ROYAL GLOBAL UNIVERSITY
GUWAHATI

(Royal School of Applied and Pure Sciences)
(Department of Chemistry)

Learning Outcomes based Curriculum Framework (LOCF)

For

M.Sc. Chemistry

SYLLABUS

&

COURSE STRUCTURE

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M.Sc.

Course Structure

1st semester								2nd semester							
Sl. No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**	**Sl. No.**	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Subjects (please use rows as required)								**Core Subjects (please use rows as required)**							
1	CHY014C101	Physical Chemistry I	4	0	0	4	4	**1**	CHY014C201	Physical Chemistry II	4	0	0	4	4
2	CHY014C102	Organic Chemistry I	4	0	0	4	4	**2**	CHY014C202	Inorganic Chemistry I	4	0	0	4	4
3	CHY014C103	Quantum Chemistry	4	0	0	4	4	**3**	CHY014C203	Spectroscopy I	4	0	0	4	4
4	CHY014C114	Inorganic Chemistry Lab	0	0	8	4	8	4	CHY014C214	Organic Chemistry Lab	0	0	8	4	8
Ability Enhancement Compulsory Course (AECC)*								**Ability Enhancement Compulsory Course (AECC)***							
5	CEN984A101	Communicative English – I	1	0	0	1	1	5	CEN984A201	Communicative English – II	1	0	0	1	1
6	BHS984A103	Behavioural Science-I	1	0	0	1	1	6	BHS984A203	Behavioural Science-II	1	0	0	1	1
								Ability Enhancement Elective Course (AEEC) (Skill Based):							
								7		AEEC-1	2	0	0	2	2
Elective: Discipline Specific DSE (Choose any one)								**Elective: Discipline Specific DSE (Choose any one)**							
7	CHY014D101	Analytical Chemistry	4	0	0	4	4	8	CHY014D201	Biochemistry	4	0	0	4	4
8	CHY014D102	Food & Nutrition	4	0	0	4	4	9	CHY014D202	Chemistry of Macromolecules	4	0	0	4	4
Total						**22**		**Total**						**24**	

3rd semester								4th semester							
Sl. No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**	**Sl. No.**	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Subjects (please use rows as required)								**Core Subjects (please use rows as required)**							
1	CHY014C301	Organic Chemistry II	4	0	0	4	4	1	CHY014C401	Environmental & Green Chemistry	**4**	**0**	**0**	**4**	**4**
2	CHY014C302	Inorganic Chemistry II	4	0	0	4	4	2	CHY014C402	Spectroscopy II	**4**	**0**	**0**	**4**	**4**
3	CHY014C313	Physical Chemistry Lab	0	0	8	4	8								
Ability Enhancement Compulsory Course (AECC)*								**Ability Enhancement Compulsory Course (AECC)***							
4	CEN984A301	Communicative English – III	1	0	0	1	1	3	CEN984A401	Communicative English – IV	**1**	**0**	**0**	**1**	**1**

Ability Enhancement Elective Course (AEEC) (Skill Based):																
5		AEEC-2	2	0	0	2	2									
Elective: Discipline Specific DSE (Choose No 12 and any two from No 6-11)								**Elective: Discipline Specific DSE (Choose No 10 and any two from No 4-9)**								
6	CHY014D 301	Chemical Kinetics & Electrochemistry	4	0	0	4	4	**4**	CHY014 D401	Advanced Quantum Chemistry	**4**	**0**	**0**	**4**	**4**	
7	CHY014D 302	Heterocyclic Compounds & Natural Products	4	0	0	4	4	**5**	CHY014 D402	Catalysis & Surface Chemistry	**4**	**0**	**0**	**4**	**4**	
8	CHY014D 303	Bio-inorganic Chemistry	4	0	0	4	4	**6**	CHY014 D403	Medicinal Chemistry	**4**	**0**	**0**	**4**	**4**	
9	CHY014D 304	Supramolecular Chemistry	4	0	0	4	4	**7**	CHY014 D404	Organic Photochemistry & Pericyclic Reactions	**4**	**0**	**0**	**4**	**4**	
10	CHY014D 305	Spectral Techniques in Inorganic Chemistry	4	0	0	4	4	**8**	CHY014 D405	Chemistry of Materials	**4**	**0**	**0**	**4**	**4**	
11	CHY014D 306	Computer in Chemistry	4	0	0	4	4	**9**	CHY014 D406	Organometallic Chemistry & Catalysis	**4**	**0**	**0**	**4**	**4**	
12	CHY014D 331	Literature Survey	0	0	8	4	8	**10**	CHY014 C423	Project	**0**	**0**	**0**	**12**	**12**	
Total						**27**				Total				**29**		

