products of proposed reactions/ reaction sequences.
- Propose suitable reactants/ reaction sequences to carry out desired chemical transformations.

Recommended Text Books:

1. Organic Synthesis – the disconnection approach, Stuart Warren.
2. Advanced Organic Chemistry, J. March.
3. Selected Organic Synthesis, Ian Fleming.

Course Title	**:** Solid State Chemistry
Course Code	**:** CHE 476 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Dr. N. Kottegoda

Objectives:

- Solid-state chemistry underpins the research and applications of inorganic materials. Most of the solid materials around us function because of their specific solid state structures - and that the properties of these solids are not just a result of the molecular structure of their constituents but more importantly collective solid state effects. This course will concentrate on understanding bonding and theories of solids and how the structures of these materials are related to solid-state properties. The underlying chemistry and properties are often sensitive to the way that the constituent atoms and molecules are packed together and therefore, this aspect of solid-state control will also be examined in detail.

Course Content:

1. The solid state
   Crystal packing and bonding, Pauling's rules
   (2 hours)
2. Solid state synthesis
   Solid state synthesis (shake and bake methods), sol gel method, hydrothermal methods, intercalation deintercalation methods, vapour phase transport, chemical vapour deposition, examples for synthesis of technologycally important solids.
   (2 hours)
3. Structure-property relationships
   Conducting properties, theories and properties of solids, Einsteen model, Debye model, free electron theory, Classical theory, Band theory, band structure of metals, fermi level, conduction band valence band, semi-conductors, intrinsic and extrinsic semi-conductors, metallic conductivity, p-type, n-type semi-conductors, hopping semi conductivity.
   (2 hours)
4. Insulators
   (1 hour)
5. Superconductivity
   Miessner effect, zero resistance, critical temperature, structures leading to superconductivity ionic conductivity: defects, thermodynamic consideration of defects, extrinsic and intrinsic ionic conductivity, applications.
   (1 hour)
6. Solid state electrolytes and applications
   (2 hours)
7. Ferro- electric materials
   Theory, hysteresis, structures of materials and ferroelectricity, pyro and piezoelectricity applications of conducting materials, applications.
   (1 hour)
8. Magnetic properties
   Curie and Curie-Weiss law, magnetic moments, ferro- and antiferromagnetic ordering, domain structure, magnetic properties of d and f block compounds,

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applications of magnetic materials, hysteresis losses and soft magnetic materials, hard magnetic materials and permanent magnets, Magnetic data storage, applications.

(3 hours)

9. Optical properties
   Applications of solid materials in optical devices.

(1 hour)

Method of Assessment:

End semester examination.

Learning Outcomes:

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

- Discuss the fundamentals associated with the structure and properties of crystalline materials.
- Explain how the different types of bonding influence the structure and properties of crystalline material.
- Explain the structural principles behind the packing of solid spheres and the way in which a range of structures can be described in terms of this packing.
- Use Pauling's principles to discuss the bonding and packing environment of solids.
- Appreciate the significance of defects, dislocations, grain boundaries, and predict their effects on electrical, magnetic, optical and mechanical properties.
- Explain the different approaches for synthesis of solids.
- Compare the advantages and drawbacks of different synthesis approaches.
- Design synthesis methods for technologically important solids.
- Explain the conducting properties using the classical theories.
- Explain the different types of conductivities observed in solids referring to their structure.
- Use band theory to explain the conducting properties.
- Use free electron theory to explain the conducting properties.
- Explain the drawbacks of different theories that explain the conducting properties.
- Explain the metallic, di, super, peizo, pyro, ferro-, ferri and anti-ferro electric properties of solids referring to their structure.
- Explain the applications of solid materials as various conductors.
- Explain the behavior of various solid electrolytes and their applications
- Explain the magnetic properties of solid materials referring to the structure.
- Explain the existence of ferro, ferri, anti- ferri magnetism relating to the structure.
- Use and apply Curie and Curie Weiss law related to magnetic materials.
- Explain the applications of magnetic materials in various industries.
- Explain the optical properties of solids referring to their structures.
- Explain the applications of the optical materials in various industries.

