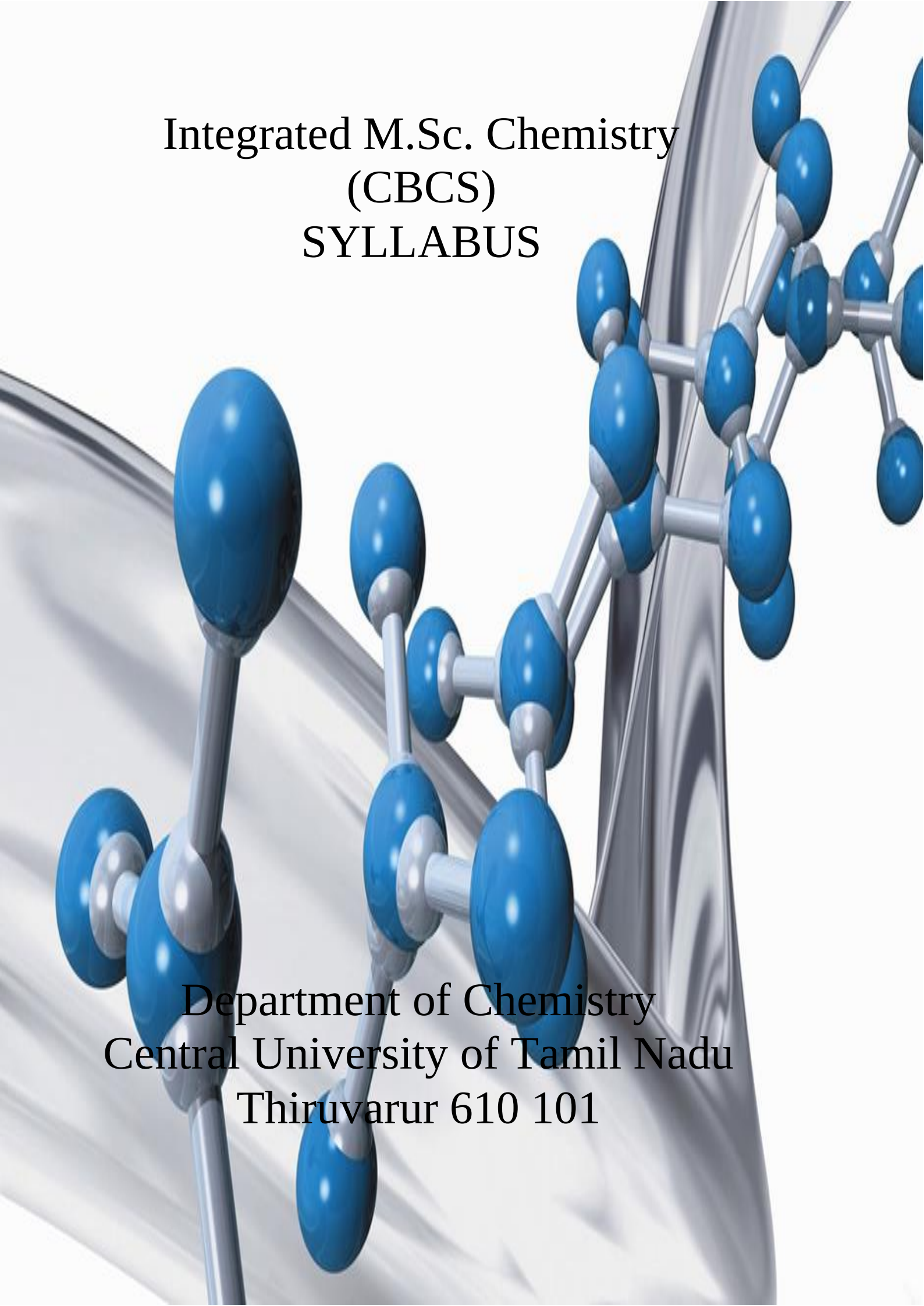
Integrated M.Sc. Chemistry
(CBCS)
SYLLABUS



Department of Chemistry
Central University of Tamil Nadu
Thiruvarur 610 101

Name of the course	:	**Integrated M. Sc. (Chemistry)**
Duration	:	10 semesters
Intake	:	30
Eligibility	:	Plus two examination or equivalent of any recognized board in India with 60% marks (Chemistry, Mathematics, Physics and Computer Science/Biology) for general category, 55% marks for OBC (Non-creamy layer) and 50% marks for SC/ST candidates. The candidates should not have completed 20 years of age as on 01-07-2015.

Course Structure

The five year program is spread into ten semesters where in first four semesters are designed for broad subject based understanding. Later six semesters will have increased focus on chemistry.

The subject courses in the early stage of iM.Sc programme are simplified and of basic level that bolsters the inter-disciplinary way of learning. The third and subsequent year courses have been designed on advanced theories in chemistry with emphasis on concurrent modern laboratory techniques. Further the iM.Sc (Chemistry) programme has been included with experiments that provide exhaustive hands on experience on various sophisticated instruments, experimental techniques to enable the students secure jobs in corporate. The final semester is dedicated to specialization within the subject with research level training.

The rules and regulations of Choice Based Credit System (CBCS) are applicable to this program. Generally, a student takes ten semesters to complete the program. The courses offered under CBCS, has certain credit number (2, 3 or 4). Core requirements of the programs are clearly defined. In the first two years of the program, a student has common course load with students from other departments. From fifth semester onwards, students will have courses more tuned towards chemistry. Apart from courses offered by the Department of Chemistry, student shall take prescribed number of elective courses either from parent department or from other departments

CENTRAL UNIVERSITY OF TAMIL NADU, THIRUVARUR
iM.Sc. CHEMISTRY SYLLABUS CREDIT DISTRIBUTION

Course Code	Title of the Course	Credits
CY1101	General Chemistry I	3
CY1201	General Chemistry II	3
CY1202	General Chemistry Practical – I	2
CY2101	General Chemistry III	3
CY2102	General Chemistry Practical – II	2
CY2201	General Chemistry IV	3
CY2202	General Chemistry Practical – III	2
CY3101	Acids, bases and compounds of p-block elements	3
CY3102	Nucleophiles, selected rearrangements and simple heterocycles	3
CY3103	Thermodynamics, kinetics and electrochemistry	3
CY3104	Analytical and Inorganic Chemistry Laboratory	3
****	**ELECTIVE**	**3**
CY3201	Metallurgy, solid state chemistry and coordination chemistry	3
CY3202	Carbanions, functional groups and natural products	3
CY3203	Chemical kinetics and soft matter	3
CY3204	Physical Chemistry Laboratory I	3
CY3205	Organic Chemistry Laboratory I	3
****	**ELECTIVE(x 2)**	**6**
CY4101	Crystal packing and Coordination Chemistry	4
CY4102	Stereochemistry, aromaticity and heterocycles	4
CY4103	Quantum chemistry and group theory	4
CY4104	Advanced Organic Chemistry Laboratory I	3
****	**ELECTIVE(x 2)**	**6**
CY4201	Photochemistry, pericyclics and rearrangements	4
CY4202	Quantum chemistry and molecular spectroscopy	4
CY4203	Advanced Physical Chemistry Laboratory I	3
****	**ELECTIVE(x 2)**	**8**
CY5101	Bio-inorganic chemistry and inner transition elements	4
CY5102	Statistical thermodynamics, chemical kinetics and electrochemistry	4
CY5103	Seminar and Literature Review	3
CY5104	Advanced Inorganic Chemistry Laboratory I	3
****	**ELECTIVE(x 2)**	**7**
CY5201	Research Project	6
****	**ELECTIVE**	**3**
TOTAL CREDITS		**124**

Course code:

CY – Chemistry, First digit – year of study, second digit – odd or even semester, last two digit - course number; CYE – Chemistry Elective; the numbers signifies the elective number

Semester: 1

Subject Code: CY1101

Title: General Chemistry I

Credits: 3 **3-0-0-3**

Specific objectives:

To introduce the basic principles of organic and inorganic chemistry

Learning outcomes:

Ensures students to understand and acquire knowledge on introductory aspects of organic and inorganic chemistry.

Pre-requisite:

Basic knowledge of atomic structure, molecules and valence.

Syllabus:

Electronic Structure and Periodic Properties: Hydrogen atomic orbitals and their description. Quantum numbers – principal, azimuthal, magnetic and spin quantum numbers and their significance - radial and radial distribution functions-angular functions – principles governing the occupancy of electrons in various quantum levels – Pauli's exclusion principle – Aufbau principle –Screening effect– an effective nuclear charge – Hund's rule – (n+1) rule – stability of half-filled and fully-filled orbitals.
Periodic properties – variation of atomic volume, atomic and ionic radii, ionization potential, electron affinity and electronegativity along periods and groups – factors affecting the periodic properties.

Chemical Bonding: Types of bonds - Ionic bond – lattice energy, Born-Haber cycle and Born-Lande equation - Fajan's rule Crystal structures: fcc, bcc and simple cubic lattices. Covalent bond – Lewis octet rule, resonance, VSEPR theory - shapes of simple inorganic molecules containing lone pair and bond pairs of electrons ($BeCl_2$, NH_3, H_2O, PCl_3, XeF_4, SF_4, BrF_5, ClF_5, PCl_5, SF_6, I_3^-), VBT - hybridization, polarity of bonds – Ionic character of covalent bond and electronegativity- coordinate bond. Molecular orbital theory- sigma, pi and delta bonds - diatomic and polyatomic molecules. Intermolecular forces – non-covalent interaction, van der Waals forces and hydrogen bonding.

Introductory Organic Chemistry: IUPAC nomenclature: Alkanes, cycloalkanes, alkenes, alkynes, halogen compounds, alcohols, ethers, aldehydes, ketones and carboxylic acids; Hybridization and geometry of molecules: methane, ethane, ethylene, acetylene; Electronic effects: Inductive – resonance - hyper conjugation and steric effect; Cleavage of bonds: Homolytic and Heterolytic bond fission; Reaction Intermediates and their stability: Carbocations, carbanions and free radicals.

Prescribed Books

1. Whitten, K. W; Davis, R. E; Peck, L; Stanley, G. G; Chemistry, C engage Learning; 9th edition, 2009.
2. Chang, R.; Goldsby, K. Chemistry, Mc-Graw Hill, 11th edition, 2012.
3. Mahan, B. H.; Myers, R. J. University Chemistry, Benjamin-Cummings Publishing Company; 4th Sub edition, 2000.
4. Morrison, R. T.; Boyd, R. N.; Organic Chemistry, 6th edition, 2000.
5. Lee, J. D. Concise Inorganic Chemistry, Blackwell Science, 5th edition, 1996.
6. Atkins, P. W. Paula, J.; Physical Chemistry, Oxford Publications, 8th edition, 2009.
7. Sharpe, A.G. Inorganic Chemistry, 3rd Edition, Pearson, 2010.