I. Core courses may be of the following:

(i) Theory (4) =Credit 4 with no tutorial

(ii) Theory(3) + Tutorial (2) = Credit 4 for theory paper

(iii) V

Theory (3)+ Practical(2)= Credit 4 for Theory and Practical combined

(iv) Practical (4) =Credit 4 for Only practical papers

Note: There may be variations in Core component of the structure from dept. to dept. It is expected the variation should not be too large in terms of number of papers or in terms of credits.

II. Ability Enhancement Compulsory Course (AECC)*

(a) Communicative English : Four courses in all semester – Credit assigned: 1

(i) Developing Oral Communication & Listening Skills

(ii) Conversation & Public Speaking

(v) Communication & Presentation Skills

(vi) Effective Workplace Communication

(Subjects may be offered after consultations with Royal School of Languages and requirements of the department.)

(b) Behavioural Science: 2 courses in 1st and 2nd semesters –Credits assigned: 1*

(i) Introduction to behavioural science

(ii) Development of Individuals and Behavioural Skills

(Subjects may be offered after consultations with Royal School of Behavioural & Allied Sciences and requirements of the department.)

III. Ability Enhancement Elective Course (AEEC) (Skill Based):

	AEEC/SEC-1 (in second semester) (Choose any one)	**AEEC/SEC-2(in third semester) (Choose any one)**
1	ILD-1	ILD-2
2	FRENCH-1	FRENCH-2
3	C++	LATEX
4	SCILAB	
5	MATLAB	Any other skill based courses offered by other schools of RGU and opted by Student
6	Any other skill based courses offered by other schools of RGU and opted by Student	

IV. Elective: Discipline Specific DSE

Note: DSE1-1 - DSE1-5 means 5 DSE papers are offered in 1st semester out of which 1 may be chosen

Evaluation of Students:

- **Continuous Evaluation:** Assignments, Class Tests, Quizzes, Seminar – 15%
- **Mid-term examination:** 10%
- **Attendance :** 5%
- **End-term examination:** 70 %

Scheme of Evaluation

Theory Papers (T):

- Continuous Evaluation: 15% (Assignment, Class Test, Viva, Seminar, Quiz : Any Three)
- Mid-term examination: 10%
- Attendance: 5%
- End Term Examination: 70%

End term examination: 70 %

Practical Papers (P):

- Continuous Evaluation: 25% (Skill Test, lab copy, viva, lab involvement: Any Three)
- Attendance: 5%
- End term examination: 70 %

Combined Theory & Practical Papers (TP):

- Continuous Evaluation: 15% (Assignment. Class Test, Lab Experiment, Lab Copy, Viva: Any Three)
- Mid-term examination: 10%
- Attendance: 5%
- End term examination: 70 %

SYLLABUS (1ST SEMESTER)

Paper I/Subject Name: Physical Chemistry I **Subject Code: CHY014C101**

L-T-P-C – 4-0-0-4 **Credit Units: 4** **Scheme of Evaluation: (T)**

Objective: The objectives of **Physical Chemistry I** are:

- To provide the concepts of thermodynamics and its applications to physical and chemical systems
- To enable the students to understand the phase rule and its application to three component systems
- To provide the basic understanding of statistical thermodynamics
- To provide the fundamental concepts of theories of ion-solvent interactions

Prerequisites:

- Concept of phase rule, non-ideal solution, entropy, electro-chemistry
- Concept of thermodynamics from B.Sc. level

Detailed Syllabus:

Modules	Topics & Course content	Periods
I	**Classical Thermodynamics** Thermodynamics of real gases and gas mixtures, Fugacity, relation between fugacity and pressure, variation of fugacity with temperature and pressure, non-ideal solutions, Activity, dependence of activity on temperature and pressure, Fugacity coefficients and activity coefficients–different scales of activity coefficients. Non-equilibrium thermodynamics: Review of basic concepts of force, flow and entropy production, rate of entropy production, entropy production in chemical reactions, coupled forces and flows and phenomenological relations; Onsager reciprocal relations.	**12**
II	**Statistical Thermodynamics** Statistical mechanics of systems independent particles- Maxwell Boltzmann distribution law, entropy and probability, calculation of thermodynamic properties for independent particles-molecular partition functions, physical significance of partition function, evaluation of partition function-translational, rotational, vibrational and electronic partition functions. Statistical interpretation of work and heat, thermodynamic properties of ideal monoatomic and diatomic molecules-Suckur-Tetrode equation, calculation of partition functions, thermodynamic function, principles of equipartition.	**12**

III	**Dynamic Electro-chemistry** Ion size factor and ion-solvent interactions–The Born model. Thermodynamic parameters of ion-solvent interactions–structural treatment, the ion-dipole model–its modifications, ion quadrupole and ion–induced dipole interactions. Primary solution–Determination of hydration number, compressibility method and viscosity mobility method. Debye-Húckel theory of ion-ion interactions–derivation, validity and limitations, Debye-Huckel-Onsager treatment and its extension to concentrated solutions.	**12**
IV	**Phase equilibrium** Phase equilibrium of two-component system, phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions. Application of Gibbs phase rule to three component systems – triangular plots–water-acetic acid–chloroform system. Binary solutions: Gibbs-Duhem-Margules equation and its applications to fractional distillation of binary miscible liquids (ideal and non-ideal), azeotropes, partial miscibility of liquids.	**12**
Total		**48**

Text Books:

1. *Physical Chemistry;* Atkins, P.W. and Paula, J. de; 10th edition; 2014; Oxford University Press
2. *Principles of Physical Chemistry*; Puri, B.R.; Sharma, L.R.; Pathania, M.S.; 47th edition; 2016; Vishal Publishing Company

Reference Books:

1. Glasstone, S.; *Text book of Physical Chemistry;* 11th edition; 2011; Van Nostrand company.
2. Atkins, P.W. and Paula, J. de; *Elements of Physical Chemistry;* 6th edition; 2012; Oxford University Press.
3. Kapoor, K. L.; *A textbook of Physical chemistry*; 6th edition,; 2011; Macmillan, India Ltd.
4. Bokris, J.A. and Reddy, A.K.N; *Modern Electrochemistry*; Vols. 1&2; Kluwer Academic Publishers
5. Levine, I.; *Physical Chemistry;* 6th edition; 2008; McGraw–Hill Science

Course Outcomes:

The student will

- be able to get the concepts of non-ideal solutions, fugacity, activity, fugacity coefficients, activity coefficients, non-equilibrium thermodynamics etc.
- be able to understand the concepts of statistical thermodynamics such as properties of independent particles, partition function, principles of equipartition etc.
- be able to know about the ion-solvent interactions, non-structural approach by Born model and structural approach by Bernal Flower model, methods to determine hydration number, Debye-Húckel theory.

Teaching Learning Process:

- Lectures in class rooms
- Traditional teaching using board and markers.
- Power-point presentation
- Assignments
- Group discussions

Assessment methods:

- Semester End Examination: 70 marks
- Internal Assessment: 30 marks (Mid semester examination: 10, Assignment: 05, Viva: 5, Class test: 5, Attendance: 05)

SYLLABUS (1ST SEMESTER)

Paper II/Subject Name: Organic Chemistry I **Subject Code: CHY014C102**

L-T-P-C – 4-0-0-4 **Credit Units: 4** **Scheme of Evaluation: (T)**

Objective: The objectives of this course are:-

- To provide the basic theory of reaction kinetics
- To cover the stereo chemical and conformational aspect of molecules
- To throw some lights on bonding of molecules
- To clear the concept of bond formation and bond breaking