Recommended Text Books:

1. A. R. West, Basic Solid State Chemistry, John Wiley and Sons Ltd, Chichester, 2002, Second Edition.
2. P. W. Atkins, Physical Chemistry, Oxford University Press, Oxford, Sixth Edition.

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Course Title	**:** Surface Techniques and Dynamic Surfaces
Course Code	**:** CHE 481 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Prof. P. M. Jayaweera

Objectives:

- To develop fundamental and applied knowledge of surface science and experimental aspects.

Course Content:

1. Introduction, surface sensitive techniques, clean surfaces, vacuum technology, types of pump, choice of pumping system, flanges and seals, gauges.
   (2 hours)
2. The structure of solids and surfaces, metals, semiconductors and insulators, valence band and conduction band, band gap, vacuum and fermi levels, work function.
   (2 hours)
3. ESCA experiments and electron spectrometer design, Photoelectron Spectroscopy (PES), binding energy, Koopmans' theorem. Ultraviolet Photoelectron Spectroscopy (UPS), X-ray Photoelectron Spectroscopy (XPS), Auger Electron Spectroscopy (AES). Compositional Depth Profiling.
   (4 hours)
4. Low Energy Electron Diffraction (LEED), interpretation of LEED patterns, vibrational spectroscopy, Infrared Reflection Absorption Spectroscopy (IRAS), Electron Energy Loss Spectroscopy (EELS), application of IRAS and EELS techniques, X-ray absorption spectroscopy, Extended X-ray absorption fine structure.
   (4 hours)
5. Scanning Tunneling Microscopy and Atomic Force Microscopy.
   (2 hours)
6. Application of Electron Spectroscopy in Material Science.
   (1 hours)

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Learning Outcomes:

- Able to understand ultra high vacuum systems and obtained clean surfaces for chemical analysis.
- Able to understand changes in work function upon adsorption and kinetic energy of photo electron.
- Able to understand techniques XPS, AES and depth profiling.
- Able to understand LEED, IRAS, EELS EXAFS techniques.
- Able to understand basic principles and instrumental aspects of the STM and AFM.

Recommended Text Books:

1. Surface Analysis: The Principal Techniques, John C. Vickerman and Ian Gilmore
2. The Surface Science of Metal Oxides, Victor E. Henrich and P. A. Cox
3. An Introduction to Surface Analysis by XPS and AES by John F. Watts and John Wolstenholme

Course Title	**:** Polymer Blends and Composites
Course Code	**:** CHE 483 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Visiting Lecturer

Objectives:

- To learning and understand polymer blends with phase concepts.
- Provide a description, rationalization of polymer composite processing techniques.
- Explore and learn chemistry of composites with its curing behaviors.

Course Content:

1. Phase behavior of polymer blends and its properties. (3 hours)
2. Factors effecting phase behavior. (1 hour)
3. Introduction to composites. (1 hour)
4. Types of matrix materials and reinforcements. (4 hours)
5. Chemistry of composites. (2 hours)
6. Polymer composites processing techniques. (3 hours)
7. Testing methods and industrial applications. (1 hour)

Method of Assessment:

End of course one hour theory paper

Learning Outcomes:

- Be able to learn and understand polymer blends with phase concepts.
- Be able to provide a description, rationalization of polymer composite processing techniques
- Be able to explain chemistry of composites.

Recommended Text Books:

1. Polymer Science - Gowariker / Viswanathan / Sreedhar
2. Polymer chemistry - Seymour / Carraher
3. Textbook of polymer science - Billmeyer
4. Polymeric composites - Raymond B. Seymour
5. Handbook of Polymer Composites for Engineers - Leonard Hollaway
6. Integrated Design and Manufacture Using Fibre-Reinforced Polymeric Composites - M. J. Owen, Victor Middleton, I. Arthur Jones

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Course Title	**:** Polymer Coatings and Paint Industry
Course Code	**:** CHE 484 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Dr. D. R. Ratnaweera

Objectives:

- Overview of basic concepts of polymer coatings
- Describe the functions of different components in coatings/paints
- Introduce synthesis, modifications of resins and other additives
- Introduce basic principles of formulation of coatings
- Recent advancements and future directions in polymer coatings/paints industry

Course Content:

1. Introduction of surface coatings and paints.

   (1 hour)

2. Methods of making polymeric coatings.

   (1 hour)

3. Major ingredients of paints, their functions and fundamental chemistry/ physics phenomenon behind their role.
   - Pigments
   - Resin
   - Solvent
   - Driers
   - Wetting and dispersing agents
   - Anti skimming agent
   - Anti settling agents
   - Anti floating and anti-flooding agents
   - Flow controlling and leveling agents
   - Deforming agents
   - Fungicides and preservatives

   (3 hours)

4. Dispersion of pigments and other additives in polymeric resins.
   - Electrostatic and steric stabilization techniques
   - Anchoring mechanisms and major types of dispersants
   - Flooding and floating

   (2 hour)

5. Synthesis, modifications and curing of,
   - Alkyd resins
   - Epoxy resins
   - Polyurethane resins
   - Acrylic resins
   - Silicon coatings
   - Energy curable resins

   (5 hour)

6. Formulation of paints

   (1 hour)

7. Coating and paints testing.

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(1 hour)

8. Recent advancements and future directions in coatings.
    - Self healing coatings
    - Photoelectric applications of coatings
    - Thermoelectric applications of coatings

(1 hour)

Method of Assessment:

End of course 1 hour theory paper.

Learning Outcomes:

- Be able to describe important components of paints/surface coatings.
- Be able to formulate coatings
- Be able to describe synthesis, modifications and curing of resins
- Be able to describe major surface modification methods of additives
- Be able to describe major testing methods used to check the quality of coatings.

Recommended Text Books:

1. Coatings Materials and Surface Coatings, Arthur A. Tracton, Publication Date: November 7, 2006, ISBN-10: 1420044044 | ISBN-13: 978-1420044041, CRC press.
2. Paint and Surface Coatings - Theory and Practice (2nd Edition), Edited by: Lambourne, R., Strivens, T. A. © 1999 Woodhead Publishing.

Course Title	: Quality control and Assurance
Course Code	: CHE 485 1.0
Number of Lecture Hours	: 15
Number of Tutorial Hours	: 03
Lecturer in Charge	: Mr. Ushantha Jayalath

Objectives:

- To learning 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)

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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 course one 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.

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Course Title : Colloids and Nanochemistry
Course Code : CHE 486 1.0
Number of Lecture Hours : 15
Number of Tutorial Hours : 03
Lecturer in Charge : Dr. P. K. D. M. C. Karunaratne

Objectives:

- Identify nanomaterials as a transition between atomic/molecular and macroscopic materials.
- Provide a basic outlook on colloids.
- Understand the changes of materials properties in the Nano-regime.
- Understand size dependent (size tunable) material properties and how they arise.
- Identify different types of nanomaterials.
- Discussion of some major ways of nanofabrication under top down and bottom up approaches.
- Understand fullerenes and carbon nanotubes: Structure, properties, and fabrication.
- A brief exposure of nanomaterial characterization techniques and applications.

Course Content:

1. Introduction to colloids and nanochemistry
   Definitions, history, material properties at nano level.
   (1 hour)
2. Colloids versus nanomaterials, classification of nanomaterials.
   (1 hour)
3. Nanoconcepts
   Quantum confinement, metal to insulator transition, surface plasmon resonance.
   (2 hours)
4. Structure and growth
   (1 hour)
5. 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)
6. Buckminister fullerenes, Single wall and multi wall carbon nanotubes, nanoparticles, and quantum dots.
   (1 hour)
7. Nanocharacterization
   Microscopic imaging (TEM, SEM, AFM, STM), and spectroscopic (EELS, EDX, XPS) techniques.
   (3 hours)
8. Applications and future prospects of nanochemistry and technology.
   (1 hour)

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Method of Assessment:

End of semester 1 hour exam, essay type.