Reference Books

1. Shriver, D. Atkins, P. W.; Inorganic Chemistry, W. H. freeman and Company, 5th edition, **2009.**
2. Miessler, G. L. Tarr, D. A. Inorganic Chemistry, Prentice Hall, 5th edition, **2013.**
3. Rao, C. N. R. *Understanding Chemistry*, University Press (India) Ltd., **2001**.
4. Huheey, J. E. Keiter, E. A. Keiter, R. L. Inorganic Chemisry - Principles of Structure and Reactivity, Pearson Education, 4th edition, **2006.**
5. Douglas, B. McDaniel, D. Alexander, J. Concepts and Models of Inorganic Chemistry, 3rd edition, John Wiley & Sons, **2010.**
6. Volhardt, K.P. C. Schore, N. E. Organic Chemistry, W. H. Freeman and Company, **1990.**
7. Pine, S. H. Organic Chemistry, Tata McGraw Hill, 5th edition, **2008.**
8. Finar, I. L. Organic Chemistry, Pearson education India, 6th edition, *vol-1*, **2011.**

Semester: 2

Subject Code: CY1201

Title: General Chemistry II

Credits: 3 **3-0-0-3**

Specific objectives:

To introduce fundamental aspects of physical chemistry

Learning outcomes:

Ensures the students to understand and acquire knowledge on introductory aspects of physical chemistry topics such as thermodynamics, equilibria, solutions and electrochemistry

Pre-requisite:

Knowledge on molecules, orbitals, valance, bonding and in basic mathematics

Syllabus:

Chemical Thermodynamics: Introduction, Laws of thermodynamics – zeroth and first, energy and enthalpy, spontaneity, entropy and free energy.

Equilibria: Chemical, Ionic and Phase: Chemical equilibrium; law of mass action; K_p, K_c and K_x; Le Chatelier's principle, solubility product, Concepts of a strong, weak acids and bases; pH scale; Henderson-Hasselbach equations; Buffer solutions, Acid-base indicators; Phase Equilibria - Phase, Components, Degree of freedom, Phase rule, one component system and two component system.

Solution: Ideal solutions and Raoults law; Henrys law; colligative properties, completely miscible and partially miscible binary liquids, van't Hoff equation and van't Hoff factor.

Chemical Kinetics: Rate of reaction and rate laws; molecularity and order of reactions – zero, first, second and pseudo first order reactions. Collision theory, ARRT, Arrhenius equation.

Electrochemistry: Arrhenius theory of electrolytic dissociation, classification of electrolytes Conductance concepts; Cell constant; Galvanic cells, Applications of conductance measurements.

Prescribed Books

1. Silbey, R. J.; Albert , R. A.; Bawendi, M. G.; Physical Chemistry, Wiley, 4th edition, **2004.**
2. R. Chang, Chemistry, Tata-McGraw Hill, 1st Indian Edition, **2007**.
3. Atkins, P. W.; Paula, J.; Physical Chemistry, Oxford Publications, 8th edition, **2009**.

Reference Books

1. Castellan, G. W.; Physical Chemistry, Narosa Publishing House, 3rd edition, **2004.**
2. Kapoor K. L.; Textbook of Physical Chemistry: Thermodynamics and Chemical Equilibrium, Vol 3, 2nd edition, Macmillan Publishers India Ltd, **2009**.
3. Raff, L. M.; Principles of Physical Chemistry, Prentice Hall, **2001.**
4. Laidler, K. L.; Chemical Kinetics, Pearson Education Inc, 3rd edition, **2011.**
5. McQuarrie, D. A.; Simon, J. D.; Physical Chemistry: A Molecular Approach, University Science Books, **2011.**
6. Levine, I. N.; Physical Chemistry, McGraw-Hill Science/Engineering/Math, 6th edition, **2008.**
7. Shillady, D.; Essentials of Physical Chemistry, CRC Press, **2012.**

Semester: 2

Subject Code: CY1202

Title: General Chemistry Practical – I

Credits: 2 **0-0-3-2**

Specific objectives:

To introduce the basic chemistry skills through qualitative and quantitative analytical experiments.

Learning outcomes:

Ensures the students to understand the concepts of qualitative analysis, quantitative analysis and basic chemistry laboratory skills.

Pre-requisite:

Basic knowledge in chemistry, stoichiometry, and balancing equations.

Syllabus:

1. Demonstration and concept of good lab practices including safety, glassware handling, chemical nature understanding, chemical handling, chemical /glassware waste management, Error Analysis, notebook maintenance.

2. Calibration and handling of balances, pipettes and burettes, basic principles and experiments related to sample and reagent preparation: practical concept of Molarity, Molality, Normality, equivalence, weight %, vol. %, Preparation of standard solutions.

I. Acidimetry and Alkalimetry

1. Estimation of NaOH using standard Na_2CO_3 solution and link HCl solution
2. Estimation of HCl using standard H_2SO_4 solution and link NaOH solution

II. Permanganometry

3. Estimation of FAS (Mohrs salt) using standard FeSO4 solution and link KMnO4 solution
4. Estimation of hydrogen peroxide using standard oxalic acid solution and link KMnO4 solution

III. Iodo and Iodimetry

5. Estimation of copper by using standard $K_2Cr_2O_7$ solution and link Sodium thiosulphate solution

IV. Complexometric

6. Estimation of zinc by using standard zinc sulphate solution and link EDTA solution

Qualitative Analysis

Semi-micro analysis of a mixture containing two anions (Interfering anions) and two cations.

Reference Books

1. Jeffery, G. H., Bassett, J., Mendham, J., Denney, and R. C., Vogel's quantitative chemical analysis, 5th edition, Longman Scientific and Technical, **1989**.
2. Svehla, G: *Vogel's qualitative inorganic analysis*, 7th Edition, Prentice Hall, **1996**
3. Mendham, J., Denney, J. C., Barnes, J. D., and Thomas, M. J. K., : *Vogel's Prescribed book of qualitative chemical analysis*, 6th Edition, Prentice Hall, **2000**.
4. Morris Hein, Judith N. Peisen and Robert L. Miner, Foundations of College Chemistry in the Laboratory, John Wiley and Sons, **2011**
5. Woollins, J. D; *Inorganic experiments*, 3rd Edition, Wiley-VCH Verlag GmbH Co. **2012**.

Semester: 3

Subject Code: CY2101

Title: General Chemistry III

Credits: 3 **3-0-0-3**

Specific objectives:

To introduce the principles and fundamental aspects of inorganic chemistry.

Learning outcomes:

Ensures the students to understand and acquire knowledge on redox processes, nuclear chemistry and the chemistry of alkali and alkaline earth metals.

Pre-requisite:

Basic idea in chemical bonding, electronegativity and periodic properties**.**

Syllabus:

Oxidation and Reduction Reactions: Oxidation and reduction reactions – oxidation number concept, balancing redox equations by oxidation number method and ion-electron method – equivalent weight of oxidizing and reducing agents

Nuclear Chemistry: Introduction – composition of nucleus and nuclear forces. Nuclear stability – n/p ratio, mass defect, binding energy, packing fraction and magic numbers, shell and drop models. Isotopes – detection and separation. Isotopic constitution of elements and

whole number rule. Deviation of atomic weights from whole numbers. Isobars, isotones and isomers.

Radioactivity and Nuclear Transformations: Radioactivity – discovery, detection and measurements (Wilson cloud chamber). Radioactive emanations. Disintegration theory – modes of decay – Group displacement law – Rate of disintegration – Half life and average life – Radioactive series. Nuclear transformations – use of projectiles – nuclear reactions – fission and fusion. Nuclear reactors.

Hydrogen, Hydrides and Alkali and Alkaline Earth Metals: Hydrogen: Electronic structure, abundance, preparation and properties, isotopes, ortho- and para hydrogen. Hydrides: ionic, covalent, metallic and intermediate hydrides; Hydrogen bonding. Alkali metals: Introduction, halides, oxides and hydroxides, salts of oxoacids and aqueous solution chemistry. Alkaline earth metals: Introduction, halides, oxides and hydroxides, salts of oxoacids, and aqueous solution chemistry

Prescribed Books

1. Lee J. D., Concise Inorganic Chemistry, 5th Edition, Blackwell Science, **1996**.
2. Sharpe G., Inorganic Chemistry, 3rd Edition, Pearson, **2010**
3. Atkins P., Overton T., Rourke J., Weller M., and Armstrong F., Inorganic Chemistry, 5th Edition, Oxford University Press, **2010**.
4. Arnikar, H. J., Essentials of Nuclear Chemistry, 4th edition, New Age International Publishers Ltd., New Delhi, 1995.
5. Loveland, W. D., Morrissey, D. J., Seaborg, G. T., Modern Nuclear Chemistry, Wiley-VCH Verlag GmbH Co. KGaA, 2006.
6. Huheey, J. E., Keiter, E. A., Keiter, R. L., and Medhi, O. K.; Inorganic Chemistry - Principles of Structure and Reactivity, 4th edition, Pearson Education, 2006.
7. Glasstone, Source Book on Atomic Energy, 3rd edition, Affiliated East West Press, 1979.

Reference Books

1. Greenwood N. N. and Earnshaw A., Chemistry of the Elements, 2nd edition, Elsevier, **2005**.
2. Housecraft C. E. and Sharpe A. G., Inorganic Chemistry, 4th edition, Pearson, **2012**.
3. Chang R., Chemistry, 1st Indian edition, Tata-McGraw Hill, **2007**.
4. Douglas B., McDaniel D. and Alexander J., Concepts and Models of Inorganic Chemistry, 3rd edition, John Wiley & Sons, **2010**.
5. Cotton F. A., Wilkinson G., Murillo C. A. and Bochmann M., Advanced Inorganic Chemistry, 6th edition, John Wiley & Sons, **2008**.

Semester: 3

Subject Code: CY 2102

Title: General Chemistry Practical – II

Credits: 2 **0-0-3-2**

Specific objectives:

To introduce the basic concepts of physical chemistry through simple physical chemistry experiments.