Prerequisites: Concept of basic mechanistic and stereo chemical organic chemistry

Detailed Syllabus:

Modules	Topics & Course content	Periods
I	**Reaction mechanism** Structure and Reactivity: Types of mechanisms, types of reactions, thermodynamic and kinetic requirements, Hammond postulate, Curtin-Hammett principle, transition states and intermediates, methods of determining mechanisms, isotopic effects. Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes and nitrenes. Effect of structure on reactivity. The Hammett equation and linear free energy relationship (sigma-rho) relationship, Taft equation.	**12**
II	**Stereochemistry and conformational analysis** Acyclic systems upto 4 chiral centres, compounds with asymmetric carbons in branched chain, Klyne-Prelog conformational terminology. Axial chirality, planer chirality. Conformation of cyclic systems: cyclohexene, cyclohexanone, decalin. Optical activity in absence of chiral carbon (biphenyls, allenes and spiranes). Conformational effect on reactivities and physical properties of molecules.	**12**
III	**Bonding in organic compounds** Aromaticity: Concept of Aromaticity, non-aromaticity and antiaromaticity, pseudo aromaticity, homo aromaticity, NMR in aromatic character, Huckel's rule and its limitations, non-benzonoid compounds (aromaticity), alternate and non-alternate hydrocarbons, annulenes, fulvenes, fulvalenes, azulenes, fullerenes. Supramolecular chemistry: Addition compounds: Crown ether complex, Cryptands. Inclusion compounds, Cyclodextrins, Catenanes, Rotaxanes and their applications.	**12**

IV	**Disconnection approach** An introduction to synthons and synthetic equivalents, disconnection approach, functional group inter conversion, importance of order of events in organic synthesis, one group C-X and two group C-X disconnections, chemo selectivity, reversal of polarity, cyclisation reactions, amine synthesis. Protecting groups: Principle of protection of alcohol, amine, carbonyl and carboxyl groups. One group C-C disconnection: alcohol, carbonyl compounds, regioselectivity. Use of acetylene in organic synthesis. Diels –Alder reactions, Michael addition and Robinson annulation.	**12**
Total		**48**

Text books:

1. *Advanced organic chemistry: Reactions, mechanism and structure*; March Jerry; 7th edition; John Wiley; 2015; United States of America.
2. *Advanced organic chemistry*; Carey F. A. and Sundberg R. J.; 5th edition; 2007; Plenum.
3. *A guide book to mechanism in organic chemistry*; Sykes Peter; 6th edition; Longman.

Reference books:

1. Ingold C.K.; *Structure and mechanism in organic chemistry*; 2nd edition; Cornell University press.
2. Norman R.O.C.and Coxon J. M.; *Principle of Organic Synthesis*; 3rd edition; 1993; Blackie academic professional.
3. Warren S.; *Designing organic synthesis*; 2nd edition; 2008; Wiley; UK.
4. Nasipuri D.; *Stereochemistry of organic compounds*; 5th edition; 2014; New age international
5. Kalsi P.S.; *Stereochemistry of organic compounds*; 2007; New age international.

Course outcomes:

Students will

1. learn about kinetics of organic reactions
2. have information about three dimensional orientation of molecules and its effect on molecular reactivity
3. have some idea about bonding of molecules
4. develop concept about strategy of a new reaction .

Teaching Learning Process:

- Lectures in class rooms
- Hands-on learning using different three-dimensional models
- Assignments
- Group discussions

Assessment methods:

- Semester End Examination: 70 marks
- Internal Assessment: 30 marks (Mid semester examination: 10, Assignment: 05, Viva: 5, Class test: 5, Attendance: 05)

SYLLABUS (1ST SEMESTER)

Paper II/Subject Name: Quantum Chemistry **Subject Code: CHY014C103**

L-T-P-C – 4-0-0-4 **Credit Units: 4** **Scheme of Evaluation: (T)**

Objective: The objectives of **Quantum Chemistry** are

- To provide the basic principles and topics of quantum chemistry.
- To apply the fundamental postulates in solving different problems in quantum mechanics.
- To discuss the concept of formation of molecular orbitals.