Learning Outcomes:

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

Recommended Text Books:

1. Introduction to Nanoscience and Nanotechnology by Chris binns.
2. Introduction to Nanoscale Science and Technology by Ventra, Evoy and Heffin

Course Title	**:** The Chemistry of Plant Products and Their Applications in Industry
Course Code	**:** CHE 466 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Dr. M. G. C. Padumadasa

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Objectives:

- To identify plants as a source of raw materials for industry
- To provide an understanding of the chemistry of selected plant metabolites of industrial importance.
- To provide an understanding of the methods of extraction and processing of plant metabolites to industrially useful products.

Course Content:

1. Importance of the role of plants as a provider of raw materials for industry.

2. Products based on primary metabolites:- Fixed oils - Cellulose and starch

3. Products based on secondary metabolites:- Pharmacologically active compounds Products from medicinal plants used in traditional medicine, modern herbal healthcare products and modern pharmaceuticals. Compounds with sensory properties. Products from Aromatic plants used in flavors and fragrances.

4. Production of non-alcoholic beverages from plants. (tea, coffee, cocoa)

Method of Assessment:

1 hour end of semester examination.

Learning Outcomes:

The students should be able to,

- Display their appreciation and understanding of the role of plants as a provider of chemicals for the industry.

- Describe the methods used to convert plant metabolites to industrially useful products and display their understanding of the chemical, physical and biological principles underlying these methods.

Recommended Text Books:

1. De Silva, K. T. Ed., (1995) "A Manual on the Essential Oil Industry" (UNIDO, Vienna).
2. Finar, I. L. (1975) "Organic Chemistry" Vol. 2, 5th Edition.
3. Jayaweera, D. M. A., "Medicinal Plants of Ceylon" Vol. I to V (NARESA, Sri Lanka).
4. Harborne, J. B., (1975) "The Flavanoids" Chapman & Hall London.
5. Sanderson G. W., (1972) *The Chemistry of Tea and Tea Manufacture* in "Advances in Food Research".
6. Haslam, E., (1996) "Chemistry of Vegetable Tanins" Academic Press N.Y.
7. Shahidi. F., and Nazk. M., (2004) "Phenolics in Food and Nutraceuticals" CRC Press, LLC.

Course Title	**:** Supramolecular Chemistry
Course Code	**:** CHE 491 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Dr. N. T. Perera

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Objectives:

- To discuss the fundamental concepts, current research and applications of supramolecular chemistry.

Course Content:

1. Introduction, concepts, supramolecular interactions: ion-ion interactions, ion-dipole interactions, dipole-dipole interactions, hydrogen bonding, cation-π-interactions, π-π-interactions, Van der Waals interactions, hydrophobic effect, and metal-coordination bonds.

   (3 hours)
2. Hosts for cationic, anionic and neutral guests.

   (3 hours)
3. Synthetic considerations: kinetic and thermodynamics of supramolecular assemblages, programmed supramolecular systems.

   (3 hours)
4. Supramolecular architecture, receptor design principles, supramolecular chirality.

   (2 hours)
5. Applications: molecular switches and sensors, supramolecular photochemistry, light-powered nanoscale electronic devices, mechanical machines, supramolecular reactivity, organocatalysis.

   (4 hours)

Method of Assessment:

One hour theory paper and assignments.

Learning Outcomes:

- Explain the fundamental concepts of supramolecular chemistry.
- Critically analyze current research.
- Assess the applicability of supramolecular assemblages.

Recommended Text Books:

1. Supramolecular Chemistry, Concepts and Perspectives by Jean-Marie Lehn, VCH, 1995.

Course Title	**:** Molecular Modeling and Computational Chemistry
Course Code	**:** CHE 492 1.0
Number of Lecture Hours	**:** 15
Number of Tutorial Hours	**:** 03
Lecturer in Charge	**:** Dr. R. S. Jayakody

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Objectives:

- To introduce the basic concepts and principles in Molecular Visualization, Molecular Modeling and Computational Chemistry. The course is designed for Chemistry students with no background in computational chemistry. Molecular Graphics, Drawing, 3D visualization, Molecular Building, Property calculations and dynamics of molecules will be covered. Both quantum mechanical and molecular mechanical methods are covered. Students will also become familiar with different soft ware packages including NWCHEM, VMD, GROMACS, GAUSSIAN, PYMOL, AVOGADRO etc.