Learning outcomes:

Ensures the students to understand the concepts in physical chemistry and to measure the important physico-chemical properties through various experimental methods.

Pre-requisite:

Basic knowledge in basic physical chemistry.

Syllabus:

1. Understanding error, accuracy and precision by measuring physical parameters
2. Determination of physical properties of materials.
3. Experiments involving colligative properties, chemical equilibria, chemical kinetics and electrochemistry.

Reference Books

1. Halpern, A. M., and McBane, G. C. Experimental Physical Chemistry: A Laboratory Prescribed Book, W. H. Freeman, 3rd edition, **2006.**
2. Hein, M.; Peisen, J. N., and Miner, R. L. Foundations of College Chemistry in the Laboratory, John Wiley & Sons Inc., **2011.**
3. Dave, R. K. Experiments in Physical Chemistry, Campus Books International, **2011.**

Semester: 4

Subject Code: CY 2201

Title: General Chemistry IV

Credits: 3 **2-1-0-3**

Specific objectives:

To introduce the basic organic reactions, reaction mechanisms, stereochemistry and aromaticity.

Learning outcomes:

Ensures the students to understand and acquire knowledge on basic organic reactions and mechanisms involved in organic synthesis. Students also learn about basic stereochemistry and aromaticity.

Pre-requisite:

Knowledge in introductory organic chemistry.

Syllabus:

Basic Organic Chemistry: Alkanes: preparation by reduction of alkyl halides, Wurtz reaction and Kolbe's electrolytic method with mechanism; Alkenes: preparation by dehydration of alcohols, dehydrohalogenation of alkylhalides, dehalogenation of vicinal dihalides and by Kolbe's electrolytic method; Alkynes: Preparation by dehydrohalogenation of vic-dihalides and gem-dihalides, dehalogenation of tetrahalides; Cycloalkanes, preparations and properties.

Reactions: Mechanism of free radical halogenation of alkanes, Addition reactions with halogens, hydrogen halide (Markovnikov's rule, peroxide effect), hydroboration, ozonolysis, hydroxylation with KMnO4, allylic substitution by NBS; Types of dienes - Conjugated dienes: 1,3-butadiene-preparation, stability- 1,2 & 1,4 - addition, Diels- Alder reaction.

Stereochemistry: Introduction, Concept of Isomerism, Classification of Stereoisomers, Optical isomerism, Chirality & elements of symmetry, Wedge formula, Fischer projection, Newman projection. Relative and absolute configurations, sequence rules, D & L, R & S systems of nomenclature. Understanding with examples for enantiomers, meso form, diastereoisomers, inversion, retention, and racemization. Geometrical Isomerism: About C=C, E-Z notation- determination of configuration. Conformational analysis: Ethane, 1,2 – dihalo and dihydroxyethanes and butane.

Aromaticity and Aromatic substitutions: Introduction to Aromaticity, Basic aspects of Aromaticity, Huckel's rule, aromaticity of benzenoid compounds. Electrophilic substitution reactions, directing groups, orientation and reactivity.

Prescribed books

1. Morrison R. T., Boyd R. N. and Bhattacharjee S. K., *Organic Chemistry*, Seventh Edition, Pearson Prentice Hall, **2011**.
2. Finar I.L., *Organic Chemistry, Volume 1, 6th edition, Pearson education India*, **2011**.
3. Carey, F.A., and Sundberg R.J., Advanced Organic Chemistry, Part A: Structure and Mechanisms, 5thedition, **2007**.
4. Nasipuri, D., *Stereochemistry* of Organic Compounds: Principles and Applications, 4th edition, New Academic Science Publisher. **2012**.
5. Ernest L Eliel, Samuel H. Wilen, Stereochemistry of organic compounds, Wiley India edition, **2008**.

Reference books

1. Peter K., Vollhardt, C., and Schore N. E., *Organic Chemistry*, W. H. Freeman and Company, **2010**.
2. Pine S. H., *Organic Chemistry*, Tata McGraw Hill, 5th edition, **2008**.
3. R. Chang, Chemistry, 1st Indian Edition, Tata-McGraw Hill, **2007**.
4. Guidebook to Mechanism in Organic Chemistry (6th Edition), Peter Sykes, Longman Scientific & Technical, **1985**.
5. March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, Michael B. Smith, Jerry March John Wiley & Sons, 6th edition, **2007**.

Semester: 4

Subject Code: CY 2202

Title: General Chemistry Practical – III

Credits: 2 **0-0-3-2**

Specific objectives:

To introduce the basic concepts of organic chemistry, such as purification techniques, one step synthetic preparations and qualitative analysis of organic compounds through simple experiments.

Learning outcomes:

Students will be exposed to hands on experience to an introductory level of synthetic organic chemistry lab. Trained in the purification techniques, identification of functional groups and preparation of simple organic compounds.

Pre-requisite:

Knowledge in basic thermodynamics, and writing reaction mechanisms

Syllabus:

1. Melting point determination.
2. Crystallization, decolourization using charcoal.
3. Qualitative analysis of simple organic compounds.
4. Single step preparation of organic compounds.

Reference Books

1. Vogel's Practical Organic Chemistry, 5th edition, Pearson Publishers.
2. Experimental Organic Chemistry Vol. 1 and 2, Singh, P. R., Gupta, D. S., Bajpai, K. S., Tata McGraw Hill.
3. Bansal R. K., Laboratory Manual in Organic Chemistry, New Age International Pvt Ltd Publishers, **2009.**
4. Monograph on Green Chemistry Laboratory Experiments, Ranu, B. C., (Ed.) Green Chemistry Task Force Committee, DST, New Delhi, **2012**.

Semester: 5

Subject Code: CY3101

Title: Acids, bases and compounds of p-block elements

Credits: 3 **3-0-0-3**

Specific objectives:

To introduce the basic inorganic chemistry concepts and the properties of the Boron, Carbon, Nitrogen, Oxygen family compounds.

Learning outcomes:

Ensures the students to understand basic principles of inorganic chemistry. In addition to the principles and concepts, the students will learn the synthetic chemistry and properties of various compounds from Boron group, Carbon group and Noble gases group.

Pre-requisite:

Knowledge in chemical bonding, periodic properties, and basic thermodynamics.

Syllabus:

Acids and Bases, Chemistry in Aqueous and Non-aqueous Solvents: Theory of Acid-bases: Bronsted-Lowry theory, Lewis theory, Lux-Flood definition, Usanovich definition, HSAB theory and symbiosis - Gas phase acid-base chemistry – Solvent levelling effects. Chemistry in aqueous and Non-aqueous Solvents - super acids - molten salts.

Boron Group: Introduction; oxidation states, hydrides, halides, oxides, oxo acids, hydroxides, oxoanions, nitrogen and phosphorous derivatives. Al, Ga, In and Tl salts of oxoacids and aqueous solution chemistry, organometallic compounds.

Carbon Group: Introduction; allotropes of carbon, Intercalation compounds of graphite; hydrides, carbides, silicides, halides, oxides, oxo acids, hydroxides; silicates; silicones, cyanogen, its derivatives and silicon nitride; aqueous solution chemistry and oxoacid salts of Sn and Pb.

Nitrogen Group: Introduction; oxidation states, hydrides; halides; oxides; oxo acids; salts of oxo acids; oxo anions; hydroxides; nitrides, phosphides and arsenides; Phosphazenes; aqueous solution chemistry; organic derivatives.

Oxygen Group and Halogen Family: Oxygen group: Introduction – Hydrides; Halides, Oxohalides and complex halides – Oxides, Oxoacids and their salts – Sulphur-nitrogen compounds – Aqueous solution chemistry of S, Se and Te – Organic derivatives. Halogen family: comparative study of halogens and their compounds – Oxides and oxoacids of halogens (structure only) – Basic properties of halogens – Inter-halogen compounds – preparation, properties and uses – Pseudohalogens – Preparation, properties and uses of cyanogens and thiocyanogen comparison with halogens – Anomalous properties of fluorine.

Noble gases: Introduction – compounds of Xe, Kr and Rn – Preparation, structure and bonding – Reactivity

Prescribed Books

1. Huheey J. E., Keiter E. A. and Keiter R. L. and Medhi O. K., Inorganic Chemistry - Principles of Structure and Reactivity, 4th edition, Pearson Education, 2006.
2. Atkins P., Overton T., Rourke J., Weller M. and Armstrong F., Inorganic Chemistry, 5th edition, Oxford University Press, 2010
3. Lee J. D., Concise Inorganic Chemistry, 5th Eeition, Blackwell Science, 1996.
4. Miessler G. L. and Tarr D. A., Inorganic Chemistry, 3rd edition, Pearson, 2004.
5. Sharpe A. G., Inorganic Chemistry, 3rd edition, Pearson, 2010

Reference Books

1. Greenwood, N. N., and Earnshaw, A., Chemistry of the Elements, 2nd edition, Elsevier, 2005.
2. Housecraft, C. E. and Sharpe, A. G., Inorganic Chemistry, 4th edition, Pearson, 2012.
3. Massey, A. G., Main Group Chemistry, 2nd edition, John and Wiley & Sons, LTD, 2000.

4. Cotton, F. A., Wilkinson, G., Murillo, C. A. and Bochmann, M.; Advanced Inorganic Chemistry, 6th Edition, John Wiley & Sons, 2008.
5. Douglas, B., McDaniel, D. and Alexander, J., Concepts and Models of Inorganic Chemistry, 3rd Edition, John Wiley & Sons, 2010.

Semester: 5

Subject Code: CY3102

Title: Nucleophiles, Selected Rearrangements and Simple Heterocycles

Credits: 3 **3-0-0-3**

Specific objectives:

To introduce the basic organic reaction mechanisms, rearrangements and biomolecules.

Learning outcomes:

Ensures the students to understand and acquire knowledge on basic organic reaction mechanisms, synthetic transformations by rearrangements, biomolecules and heterocyclic.

Pre-requisite:

Knowledge in reactive intermediates, chemical bonding, and writing reaction mechanism

Syllabus:

Nucleophilic substitutions: Mechanisms for nucleophilic substitution – structural and solvation effects on reactivity – Neighbouring-Group Participation (NGP) – structure and reactions of carbocation intermediates.

Carbanion and other carbon nucleophile: Acidity of hydrocarbons – carbanion character of organometallic compounds – carbanions stabilized by functional groups – enols, enamines and imines – carbanions as nucleophiles in SN2 reactions.