Prerequisites:

- Concept of linear algebra, differential equations both ordinary & partial, calculus and matrices.

Detailed Syllabus:

Modules	Topics & Course content	Periods
I	**Basic Principles of Quantum Mechanics** Origin of the quantum theory, wave functions of one-particle and many-particles system, probability density, well-behaved functions, normal and orthogonal functions. Operators in quantum mechanics, eigen values and eigen functions, Hermitian operators and their properties, commutation of operators, postulates of quantum mechanics, expectation values of observable properties. Angular momentum of a one-particle system, spin and orbital angular momenta.	**12**
II	**Some Exactly Solvable Problems in Quantum Mechanics** Quantum mechanical treatment of translational motion of a particle, particle in one and three dimensional boxes, concept of degeneracy, harmonic oscillator, rotational motion of a particle: particle on a ring, rigid rotator, hydrogen and hydrogen like atoms, graphical presentation of orbitals (s, p and d), radial and angular probability distribution plots.	**12**
III	**Approximate Methods** Need for approximation methods, perturbation and variation methods and their application to Helium atom, symmetric and antisymmetric wave functions, Pauli's exclusion principles, many electron atoms, slater determinants, qualitative treatment of Hartree theory and Hartree-Fock SCF procedure.	**12**

IV	**Chemical Bonding** Born-Oppenheimer approximation, separation of electronic and nuclear motion, hydrogen molecule ion: linear combination of atomic orbital (LCAO)-molecular (MO) theory, valance bond (VB) and MO (LCAO) treatment of hydrogen molecule, comparison of MO and VB treatments and their equivalence limit, Huckel MO theory, FMO.	**12**
Total		**48**

Text Books:

1. *Quantum Chemistry*; Levine, I.N.; 5th edition, 2000; Prentice Hall of India
2. *Quantum Chemistry;* Prasad, R.K.; 4th edition; 2009; New Age International Publishers Limited

Reference Books:

1. Chandra, A.K.; I*ntroductory Quantum Chemistry*; 4th edition; 2006; Tata McGraw Hill
2. Sen, B.K.; Quantum Chemistry Including Spectroscopy; 4th edition; 2011; Kakyani Publisheres, New Delhi
3. McQuarrie, D.A.; *Quantum Chemistry*; 2nd edition; 2011; Viva Books Pvt Ltd
4. Atkins, P.W and S.F. Ronald; *Molecular Quantum Mechanics;* 5th edition; Oxford University Press

Course Outcomes:

The students will

1. understand and use the terminology and nomenclature in quantum chemistry and topics discussed in the course.
2. be able to understand the basic concepts in quantum mechanics, atomic and molecular structure.
3. understand elementary numerical procedures and the basic relationships of quantum mechanics and molecular systems.

Teaching Learning Process:

- Lectures in class rooms
- Traditional teaching using board and markers.
- Assignments
- Using computational techniques

Assessment methods:

- Semester End Examination: 70 marks
- Internal Assessment: 30 marks (Mid semester examination: 10, Assignment: 05, Viva: 5, Class test: 5, Attendance: 05)

SYLLABUS (1ST SEMESTER)

Paper IV/Subject Name: Inorganic Chemistry Laboratory **Subject Code: CHY014C114**

L-T-P-C – 4-0-0-4 **Credit Units: 4** **Scheme of Evaluation: (P)**

Objective: The objectives of **Inorganic Chemistry Laboratory** are

- To provide knowledge of inorganic chemistry in scientific and technological aspects
- To help students in the development of curiosity and interest in inorganic chemistry
- To improve the understanding of the concepts and application of inorganic chemistry since the practical course is in relevance to the theory courses

Prerequisites:

- Concept of ionic and covalent bonding
- Concept of non-transition elements and their chemistry
- Basic concept of solid state chemistry from B.Sc. level

Detailed Syllabus:

List of Experiments:

1) Preparation of following inorganic compounds:
   i) Potassium trioxalatoaluminate(III)trihydrate, $K_3[Al(C_2O_4)_3].3H_2O$
   ii) Hexaamminenickel(II) chloride, $[Ni(NH_3)_6]Cl_2$
   iii)Potassiumtrioxalatoferrate(III) trihydrate, $K_3[Fe(C_2O_4)_3].3H_2O$

2) Preparation of potassiumtrioxalatochromate(III) trihydrate $K_3[Cr(C_2O_4)_3].3H_2O$ and determination of concentration of chromium and oxalate ion.