Course Content:

1. What is Computational Chemistry - an overview of the course.

   (1 hour)
2. Molecular graphics and Visualization- generating 2D structures and 3D structures, different rendering modes, introduction of visualization software.

   (1hour)
3. Introduction to Molecular Modeling (differentiate FF an Electronic Structure /ab-initio methods), Molecular Builders (ArgusLab and Avogadro)

   (1 hour)
4. Challenges in Molecular Modeling - an overview
   system size , static properties vs Dynamics, accuracy of the results, computer time, scaling of the computer codes, super computers / High performance Computing and Parallel computing, storage issues, problems of the models, is your modeling task realistic?

   (1 hour)
5. Molecular Mechanics / Force Field Methods: introduction to FF methods and different FFs (CHARMM, AMBER) detailed description of classical treatment of chemical systems in FF methods.

   (3 hours)

6. Potential Energy Surface, Energy Minimization and Minimization algorithms. (1hour)
7. Introduction to Molecular Dynamics - application of F=*ma* (Newton's law of motion) to chemical systems to mimic their dynamics. Different integrators (Leap frog & Verlet) and their pluses and minuses. Why Dynamics? Calculation and analysis of time evolutionary properties. (2 hours)
8. Monte Carlo Method: Principles, conformational search, simulated annealing with MC. (1 hour)
9. Introduction to Semi-Empirical Methods: introduction to SE method and AM1 calculations with ArgusLab. (1 hour)
10. Ab-Initio Methods: Basis sets, HF-theory principles and application. Treatment of electron correlation: Moller-Plesset and Coupled-Cluster methods. (2 hours)
11. Introduction Density Functional Theory: DFT method and its applications. (1 hour)

Method of Assessment:

1 hour end of unit examination.

Learning Outcomes:

- Identify and apply various Molecular graphics tools.
- Ability to identify the correct computational tool for a given chemical problem.
- The student should be able to carry out simple calculations such as energy minimization, geometry optimization and molecular dynamics simulation.
- Demonstrate a higher level of competence dealing with various electronic structure methods.
- Use computational chemistry as a tool to effectively address the chemistry problems.

Recommended Text Books:

1. Introduction to Computational Chemistry, Jensen F., John Wiley & Son 2006.
2. Essentials of Computational Chemistry: Theories and Models, Christopher J. Cramer, John Wiley & Sons, 2005.

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Course Title	**:** Chemistry of Atmosphere and Water
Course code	**:** CHE 493 1.0
Number of lecture hours	**:** 15
Number of tutorial hours	**:** 03
Lecturer in Charge	**:** Dr. C. D. Jayaweera

Objectives:

- To give an understanding of the atmosphere, aerosols and cloud formation

Course content:

1. The atmosphere - Climate, Layers, pressure and temperature in the atmosphere, expressing the amount of a substance in the atmosphere, Temporal and spatial scales of atmospheric processes, atmospheric life time. (2 hours)
2. Chemistry of the atmospheric aqueous phase. (2 hours)
3. Properties of the atmospheric aerosols. (2 hours)
4. Dynamics of single aerosol particles. (2 hours)
5. Thermodynamics of atmospheric aerosol systems.
   H_2SO_4 - NH_3 - H_2O system, NH_3 - HNO_3 - H_2O system, H_2SO_4 - NH_3 - H_2O system (3 hours)
6. Interaction of aerosols with radiation. (1 hour)
7. Inorganic aerosols in the atmosphere. (1 hour)
8. Nucleation. (2 hours)
9. Cloud Chemistry. (2 hours)

Learning outcomes:

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

- Understand the formation, growth, dynamics and properties of aerosols
- Know the formation and chemistry of clouds
- Gain understanding of the science underlying the description of atmospheric processes

Recommended Textbooks:

1. Atmospheric Chemistry and Physics, John H. Seinfeld and S. N. Pandis, John Wiley and Sons, Inc., 2006.

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