Polar addition and elimination reactions: Addition of hydrogen halides to alkenes – acid catalysed hydration and related addition reactions addition to halogens – sulfenylation and selenylation reactions – addition reactions involving epoxides, E1, E2, E1cb and pyrolytic eliminations.

Rearrangements: Classification – pinacol-pinacolone, benzidine, Beckmann and Bayer-Villiger.

Biomolecules: Chemistry of amino acids and proteins

Heterocycles: Nomenclature – synthesis and reactions of pyrrole, furan, thiophene and pyridine.

Prescribed Book

1. Carey, F.A., and Sundberg, R.J., Advanced Organic Chemistry, Part A: Structure and Mechanisms, 5th edition, **2007**.

Reference Books

1. Morrison, R. T., Boyd R. N., and S. K. Bhattacharjee, Organic Chemistry, 7th edition, Pearson Prentice Hall, **2011**.
2. Pine, S. H., Organic Chemistry, Tata McGraw Hill, 5th edition, **2008**.
3. Smith M. B., and Jerry March, March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, John Wiley & Sons, 6th edition, 2007.
4. Finar I. L., Organic Chemistry, Vol. I & II, 5th edition, Longman Ltd., New Delhi, 1975.
5. Peter Sykes, Guidebook to Mechanism in Organic Chemistry (6th edition), Longman Scientific & Technical, 2003.
6. Joule, J.A., Mills, K, Heterocylic Chemistry, 5th edition, John Wiley and Sons, 2010.
7. Handbook of Heterocyclic Chemistry, 3rd Edition

Semester: 5

Subject Code: CY3103

Title: Thermodynamics, kinetics and electrochemistry

Credits: 3 **3-0-0-3**

Specific objectives:

To introduce the basic thermodynamics chemical kinetics and electrochemistry.

Learning outcomes:

Ensures the students to understand and acquire knowledge on spontaneous and nonspontaneous reactions based on thermodynamic variables. This course also ensure the understanding of kinetics process and electrochemical reactions.

Pre-requisite:

Basic thermodynamics, introductory chemical kinetics, solutions and introductory electrochemistry.

Syllabus:

Chemical Thermodynamics: Introduction to Thermo-chemistry, Kirchhoff's equation and applications: Entropy, entropy changes in reversible and irreversible processes, physical concept of entropy, entropy changes of an ideal gas in different processes, entropy of an

ideal gas, Free energy concept, Gibbs and Helmholtz free energies, variation of free energy with temperature and pressure. Gibbs-Helmholtz equations, Criteria for reversible and irreversible processes based on entropy and free energy. Fundamentals of open and closed systems, partial molar properties, Gibbs-Duhem equations, concepts of activity, fugacity. Third law and concept of absolute entropy.

Solutions: Non-ideal solutions, Azeotropic mixtures. Distillation of miscible and immiscible liquids.

Kinetics: Elementary, parallel, opposing and consecutive reactions, mechanism of complex reactions, chain reactions. Theories of reaction rates: theories of unimolecular and bimolecular reactions, thermodynamic treatment.

Electrochemistry: Reversible and irreversible cells, cell EMF, Reactions in reversible cells, free energy and EMF of reversible cell. Single electrode potential (Nernst equation), Standard electrode potential. EMF of reversible cell from electrode potentials. Types of reversible electrode, reference electrodes. Applications of current and potential measurement. Theory of activity co-efficient of strong electrolytes. Concentration cells – electrode, electrolyte; liquid junction potential, over voltage and few applications.

Prescribed Books

1. McQuarrie, D. A.; Simon, J. D.; Physical Chemistry: A Molecular Approach, University Science Books, **2011.**
2. Silbey, R. J.; Albert , R. A.; Bawendi, M. G.; Physical Chemistry, Wiley, 4thedition, 2004.
3. R. Chang, Chemistry, 1st Indian Edition, Tata-McGraw Hill, 2007.
4. Atkins, P. W.; Paula, J.; Physical Chemistry, Oxford Publications, 8th edition, 2009.

Reference Books

1. Castellan, G. W.; Physical Chemistry, Narosa Publishing House, 3rd edition, **2004.**
2. Kapoor K. L.; Textbook of Physical Chemistry: Thermodynamics and Chemical Equilibrium, Vol. 3, 2nd edition, Macmillan Publishers India Ltd, 2009.
3. Raff, L. M.; Principles of Physical Chemistry, Prentice Hall, 2001.
4. Laidler, K. L.; Chemical Kinetics, Pearson Education Inc, 3rd edition, 2011.
5. Levine, I. N.; Physical Chemistry, McGraw-Hill Science/Engineering/Math, 6th edition, 2008.
6. Shillady, D.; Essentials of Physical Chemistry, CRC Press, 2012.

Semester: 5

Subject Code: CY3104

Title: Analytical and Inorganic Chemistry Laboratory

Credits: 3 **0-1-5-3**

Specific objectives:

To introduce the experimental methods such as volumetric, gravimetric experiments and semi-micro qualitative.

Learning outcomes:

The students will be exposed to the error analysis, principles of chromatography and other advanced instrumentation techniques.

Pre-requisite:

Knowledge in Basic Inorganic chemistry.

Syllabus:

1. Semi-micro qualitative analysis of a mixture containing two common and two rare -- cations.
2. Estimation of inorganic compound in a mixture by Volumetric and Gravimetric analysis.

Reference Books

1. Svehla, G.: *Vogel's qualitative inorganic analysis*, 7th edition, Prentice Hall, **1996**
2. Mendham, J., Denney, R. C., Barnes, J. D., and Thomas, M. J. K.: *Vogel's prescribed book of qualitative chemical analysis*, 6th edition, Prentice Hall, **2000**.
3. Woollins, J. D.; *Inorganic experiments*, 3rd edition, Wiley-VCH Verlag GmbH @Co. KGaA, **2012**.
4. Hein, M., Peisen, J. N., and Miner, R. L.; *Foundations of College Chemistry in the Laboratory*, John Wiley and Sons, **2011**
5. Jeffery G H, Bassett J. Mendham J, Denney R C, *Vogel's Prescribed Book of Inorganic Quantitative Analysis*, Longman, **1984**.
6. A. J. Elias, *A Collection of Interesting General Chemistry Experiments*, Universities Press, Sangam Books Ltd, **2002**.
7. In-house manual prepared by Department of Chemistry, CUTN, Thiruvarur.

Semester: 6

Subject Code: CY 3201

Title: metallurgy, solid state chemistry and coordination chemistry

Credits: 3 **4-0-0-4**

Specific objectives:

To introduce the basic principles in Redox chemistry, solid state chemistry and nuclear chemistry.

Learning outcomes:

Ensures the students to understand basic principles in Redox chemistry, solid state chemistry and nuclear chemistry.

Pre-requisite:

Knowledge in basic inorganic chemistry, and solid state chemistry.

Syllabus:

Solid State Chemistry: Classification of solids – Isotropic and anisotropic crystals. Laws of crystallography representation of planes – Miller indices, space lattice, crystal systems – seven primitive, unit cells –X –ray diffraction – derivation of Bragg's equation – determination of structure of NaCl by Debye Scherrer (powder method) and rotating crystal method determination of Avogadro's number – packing of ions in crystals radius ratio rules and its limitations - discussion of structure of KCl & CsCl – defects in crystals – stoichiometric and non-stoichiometric – methods of growing crystals – from melt and from solution (hydrothermal method, Gel method) .

Coordination Chemistry I: Basic coordination chemistry: ligands, IUPAC nomenclature – coordination geometries, isomerism. Theories of coordination compounds - Werner's theory – Valence band theory and crystal field theory d-orbital splitting (octahedral and tetrahedral only) - spin only magnetic moment – spectrochemical series.

Coordination Chemistry II: Studies of coordination compounds in solution – detection of complex formation in solution – Stability constants – stepwise and over-all formation constants – simple methods (Potentiometric, pH metric and photometric methods) of determining the formation constants - factors affecting stability – statistical and chelate effects – forced configurations.

Metallurgy: Various processes involved in extraction of metals: Concentration of ores – froth floatation, magnetic separation, calcinations, roasting, smelting, flux, aluminothermic process – purification of metals – electrolysis, zone refining, van Arkel de Boer–.Alloys

and their properties. Latimer and Pourbaix diagrams, applications of redox reactions to extraction of elements from their ores: Ellingham diagrams.

Prescribed Books

1. Huheey, J. E., Keiter, E. A., Keiter, R. L. and Medhi, O. K., *Inorganic Chemistry - Principles of Structure and Reactivity*, 4th edition, Pearson Education, **2006**.
2. Atkins, P., Overton, T., Rourke, J., Weller M., and Armstrong, F., *Inorganic Chemistry*, 5th edition, Oxford University Press, **2010**
3. Lee, J. D., Concise Inorganic Chemistry, 5th edition, Wiley-India, **2010**.
4. Azaroff, L.V., Introduction to Solids, Mc.Graw hill, New York. **1960**
5. West, A. R., Solid State Chemistry and Its Applications, John Wiley & Sons, **1984**.
6. Chakrabarty, K., Solid State Chemistry, New Age Publishers, **1996.**

Reference Books

1. Miessler, G. L., and Tarr, D. A., Inorganic Chemistry, 3rd edition, Pearson, **2004**.
2. Gilreath, E. S., *Fundamental concepts of Inorganic Chemistry*', International student's edition. Mcgraw-Hill Kogakusha, Ltd., **1958**.
3. Chatwal G., and Yadu, M.S., 'Co-ordination Chemisty', 1st edition, Himalaya Publishing House, **1992**.
4. Douglas, B., McDaniel, D., and J. Alexander, Concepts and Models of Inorganic Chemistry, 3rd edition, John Wiley & Sons, 2010.
5. Cotton, F. A., Wilkinson, G., Murillo, C. A., and Bochmann, M., Advanced Inorganic Chemistry, 6th edition, John Wiley & Sons, 2008.
6. Day Jr, M. C., and Selbin, J. Theoretical Inorganic Chemistry, Literary Licensing, LLC, 2012
7. Boyer, H. E., and Gall, T. L., Metals Handbook, Desk edition, 1984CY3202

Semester: 6

Subject Code: CY3202

Title: Carbanions, functional groups and natural products

Credits: 3 **4-0-0-4**

Specific objectives:

To introduce the advance organic reaction mechanisms, organic transformation and biomolecules.

Learning outcomes:

Ensures the students to understand and acquire knowledge on advance organic reaction mechanisms, synthetic transformations in organic chemistry, carbohydrates, terpenoids, alkaloids, vitamins and co-enzymes.