3) Quantitative analysis of ore/alloy:
   i) Determination of the amount of calcium in the lime stone sample
   ii) Determination of the percentage of copper in Brass sample
   iii) Determination of the percentage of iron in steel sample

4) Determination of concentration of components in a mixture
   i) Esimation of Fe^{II} and Fe^{III} in a mixture
   ii) Estimation of Na_2CO_3 and $NaHCO_3$ in a mixture

5) Estimation of alkali content of antacid tablets.
6) Green Chemistry experiments:
   i) Recovery and reuse of sulfur dioxide (Obendrauf's Method)
   ii) Green synthesis of Tetrabutylammonium tribromide (TBATB)
   iii) Preparation of Bis(acetylacetonato)copper (II)

Text Books:

1. *Green Chemistry Experiments: A Monograph;* Sharma R.K., Sidhwani I.T., Choudhuri M.K.; 1st edition (December, 2012) ; I K International Publishing House.

2**.** *Vogel's Qualitative Inorganic Analysis;* Svehla G. and Sivasankar B.; 7th edition;Pearson.

Reference Books:

1.Barua, S.*; A text Book of Practical Chemistry*; 2th edition; 2016;Kalyani Publishers.

2. Mendham J., Denney R.C., Barnes J.D. and. ThomasM.J.K.; *Vogel's Textbook of Quantitative Chemical Analysis,* 6th edition, 3rd Indian Reprint, 2003, Pearson Education Pvt. Ltd., New Delhi

Course Outcomes:

The student will

- be able to know the techniques that are useful in modern inorganic chemistry field.
- be able to develop analytical abilities for independent thinking.

Teaching Learning Process:

- Theoretical explanation in class rooms.
- Execution of experiments
- Recording of data and observation of result
- Regular evaluation of lab copy

Assessment methods:

- Semester End Examination: 70 marks
- Internal Assessment: 30 marks (Copy: 10, Skill test: 05, Viva: 10, Attendance: 05)

SYLLABUS (1ST SEMESTER)

Paper DSE I/Subject Name: Analytical Chemistry **Subject Code: CHY014D101**

L-T-P-C – 4-0-0-4 **Credit Units: 4** **Scheme of Evaluation: (T)**

Objective: The objectives of **Analytical Chemistry** are

- To provide a thorough background in those chemical principles those are particularly important to analytical chemistry
- To provide the knowledge of terms, facts, concepts, techniques and principles of the subject and to develop the ability to apply skills in the proper handling of apparatus and different chemicals
- To develop problem solving skills

Prerequisites:

- Concept of acid-base, oxidation-reduction, strength of solution, etc.
- Concept behind various theories of instruments.

Detailed Syllabus:

Modules	Topics & Course content	Periods
I	**Treatment of Analytical Data** Definition and brief idea of the following terms: Significant figures, accuracy and precision, mean, median, variance, confidence limits, deviation, relative mean deviation, standard deviation. Types of errors in chemical analysis: Determinate and indeterminate error, absolute errors, relative errors, constant and proportional errors, minimization of determinates errors.	**12**
II	**Chromatography and Thermal Methods of Gravimetry** Theory of chromatography, retention time, classification of chromatography, chromatographic techniques – principles, experimental techniques and applications of Gas Chromatography, Liquid Chromatography, Column Chromatography, Thin Layer Chromatography, High-Performance Liquid Chromatography. Thermal Methods: Principle and application of thermal methods of analysis — TGA, DTA and DSC.	**12**
III	**Optical Methods** Fundamental laws of spectrophotometry, nephelometry, turbidometry and fluorimetry. Spectrophotometric titrations. Atomic emission spectrometry: Excitation sources (flame, AC and DC arc), spark, inductively coupled plasma, glue discharge, laser microprobes, flame structure, instrumentation and qualitative and quantitative analysis. Atomic absorption spectrometry: Sample atomization techniques, instrumentation, interferences, background correction, and analytical applications. Theory, instrumentation and applications of: Atomic fluorescence spectrometry, photoelectron spectroscopy, SEM, TEM, AFM	**12**