Pre-requisite:

Basic idea on functional groups interconversion, and writing reaction mechanism

Syllabus:

Addition, condensation and substitution reactions of aldehydes and ketones: Reactivity of carbonyl compounds towards addition – hydration and addition of alcohols to aldehydes and ketones – condensation reactions of aldehydes and ketones with nitrogen nucleophiles – intramolecular catalysis of carbonyl substitution reactions – addition of organometallic reagents to carbonyl groups – addition to enolates and enols to carbonyl compounds: Aldol addition and condensation reactions, corssed aldol, cannizaro reaction, Perkins reaction.

Organic transformations based on carbanions: Dicarboxylic acids, dicarbonyls, diesters**,** Acidity of α-hydrogens, alkylation of diethyl malonate and ethyl acetoacetate. Synthesis using diethyl malonate and ethyl acetoacetate, Claisen condensation. Knoevenagel condensation, Reformatsky reactions.

Alkaloids and terpenoids: Occurrence, importance, general methods of structural elucidation and biosynthesis.
Alkaloids: Structure and synthesis of nicotine and piperine, morphine, cocaine.
Terpenes: classification, Isoprene rule, structure and synthesis of citral, geraniol and α-terpineol.

Carbohydrates: Structural elucidation of glucose, inter-conversion of aldoses to ketoses and vice-versa, stepping up and stepping down reactions. Epimer, Anomer, optical properties, elementary stereochemistry. Structure of sucrose, maltose, cellulose and starch.

Vitamins and Co-enzymes: structure and biological activity of retinol, riboflavin, ascorbic acid, pyridoxine, lipoic acid, NAD, NADH.

Prescribed Books

1. Carey, F.A., and Sundberg, R.J., Advanced Organic Chemistry, Part A: Structure and Mechanisms, 5th dition, **2007**.
2. March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, Michael B. Smith, Jerry March John Wiley & Sons, 6th edition, **2007**.
3. Thomson, R.H., The Chemistry of Natural Products, Publisher- Springer, Netherlands; 2nd edition. **1993**.

Reference Books

1. Morrison, R. T., Boyd, R. N. and Bhattacharjee, S. K., Organic Chemistry, 7th edition, Pearson Prentice Hall, **2011**.
2. Pine, S. H., Organic Chemistry, Tata McGraw Hill, 5th edition, **2008**.
3. Guidebook to Mechanism in Organic Chemistry (6th Edition), Peter Sykes, Longman Scientific & Technical, **1985**.
4. Grossman, R. B. The Art of Writing Reasonable Organic Reaction Mechanisms, 2nd edition, Springer, **2010**.
5. P.S. Kalsi, Organic Reactions and Their Mechanisms, 1st edition, New Age International Pub., New Delhi, **1996**.
6. Finar, I. L., Organic Chemistry, Vol. I & II, 5th edition, Longman Ltd., New Delhi, **1975**.

Semester: 6

Subject Code: CY3203

Title: Chemical kinetics and soft matter

Credits: 3 **4-0-0-4**

Specific objectives:

To introduce the principle of surface chemistry, macromolecules, colloids, enzyme kinetics and soft matter chemistry.

Learning outcomes:

Ensures the students to understand and acquire knowledge on surface chemistry enzyme kinetics for calculation of Michaelis-Menten constant. This course also ensure the understanding of physico/chemical properties of colloidal particles and scattering properties and gels.

Pre-requisite:

Basic knowledge on surface chemistry, kinetics colloidal chemistry at higher secondary level required.

Syllabus:

Surface Chemistry: Adsorption, Absorption, Types of adsorption, Freundlich-Langmuir adsorption isotherms, BET theory- Surface area determination, catalytic activity at surfaces, transition state theory of surface reactions: rates of chemisorption and desorption, unimolecular and bimolecular surface reactions, comparison of homogeneous and heterogeneous reaction rates, surface heterogeneity, Thermodynamics of surfaces : Gibbs adsorption isotherm, heat and entropy of adsorption.

Enzyme kinetics and catalysis: Enzyme kinetics (steady-state kinetics, pre-steady-state kinetics). Reaction mechanisms (ligand binding; catalytic groups: acid/base, nucleophiles, electrophiles, co-factors, metals and entropic effects). Experimental analysis of catalytic and kinetic mechanisms (spectrometry, stopped flow, isotope effects, structure/reactivity relationships). Experimental data analysis.

Macromolecules: types of polymers, conformation of polymers, number average, weight average molecular weight, determination of molecular mass of macromolecules-viscometry, ultracentrifugation, gel permeation chromatography and light scattering.

Colloids and interface: classification, preparation and purification of colloids; properties of colloidal systems; electrical properties – charge, electrical double layer; DVLO theory, electro kinetic properties: electrophoresis, electro-osmosis; Optical and Physical properties, determination of size of colloidal particles involving microscopy, scattering (ILS, DLS, x-ray, neutron), micelles, emulsions and membranes.
Gels - definition - Thermoreversible and Irreversible physical gels - inorganic gels - Small molecule organo gelators - associating polyelectrolyte gels - electrical behaviors and mechanical responses of polyelectrolyte gels.

Prescribed Books

1. Silbey, R. J.; Albert , R. A.; Bawendi, M. G.; Physical Chemistry, Wiley, 4thedition, **2004.**
2. R. Chang, Chemistry, 1st Indian edition, Tata-McGraw Hill, **2007**.
3. Atkins, P. W.; Paula, J.; Physical Chemistry, Oxford Publications, 8th edition, **2009**.
4. Odian G., Principles of polymer chemistry, 4th edition, Wiley-Blackwell, **2004**.
5. Laidler, K. L.; Chemical Kinetics, Pearson Education Inc, 3rd edition, **2011.**

Reference Books

1. Castellan, G. W.; Physical Chemistry, Narosa Publishing House, 3rd edition, **2004.**
2. Raff, L. M.; Principles of Physical Chemistry, Prentice Hall, **2001.**
3. Levine, I. N.; Physical Chemistry, McGraw-Hill Science/Engineering/Math, 6th edition, **2008.**
4. Shillady, D.; Essentials of Physical Chemistry, CRC Press, **2012.**

Semester: 6

Subject Code: CY 3204

Title: Physical Chemistry Laboratory I

Credits: 3 **0-1-5-3**

Specific objectives:

To introduce experiments in thermochemistry, chemical kinetics, macromolecules, surface chemistry, photochemistry and electrochemistry.

Learning outcomes:

Ensures the students to understand and acquire knowledge on thermochemistry, chemical kinetics, macromolecules, surface chemistry, photochemistry and electrochemistry related calculations.

Pre-requisite:

Knowledge in undergraduate level physical chemistry concepts.

Syllabus:

Experiments involving chemical thermodynamics, chemical equilibria, chemical kinetics and electro chemistry

Reference Books

1. Halpern, A. M.; McBane, G. C. Experimental Physical Chemistry: A Laboratory Prescribed Book, W. H. Freeman, 3rd edition, **2006.**
2. Viswanathan, B.; Raghavan, P. S.; Practical Physical Chemistry, Viva Books, **2010.**
3. Hein, M.; Peisen, J. N.; Miner, R. L.; Foundations of College Chemistry in the Laboratory, John Wiley & Sons Inc., **2011.**
4. Dave, R. K.; Experiments in Physical Chemistry, Campus Books International, **2011.**

Semester: 6

Subject Code: CY3205

Title: Organic Chemistry Lab I

Credits: 3 **0-1-5-3**

Specific objectives:

To introduce the preparations and estimations of organic compounds in the laboratory

Learning outcomes:

Ensures the students to understand, acquire knowledge and hands on experience for preparing various organic compound in two steps and also estimation of various organic compounds by different methods.

Pre-requisite:

Proficiency in qualitative techniques - volumetric methods and lab course.

Syllabus:

Preparations:

Two-step preparations involving acetylation, methylation, condensation, rearrangements and photochemical reactions.

Estimations:

1. Estimation of phenol and aniline - volumetric method.
2. Estimation of glucose by Betrands method.
3. Estimation of methyl ketone – iodimetric method
4. Determination of the percentage or number of hydroxyl groups in organic compounds by acetylation method.
5. Determination of iodine and saponification value of an oil sample.

Reference Books:

1. Vogel, A. I., Elementary Practical Organic Chemistry: Small Scale Preparations, Qualitative Organic Analysis, Quantitative Organic Analysis, Pearson Education, **2011**.
2. Leonard , J., Lygo G. B., Procter, Advanced Practical Organic Chemistry, 3rd edition, CRC press, **2013**.
3. Singh, P. R., Gupta, D. S., and Bajpai, K.S., Experimental Organic Chemistry, Vol. 1 and 2, Tata McGraw Hill, **1981**.
4. Bansal R. K., Laboratory Manual in Organic Chemistry, New Age International Pvt Ltd Publishers, **2009**.

Semester: 7

Subject Code: CY 4101

Title: Crystal packing and Coordination Chemistry

Credits: 4 **4-0-0-4**

Specific objectives:

To introduce the inorganic chemistry concepts and the properties of the main group elements, basic coordination chemistry and inorganic photochemistry.

Learning outcomes:

Ensures the students to understand, concepts and the properties of the main group elements, basic coordination chemistry and inorganic photochemistry.

Pre-requisite:

Knowledge in fundamental Inorganic Chemistry and solid state chemistry.

Syllabus:

The Chemistry of the Main Group Elements: Inorganic Rings, chains and cages - Catenation and Heterocatenation, Heterocyclic ring system- Borazines, Phosphazines-Monomer and Polymer, S-N ring compounds, Homocyclic rings of S, Se and Te. Silicate minerals, Isopolyanions, Boranes: boron cage compounds-*closo, nido, arachno*, carboranes; cage compounds of S and P.

Advanced Solid State Chemistry: Ionic solids, close packing, radius ratio rules, Structures of ionic crystals – AX and AX_2 type crystal structures – layer structures - lattice energy - Born-Lande, Born-Mayer and Kapustinskii equations – Derivations and applications – Decomposition of ionic solids – solubility of ionic solids. Defects and Non-stoichiometric - Intrinsic and extrinsic defects - point, line and plane defects; vacancies, Stoichiometric defects - Schottky and Frenkel defects - Non-stoichiometry – Metal excess and Metal-deficiency. Thermodynamic and structural aspects. n- and p- type semiconductors–photovoltaic cell – Superconductivity.

Theories of Metal-Ligand Bond: VB theory and its limitations – crystal field theory - splitting of d-orbitals under various geometries – factors affecting splitting – CFSE and evidences for CFSE (Structural and thermodynamic effects) – Spectrochemical series – Jahn-Teller distortion - site preferences - limitations of CFT – ligand field theory – MO theory – sigma – and pi-bonding in complexes and evidences for pi-bonding – nephelauxetic effect – angular overlap model.

Coordination Chemistry – Reaction Mechanism: Kinetics and mechanism of reactions in solution – labile and inert complexes – ligand displacement reactions in octahedral and

square planar complexes – acid hydrolysis, base hydrolysis and anation reactions – trans effect – theory and applications. Electron transfer reactions – complementary and non-complementary types – inner sphere and outer sphere processes – Excited state outer sphere electron transfer reactions - isomerisation and racemisation reactions of complexes – reactions of four and six-coordinate complexes – interconversion between stereoisomers.

Prescribed Books

1. Huheey J. E., Keiter E. A. and Keiter R. L. and Medhi O. K., *Inorganic Chemistry - Principles of Structure and Reactivity*, 4th edition, Pearson Education, **2006**.
2. Atkins, P. W.; Paula, J.; Physical Chemistry, Oxford Publications, 8th edition, **2009**.
3. B. Douglas, D. McDaniel and J. Alexander, *Concepts and Models of Inorganic Chemistry*, 3rd edition, John Wiley & Sons, **2010**.
4. F. A. Cotton and G. Wilkinson, *Advanced Inorganic Chemistry*, 3rd ed., Wiley-Eastern Company, New Delhi, **1990**.
5. Azaroff, L.V., Introduction to Solids, McGraw hill, New York. **1960**
6. West, A. R., Solid State Chemistry and Its Applications, John Wiley & Sons, **1984**.
7. Chakrabarty, K., Solid State Chemistry, New Age Publishers, **1996.**
8. Keer, H. V., Principles of the Solid State, Wiley Eastern Limited, **1993**.

Reference Books

1. Day, M. C., and Selbin, J., *Theoretical Inorganic Chemistry*, Affiliated East West Press Pvt. Ltd. 2nd edition, **1985**.
2. Kettle, S. F. A., Physical Inorganic Chemistry – *A Coordination Chemistry Approach*, Spectrum Academic Publishers, Oxford University Press, **1996**.
3. Basolo, F., and Pearson, R. G., *Mechanism of Inorganic Reactions*, John Wiley, New York, **1967**.
4. Miessler, G. L., and Tarr, D. A., *Inorganic Chemistry*, 3rd edition, Pearson, **2004**.
5. Housecraft, C. E., and Alan G. Sharpe, *Inorganic Chemistry*, 4th edition, Pearson, **2012**.
6. Purcell, K. F., and Kotz, J. C., *Inorganic Chemistry*, Cengage Learning, **2012**.
7. Day Jr ,M. C., and Selbin, J, *Theoretical Inorganic Chemistry*, Literary Licensing, LLC, **2012**
8. Wilkinson, G., Gillars, R. D., and Mccleverty, J. A., *Comprehensive Co-ordination Chemistry*, Pergamon Press, **1987**.
9. Wulfberg, G., *Inorganic Chemistry*, University Science Books, **2000**.

Semester: 7

Subject Code: CY 4102

Title: Stereochemistry, aromaticity and heterocycles

Credits: 4 **4-0-0-4**

Specific objectives:

To introduce advanced level study in stereochemistry, aromaticity, heterocyclics and physical organic chemistry.

Learning outcomes:

Ensures the students to understand, acquire knowledge on topicity, asymmetric synthesis, determining the reaction mechanisms by different methods, criteria for aromaticity in non benzenoid molecules and other advanced polycyclic aromatics and the nomenclature and reactions of complex heterocyclic.

Pre-requisite:

Basics knowledge in stereochemistry and physical organic chemistry.

Syllabus:

Advanced Stereochemistry: Configuration - conformation of cycloalkanes, conformation and reactivity -stereochemistry of allenes, spiranes, biphenyls, molecules with chiral planes, Topicity stereoselective and stereospecific reactions - enantioselective reactions - double stereo differentiation, asymmetric synthesis, chiral auxiliaries, chiral catalysts and reagents.

Introductory physical organic chemistry: Thermodynamic stability – general relationship between thermodynamic stability and reaction rates – electronic substituent effects on reaction intermediates – kinetic isotope effects – linear free energy relationships – principles of microscopic reversibility – substituent effects – solvent and solvent effects – methods of determination of reaction mechanism.

Aromaticity: Criteria of aromaticity - Craig's rule – non-benzenoid aromatic compounds – anti-aromaticity, homo aromaticity – fused-ring systems –hetero aromatic systems.
Nucleophilic aromatic substitution reactions – VNS - transition metal- catalyzed aromatic substitution reactions – aromatic substitution reactions involving radical intermediates.

Advanced Heterocycles: Nomenclature, heterocyclics with two hetero atoms – fused five and six membered heterocyclics – preparation and reactions of indole, quinoline, isoquinoline and carbozole.

Prescribed books:

1. Nasipuri, D., *Stereochemistry* of Organic Compounds: Principles and Applications, 4th edition, New Academic Science Publisher. **2012**.
2. Eliel, E. L., and Wilen, S. H. Stereochemistry of Organic Compounds, Wiley, **1994**.
3. F.A.Carey and R.J.Sundberg, Advanced Organic Chemistry, Part A: Structure and Mechanisms, 5thedition, **2007**.
4. Heterocyclic Chemistry- J. A. Joule, K. Mills, G. F. Smith, Blackwell publishing Ltd, 5th edition, **2010.**

Reference books:

1. Morrison, R. T., Boyd, R. N. and Bhattacharjee, S. K., Organic Chemistry, 7th edition, Pearson Prentice Hall, **2011**.
2. Pine, S. H., Organic Chemistry, Tata McGraw Hill, 5th edition, **2008**.
3. Carruthers, W., and Coldham, I., Modern methods of Organic Synthesis, Cambridge University Press, First South Asian edition, **2005**.
4. J. March and M. B. Smith, March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, 6th edition, Wiley, **2007**.

Semester: 7

Subject Code: CY 4103

Title: Quantum chemistry and group theory

Credits: 4 **4-0-0-4**

Specific objectives:

To introduce Quantum chemistry, molecular symmetry and point groups for various molecules.

Learning outcomes:

Ensures the students to understand, acquire knowledge in quantum chemistry and group theory symmetry.

Pre-requisite:

Basic mathematics and physics at the iMSc I **and** II year levels. Preliminary knowledge of symmetry and group theory.

Syllabus:

Quantum Chemistry I: Classical mechanics, black body radiation, uncertainty principle and wave particle duality, wave equation, wave functions, properties of wave functions, Normalization of wave functions, orthogonality of wave functions, one dimensional wave equation, separation of variables for solving wave equation, general solutions to wave equations, two dimensional wave equations.

Postulates of quantum mechanics, Wave function of a particle - Schrödinger equation, Eigen value problem, linear operator's classical mechanical quantities in quantum mechanics, wave function normalization, Particle in one dimensional and three dimensional box, Harmonic oscillator.

Group Theory: A systematic procedure for symmetry classification of molecules. Symmetry elements, symmetry operations, concepts of groups, Sub-groups, classes of symmetry operations, group multiplication tables. Abelian and non-Abelian point groups. symmetry criterion of optical activity, symmetry restrictions on dipole moment, representation of groups, matrix representation of symmetry operations, reducible and irreducible representations, application of orthogonality theorem.

Construction of character tables for point groups C2v, C3v and D2h, structure of character tables, determination of symmetry species for translations and rotations.

Atomic term symbols and electronic configuration for multi electron systems, Russel-Saunders coupling, J-J coupling.

Prescribed Books

1. Cotton, F. A.; Chemical Applications of Group Theory, John Wiley & Sons Inc., 3rd edition, **2009.**
2. Veera Reddy, K., Symmetry and spectroscopy of molecules, New Age International, 2nd edition, **2009**
3. McQuarie, D.; Quantum chemistry, University Science Publishers, **2007.**
4. McQuarie, D. A.; Simon, J. D.; Physical Chemistry: A Molecular Approach, University Science Books, **2011.**

Reference Books

1. Jaffe, H. H.; Orchin, M.; Symmetry in Chemistry, John Wiley & Sons Inc., **2002**.
2. Atkins, P. W.; Paula, J.; Physical Chemistry, Oxford Publications, 8th edition, **2009**.
3. Levine, I. N.; Physical Chemistry, McGraw-Hill Science/Engineering/Math, 6th edition, **2008.**
4. Raff, L. M.; Principles of Physical Chemistry, Prentice Hall, **2001.**
5. I. N. Levine, Molecular Spectroscopy, John Wiley, **1975.**
6. Harris, D. C.; Bertolucci, M. D.; Symmetry and Spectroscopy: An Introduction to Vibrational and Electronic Spectroscopy, Dover Publications, **1989.**
7. Lowe, J. P., Peterson, K.A., Quantum Chemistry, Academic press, **2011**.

Semester: 7

Subject Code: CY 4104

Title: Advanced Organic Chemistry Laboratory I

Credits: 3 **0-1-5-3**

Specific objectives:

To introduce multistep organic synthesis and its spectroscopic analysis, separation and estimation of organic compounds.

Learning outcomes:

Ensures the students to understand, acquire knowledge and have hands on experience in multistep organic synthesis and analysis by using spectroscopic techniques. Separation techniques and functional group analysis.

Pre-requisite:

Knowledge in Single step preparations.

Syllabus:

Multistep organic synthesis- conventional synthesis - microwave assisted synthesis - photochemical reactions. Purification of the compounds using column chromatography and characterization of the compounds using MS, IR, ^{1}H and ^{13}C NMR techniques.

Qualitative Analysis: Separation and analysis of organic mixture containing two components and preparation of suitable derivatives.

Prescribed Books:

1. Singh, P. R., Gupta, D. S., Bajpai, K. S., Experimental Organic Chemistry Vol 1 and 2, Tata McGraw Hill
2. Bansal, R. K., Laboratory Manual in Organic Chemistry, Wiley, **2006**.
3. Vogel , A.I., Tatchell, A.R., Furnis , B.S., Hannaford , A.J., Smith, P.W.G., Vogel's Practical Organic Chemistry, 5th edition, Pearson education Ltd, **1996**.