IV	**Electro Analytical Methods** Potentiometry: Techniques based on potential measurements, direct potentiometric systems, different types of indicator electrodes, limitations of glass electrode, applications in pH measurements, modern modifications. Polarography: Micro electrode and their specialities, potential and current variations at the micro electrode systems, conventional techniques for concentration determination, limitations of detection at lower concentrations, techniques of improving detection limit-rapid scan, ac, pulse, differential pulse square wave polarographic techniques. Applications of polarography. Amperometry: Biamperometry, amperometric titrations. Coulometry: Primary and secondary coulometry, advantages of coulometric titrations, applications. Principle of chronopotentiometry. Anodic stripping voltammetry: Different types of electrodes and improvements of lower detection limits. Voltammetric sensors.	**12**
Total		**48**

Text Books:

1. *Vogel's Qualitative Inorganic Analysis;* Svehla G. and Sivasankar B.; 7th edition; Pearson.

Reference Books:

1. MendhamJ., Denney R.C.,Barnes J.D. and. ThomasM.J.K.; *Vogel's Textbook of Quantitative Chemical Analysis*, 6th edition, 3rd Indian Reprint, 2003, Pearson Education Pvt. Ltd., New Delhi.
2. Skoog D.M., *Fundamental of Analytical Chemistry;* West, HollerAnd Crouch VIII Edition, 2005, Saunders College Publishing, New York.
3. Day R.A. and A.L., *Quantitative Analysis;* Underwood, 6th edition, 1993 Prentice Hall, Inc. New Delhi.

Course Outcomes:

The student will

- be able to know those laboratory skills that will give students confidence in their ability to obtain high quality analytical data.
- be able to develop an appreciation for difficult task of judging the accuracy and precision of experimental data.
- be able to knowthe techniques that are useful in modern analytical Chemistry.

Teaching Learning Process:

- Lectures in class rooms
- Traditional teaching using board and markers.
- Assignments
- Group discussions
- Laboratory demonstration

Assesment methods:

- Semester End Examination: 70 marks
- Internal Assessment: 30 marks (Mid semester examination: 10, Assignment: 05, Viva: 5, Class test: 5, Attendance: 05)

SYLLABUS (1ST SEMESTER)

Paper DSE II/Subject Name: Food and Nutrition Chemistry **Subject Code: CHY014D102**
L-T-P-C – 4-0-0-4 **Credit Units: 4** **Scheme of Evaluation: T**

Objective: The objectives of **Food and Nutrition Chemistry** are

.

- To help students in the development of curiosity and interest in the subject
- To help students to understand biological need of different foods
- To provide the students the fundamental concepts required to rationalise and predict the nutrition value of foods

Prerequisites:

- Concept of Biology and Physiology

Detailed Syllabus:

Modules	Topics & Course content	Periods
I	**Human Nutrition** Concept and definition of terms: Nutrition, malnutrition. Health: Scope of nutrition. Minimum nutritional requirement and RDA: Formulation of RDA and dietary guidelines reference man and reference woman. Adult consumption unit. Idea of energy and its unit, energy balance, assessment of energy requirement: deficiency and excess, determination of energy in food, B.M.R. and its regulation, S.D.A. Somatic, physical, brain and mental development, factors affecting growth and development. Importance of nutrition for ensuring adequate development. Growth & development from infancy to adulthood: Growth monitoring and promotion: Use of growth charts and standards, preventions of growth faltering.	**12**
II	**Basic concept on Food, Nutrients and Nutrition-I** Classification of food. Classification of nutrients. Carbohydrates: Definition, classification. Structure and properties. Monosaccharides: Glucose, fructose, galactose. Disaccharides: Maltose, lactose, sucrose. Polysaccharides: Dextrin, starch, glycogen, resistance starch. Sources, daily requirements, functions. Effects of too high - too low carbohydrates on health. Digestion & absorption. Blood glucose and effect of different carbohydrates on blood glucose. Glycemic Index. Functional role of sugars in food, fermentation of sugar.	**12**