Reference Books:

1. Leonard, J., Lygo, B., Procter, G., Advanced Practical Organic Chemistry, , 3rd edition, CRC press, **2013**.
2. Singh, P. R., Gupta, D. S., Bajpai, K. S., Experimental Organic Chemistry Vol 1 and 2, Tata McGraw Hill
3. Laboratory Manual in Organic Chemistry, R. K. Bansal, Wiley. **2006**.

   Silverstein, R. M. and Webster, F. X., Spectrometric identification of organic compounds, John Wiley and Sons.Inc., 6th edition, **1997**.

Semester: 8

Subject Code: CY 4201

Title: photochemistry, pericyclics and rearrangements

Credits: 4 **4-0-0-4**

Specific objectives:

To introduce the concepts of photochemistry, pericyclics, rearrangements and name reactions.

Learning outcomes:

Ensures the students to understand, acquire knowledge on Pericyclic reactions, organic photochemistry, molecular rearrangement and name reactions and their further applications in organic synthesis.

Pre-requisite:

Knowledge in basic organic reaction mechanism and orbital symmetry.

Syllabus:

Pericyclic Reactions: Pericyclic reactions – orbital correlation diagram – FMO. Diels-Alder reactions – 1,3-dipolar cycloaddition reactions – [2+2] cycloadditions and related reactions leading to cylcobutanes – [3,3] and [2,3]-sigmatropic rearrangements – unimolecular thermal elimination reactions.

Organic photochemistry: Photochemistry of alkenes, dienes and polyenes – photochemistry of carbonyl compounds – photoreductions, photooxidations and photorearrangement reactions - photochemistry of aromatic compounds.

Molecular Rearrangements: Classification – electrophilic, nucleophilic and free radical rearrangements, mechanisms of the following rearrangements – pinacol – pinacolone, Wagner – Meerwin, Tiffenev-Demjanov, Dienone- Phenol, Favorskii, Hofmann, Schmidt, Lossen, Curtius, Beckmann, Fries, Baeyer –Villager, Stevens, Benzil – Benzilic acid, Brook and Benzidine, sommelet hauser rearrangement, rearrangements.

Selected name reactions in organic synthesis: Wittig Reaction, Baylis-Hillman reaction, Henry reaction, Nef reaction, Kulinkovich reaction, Ritter reaction, Sakurai reaction, Tishchenko reaction and Ugi reaction, nazarov cyclization.

Prescribed books

1. Carey F.A., and Sundberg, R.J., Advanced Organic Chemistry, Part B: Reactions and synthesis, 5th edition , 2007.
2. Fleming, Pericyclic Reactions, Oxford University Press, Oxford, 1999.
3. Mukherjee, S.M. and Singh, S.P., Pericyclic Reactions, MacMillan India, New Delhi.

4. Sankararaman, S., Pericyclic Reactions - Applications and Theory, Wiley – VCH, 2005.
5. Turro , N. J., Scaiano, J. C., and Ramamurthy, V., Modern Molecular Photochemistry of Organic Molecules, University Science Books, 2010.
6. Sanyal and Sanyal, Reactions, Rearrangements and Reagents, Bharati Bhawan Publishers & Distributors; 4th edition, 2003

Reference books

1. Morrison, R. T., Boyd, R. N., and Bhattacharjee, S. K., Organic Chemistry,
2. 7th edition, Pearson Prentice Hall, 2011.Pine, S. H., Organic Chemistry, Tata McGraw Hill, 5th edition, 2008.
3. March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure,Michael B.Smith, Jerry March John Wiley & Sons, 6th edition, 2007.
4. Finar, I. L., Organic Chemistry, Vol. 1 & 2, 5th edition, Longman Ltd., New Delhi, 1975.
5. Guidebook to Mechanism in Organic Chemistry (6th Edition), Peter Sykes, Longman Scientific & Technical, 1985.
6. Mukherjee, S.M., and Singh, S.P., Reaction Mechanism in Organic Chemistry, 1st edition, Macmillan India Ltd., New Delhi, 1990.
7. Lowry, T. H., and Richardson, K. S., Mechanism and Theory in Organic Chemistry, 3rd edition, Addison – Wesley Longman Inc., 1998.

Semester: 8

Subject Code: CY 4202

Title: Quantum chemistry and molecular spectroscopy

Credits: 4 **4-0-0-4**

Specific objectives:

To introduce advanced concepts in quantum chemistry, molecular spectroscopy and photochemistry.

Learning outcomes:

Ensures the students to understand, acquire knowledge on advanced concepts in quantum chemistry, molecular spectroscopy and photochemistry.

Pre-requisite:

Knowledge in basic mathematics, fundamentals of introductory quantum chemistry and properties of electromagnetic radiations.

Syllabus:

Quantum Chemistry II: Rigid rotor, energy levels of a rigid rotor, spherical harmonics, Schrödinger equation for the hydrogen atom – solutions, s orbitals, p orbitals, energy levels of a hydrogen atom in magnetic field, Schrödinger equation for Helium atom. Perturbation theory, Variational methods, Hartree-Fock equations, Self-consistent field methods for solving Hartree-Fock equations, Born-Oppenheimer approximation-molecular Hamiltonian operators, Valence bond treatment for chemical bonding in molecules, molecular orbitals, molecular orbital theory for different diatomic molecular systems, photoelectron spectra, SCF-LCAO-MO wave functions, electronic states of diatomic molecules, sp, sp^2 and sp^3 hybrid orbitals, molecular term symbols, Hückel molecular orbitals, bonding in polyatomic molecules.

Molecular spectroscopy: Characterization of electromagnetic radiation, energy quantization, atomic and molecular spectra, emission and absorption spectra; Fourier transformed spectroscopy, Lasers. Microwave spectroscopy, rotation spectra of di – and poly- atomic molecules; Stark effect; Applications of microwave spectra**.** Vibrational spectra of diatomic molecules; Rotation-vibration spectra of diatomic molecules; Vibrational spectra of diatomic and ploy atomic molecules; breakdown of Born-Oppenheimer approximation. Electronic spectra of diatomic and polyatomic molecules.

Photochemistry: Basics of Photochemistry and Photophysics, Jablonski diagram. Electronically excited states: electronic, vibrational and spin levels, unimolecular and bimolecular photophysical processes. Photochemical reactions and kinetics – energy transfer, electron transfer, excited state quenching – eximer and exiplex.

Prescribed Books

1. McQuarie, D.; Quantum chemistry, University Science Publishers, 2007.
2. McQuarrie, D. A.; Simon, J. D.; Physical Chemistry: A Molecular Approach, University Science Books, 2011.
3. Prasad, R. K.; Quantum Chemistry, New Age International Publishers, 4th edition, 2010.
4. Banwell, C. N.; McCash, E. M.; Fundamentals of Molecular Spectroscopy, Tata McGraw-Hill, 4th edition, 2010.
5. Rohatgi Mukherjee K K, Fundamentals of Photochemistry, Wiley Eastern Ltd., 1992.

Reference Books

1. Raff, L. M.; Principles of Physical Chemistry, Prentice Hall, **2001.**
2. Atkins, P. W.; Paula, J.; Physical Chemistry, Oxford Publications, 8th edition, **2009**.
3. Levine, I. N.; Physical Chemistry, McGraw-Hill Science/Engineering/Math, 6th edition, **2008.**
4. Kreyszig, Advanced Engineering Mathematics, 9th edition, **2012**.
5. Harris, D. C.; Bertolucci, M. D.; Symmetry and Spectroscopy: An Introduction to Vibrational and Electronic Spectroscopy, Dover Publications, **1989.**
6. Turro T J, Ramamurthy V, Scaiano J C, Principle of molecular photochemistry – An Introduction, University Science books, 1st edition, **2008**.

Semester: 8

Subject Code: CY 4203

Advanced Physical Chemistry Laboratory I

Credits: 3 **1-0-5-3**

Specific objectives:

To introduce experiments in thermochemistry, chemical kinetics, macromolecules, surface chemistry, photochemistry and electrochemistry.

Learning outcomes:

The students will obtain hands on experience on the instrumentation and experimental techniques to measure physico-chemical parameters such as thermodynamic, electrochemical, kinetics and equilibrium parameters. Also, will get experience in the analysis and the interpretation of data.

Pre-requisite:

Undergraduate level physical chemistry concepts and calculations. Proficiency on experiments related to thermodynamics, kinetics, catalysis, electrochemistry, spectroscopy characterization methods and macromolecules.

Syllabus:

Advanced experiments on thermodynamics, kinetics, catalysis, electrochemistry, spectroscopy, photochemistry and macromolecules.

Reference Books

1. In-house laboratory manual, Department of Chemistry, CUTN.
2. Halpern, A. M.; McBane, G. C. Experimental Physical Chemistry: A Laboratory Prescribed Book, 3rd ed.; W. H. Freeman, **2006**.

Semester: 9

Subject Code: CY 5101

Title: Bio-inorganic chemistry and inner transition elements

Credits: 4 **4-0-0-4**

Specific objectives:

To introduce the principles of bioinorganic chemistry and advanced nuclear chemistry and the chemistry of f-block elements.

Learning outcomes:

Ensures the students to understand, concepts concepts of Bioinorganic Chemistry, Function and Transport of Alkali and Alkaline earth metals, Metalloporphyrins / Metalloenzymes, Nuclear Chemistry and Inner Transition elements

Pre-requisite:

Knowledge in Inorganic chemistry and coordination chemistry

Syllabus:

General Principles of Bioinorganic Chemistry: Occurrence and availability of Inorganic elements in biological systems. Basics of Biomineralisation.

Function and Transport of Alkali and Alkaline earth metals: Uptake, transport and storage of metal ions by organisms - structure and functions of biological membranes - the generation of concentration gradients (the Na^+ -K^+ pump) - mechanisms of ion-transport across cell membranes – bleomycin - siderophores (e.g. enterobactin and desferrioxamine) - transport of iron by transferring - storage of iron by ferritin - bio chemistry of calcium as hormonal messenger. Metals at the Center of Photosynthesis: Primary Processes in Photosynthesis – Photosystems I and II.

Metalloporphyrins/Metalloenzymes: Dioxygen transport and storage - hemoglobin and myoglobin: electronic and spatial structures - hemeythrin and hemocyanine - synthetic oxygen
carriers, model systems - blue copper proteins (Cu) - iron-sulfur proteins (Fe)-cytrochromes electron transport chain - carbon monoxide poisoning - iron enzymes - peroxidase, catalase and cytochrome P-450, copper enzymes - superoxide dismutase, carboxypeptidase, carbonicanhydrase, vitamin B_{12} and B_{12} coenzymes, nitrogen fixation. Medicinal bioinorganic chemistry: platinum complexes in cancer therapy – cis-platin and its mode of action – metal toxicity.

Advanced Nuclear Chemistry: Radiochemical principles in the use of tracers - applications of radioisotopes as tracers - chemical investigations, analytical applications, agricultural and industrial applications - neutron activation analysis - carbon and rock

dating - use of nuclear reactions - radioisotopes as source of electricity - nuclear medicines. Radiolysis of water and hydrated electron.

Inner Transition elements: Special features of f-block elements, introduction, occurrence, separation, oxidation states, lanthanide contraction, coordination number, structures, and simple reactions. Spectral, Magnetic properties and Analytical applications.

Prescribed Books

1. Lippard, S. J., and Berg, J. M., *Principles of Bioinorganic Chemistry*, Panima Publishing Company, New Delhi, **1997**.
2. Kaim W., and Schewederski, B., *Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life*, John Wiley & Sons, New York, USA, **2013**.
3. Bertini, I., Gray, H. B., Lippard, S. J. and Valentine, J. S., *Bioinorganic Chemistry*, 1st South Asia edition, Viva books Pvt. Ltd., **2007**.
4. Huheey, J. E., Keiter, E. A. and Keiter, R. L., and Medhi, O. K., *Inorganic Chemistry - Principles of Structure and Reactivity*,4th edition, Pearson Education, **2006**.
5. Behrens, P., Bauerlein, E., *Hand Book of Biomineralization*, 1st edition, Vol. 1& 2, Wiley-VCH, **2007**.
6. Arnikar, H. J., Essentials of Nuclear Chemistry, 4th edition, New Age International Publishers Ltd., New Delhi, **1995**.
7. Loveland, W. D., Morrissey, D. J., Seaborg, G. T., *Modern Nuclear Chemistry*, Wiley-VCH Verlag GmbH Co. KGaA, **2006**.
8. Glasstone,'*Source Book on Atomic Energy'*, 3rd edition, Affiliated East West Press, **1979.**
9. Lee, J. D. *Concise Inorganic Chemistry*, Blackwell Science, 5th edition, **1996.**

Reference Books

1. Purcell, K. F. and Kotz, J. C., Inorganic Chemistry, Cengage Learning, **2012**.
2. Cotton, F. A., Wilkinson, G., Carlos A. Murillo, Manfred Bochmann, Advanced Inorganic Chemistry, 6th ed., A Wiley - Interscience Publication, John –Wiley & Sons, USA, **2007**. Chem. Education, 62, No. 11, Bioinorganic Chemistry, State of the Art. **1985.**
2. Eichorn, G. L., Inorganic Biochemistry, Volumes 1 & 2, 2nd ed., Elsevier Scientific Publishing Company, New York, **1973**.
3. Atkins, P., Overton, T., Rourke, J., Weller M., and Armstrong, F., Inorganic Chemistry, 5th edition, Oxford University Press, **2010.**
4. Lehninger, A., Nelson, D. L., Cox, M. M,. Principles of Biochemistry, 5th edition, W.H Freeman, **2008.**
5. Alessio, E., Bioinorganic Medicinal Chemistry, 1st Edition, Wiley-VCH Verlag GmbH Co. KGaA, **2012**.

Semester: 9

Subject Code: CY 5102

Title: Statistical thermodynamics, chemical kinetics and electrochemistry

Credits: 4 **4-0-0-4**

Specific objectives:

To introduce statistical thermodynamics, chemical kinetics and electrochemistry.

Learning outcomes:

The students will acquire knowledge on statistical thermodynamics, advanced chemical kinetics, surface analytical techniques to measure surface properties of materials and the advanced principles of various electrochemical techniques.

Pre-requisite:

Basic knowledge in thermodynamics, chemical kinetics and electrochemistry.

Syllabus:

Statistical Thermodynamics: Statistical entropy, microcanonical and canonical ensembles, Maxwell-Boltzmann distribution, Thermodynamic quantities and canonical partition function, molecular partition functions, translational, rotational, vibrational and electronic partition functions. Ideal monoatomic and diatomic gases. Heat capacities - Einstein theory and Debye theory. Applications of statistical thermodynamics to activated complex theory.

Chemical Kinetics: Enzyme kinetics – Michaelis-Menten kinetics, Multi-substrate reactions, Lineweaver-Burk plot; Kinetics of fast and complex reactions: flow and relaxation methods; ultrafast reactions.

Solids, Surface growth and characterization: Growth and structure of solid surfaces, surface analytical techniques (XPS, Auger) and characterization. Solid solutions, solubility limit, phase rule, binary phase diagrams, intermediate phases, intermetallic compounds, Alloys.

Principles of electrochemistry and techniques: Theory of strong electrolytes; electrified interfaces: theories and models; basics in electro-catalysis and bio-electrochemistry; kinetics of electrode reactions; irreversible electrode processes. Cyclic voltammetry, differential pulse voltametry and square wave voltammetry, polarography, amperometry.

Prescribed Books

1. McQuarrie, D. A.; Simon, J. D.; Physical Chemistry: A Molecular Approach, University Science Books, **2011.**
2. Atkins, P. W.; Paula, J.; Physical Chemistry, Oxford Publications, 8th edition, **2009**.
3. McQuarrie, D. A.; Statistical mechanics, University Science Publishers, **2000.**
4. J.O'M Bockris and A.K.N Reddy, Modern Electrochemistry 2A: Fundamentals of Electrodics, Vol II, **2001**.
5. D. Skoog and D.West , Principles of Instrumental Analysis, Cengage Learning; 6th

edition, **2006**

Reference Books

1. Hill, T. A.; An Introduction to Statistical Thermodynamics, Dover Publications Inc., **1987**.
2. Levine, I. N.; Physical Chemistry, McGraw-Hill Science/Engineering/Math, 6th edition, **2008**.
3. Laidler, K. J.; Chemical Kinetics, Pearson Education, 3rd edition, **2011**.
4. D.R. Crow, Principles and Applications of Electrochemistry, John Wiley & Sons (New York) 2nd edition, **2001.**
5. Bard, A. J.; Faulkner, L. R.; Electrochemical Methods: Fundamentals and Applications, Wiley, 2nd edition, **2000.**

Semester: 9

Subject Code: CY 5103

Title: Seminar and Literature Review

Credits: 3 **1-0-3-3**

Specific objectives:

To introduce the survey of online journals on frontier areas of research and present them on the stage without any difficulty.

Learning outcomes:

Ensures the students to get ready for research in terms of literature in the research areas of their interest.

Pre-requisite:

Comprehension and English speaking ability

Syllabus:

Students are required to take two seminars of one hour duration. 45 minutes presentation and 15 minutes of questions and discussion. Evaluation will be based on content of the material, presentation and depth of knowledge in the topic presented.

The student will be required to make a literature survey for the project that will be carried out in the subsequent semester assigned to a faculty.

Semester: 9

Subject Code: CY 5104

Title: Advanced Inorganic Chemistry Laboratory I

Credits: 3 **0-0-3-3**

Specific objectives:

To introduce multistep inorganic compound synthesis and its spectroscopic analysis, separation and estimation of organic compounds.

Learning outcomes:

Ensures the students to understand, acquire knowledge and have hands on experience in multistep inorganic compound synthesis and analysis by using spectroscopic techniques. Separation techniques.

Pre-requisite:

Single step preparations and course.

Syllabus:

A. Estimation of metal ions using spectrophotometry

B. Synthesis, separation, purification of inorganic compounds and characterization by using various spectroscopic and analytical techniques

Reference Books

1. Elias, A. J., *A Collection of Interesting General Chemistry Experiments*, Universities Press, Sangam Books Ltd, **2002**.
2. Woollins, J. D., *Inorganic experiments*, 3rd edition, Wiley-VCH Verlag GmbH @Co. KGaA, **2012**.
3. Hein, M., Peisen, J. N., and Miner, R. L., *Foundations of College Chemistry in the Laboratory*, John Wiley and Sons, **2011**.
4. Girolami, G. S., Rauchfuss,T. B., and Angelici, R. J., Synthesis and Technique in Inorganic Chemistry: A Laboratory Manual, 3rd edition, University Science Books, **1999**.
5. Jolly, W. L., The Synthesis and Characterization of Inorganic Compounds, Prentice-Hall, Inc.**1970**.
6. In-house Laboratory Manual, Department of Chemistry, CUTN.

Semester: 10

Subject Code: CHE5201

Title: Research Project

Credits: 6 **0-3-12-9**

Research project is carried out under the supervision of a faculty in the chosen field of research by the student. Normally it will be continuation of literature survey carried out from the yester semester.

List of Electives

Course Code	Title of the Course	Credits
CYE001	Principles of Polymer Science	4
CYE002	Principles of Fluorescence Spectroscopy	4
CYE003	Asymmetric Catalysis	4
CYE004	Essentials of Carbohydrate Chemistry	4
CYE005	Organic Electronics	4
CYE006	Photochemistry in Molecules and Materials	4
CYE007	Medicinal Inorganic Chemistry	4
CYE008	Organic Semiconductors	4
CYE009	Advances in Polymer Science	4
CYE010	Advances in Carbohydrate Research	4
CYE011	Advanced Organic Materials and Catalysis	4
CYE012	Chemistry of CH Activation	4
CYE013	Advanced Bio-inorganic Chemistry	4
CYE014	Principles of Biochemistry	4
CYE015	Mathematics for Chemists and biologists	4
CYE016	Electrochemical Energy Systems	4
CYE017	Fundamentals of Analytical Chemistry	4
CYE018	Computational Chemistry	4
CYE019	Supramolecular Chemistry	4
CYE020	Mathematical methods in Chemistry	4
CYE021	Organometallics, Catalysis and Inorganic Spectroscopy	
CYE022	Physical methods in Chemistry	4
CYE023	Applications of Computational Methods in Chemistry	4

CHEE24	Chemical Lab Safety and Management	4
CHEE25	Advances in Organic Chemistry	4
CHEE26	Green Chemistry	4
CHEE27	Selected topics in synthetic organic Methods	4
CHEE28	Advanced Topics in Organometallic Chemistry	4
CHEE29	Industrial Chemistry	3

* New electives will be appended based on the availability of course instructor.