III	**Basic concept on Food, Nutrients and Nutrition-II** Lipids: Definition, Classification & Properties. Fatty acids: Composition, properties, types. Sources, daily requirements, functions. Digestion & absorption. Role & nutritional significances of PUFA, MUFA, SFA, W-3 fatty acid. Proteins: Definition, classification, structure & properties. Amino acids: classification, types, functions. Sources, daily requirements, functions. Effect of too high - too low proteins on health. Digestion & absorption. Assessment of protein quality (BV, PER, NPU). Factors affecting protein bio-availability including anti-nutritional factors.	**12**
IV	**Food Science** Dietary fibre: Classification, sources, composition, properties & nutritional significance. Minerals & trace elements: Bio-Chemical and physiological role, bio-availability & requirements, sources, deficiency & excess (Calcium, Sodium, Potassium, Phosphorus, Iron, Fluoride, Zinc, Selenium, Iodine, Chromium) Vitamins: Bio-chemical and physiological role, bio-availability and requirements, sources, deficiency & excess. Water: Functions, daily requirements, water balance. Elementary idea of probiotics, prebiotics, organic Food.	**12**
Total		**48**

Text Books:

1. *Essentials of Human Nutrition;* Mann Jim and Truswell Stewart; 5th edition; April 2017; Oxford University Press

Reference Books:

1. Rodey S..; *Food Science & Nutrition*; 2nd edition; September 2012; Oxford University Press.

Course Outcomes:

The student will

- Be able to understand the different theory of nutrition of human body.
- Be able to know the fundamental concepts of food science.
- Be able to apply the knowledge in food technology.

Teaching Learning Process:

- Lectures in class rooms
- Traditional teaching using board and markers.
- Assignments
- Group discussions

Assesment methods:

- Semester End Examination: 70 marks
- Internal Assessment: 30 marks (Mid semester examination: 10, Assignment: 05, Viva: 5, Class test: 5, Attendance: 05)

SYLLABUS (2nd SEMESTER)

Paper I/Subject Name: Physical Chemistry-II **Subject Code: CHY014C201**

L-T-P-C – 4-0-0-4 **Credit Units: 4** **Scheme of Evaluation: T**

Objective: The objectives of **Physical Chemistry-II** are

- To study the reaction mechanism, theories of reaction rate, kinetic and thermodynamic control of reactions
- To acquire the knowledge of catalyst and adsorption phenomena
- To understand the properties of polymers and techniques involved in polymerization.
-

Prerequisites:

- Concept of chemical kinetics, catalyst, adsorption and polymers

Detailed Syllabus:

Modules	Topics & Course content	Periods
I	**Reaction Kinetics** Empirical rate law and temperature dependence, steady-state approximation, determination of reaction mechanisms, oscillating reactions: Belousov-Zhabotinski reaction, chain reaction: alkane pyrolysis, branched chain reactions: the hydrogen oxygen reaction, concept of explosion limit. Collision theory, estimation of activation energy and the calculation of potential energy surface, transition state theory (TST) of biomolecular reactions, Eyring equation, kinetic and thermodynamic control of reactions, Lindemann-Hinshelwood theory of unimolecular reactions.	**12**
II	**Catalysis** Types of catalyst, specificity and selectivity, effect of particle size and efficiency of nanoparticles as catalysts. *Homogeneous catalysts*: Mechanism of homogeneous catalysis, acid-base catalysis, enzyme catalyzed reactions, Michaelis-Menten mechanism, effect of pH and temperature, enzyme inhibitor, role of transition metal ions as catalyst with special reference to Cu, Pd, Pt, Co, Ru and Rh, acid-base catalysis. *Heterogeneous catalysts:* Kinetics of heterogeneous catalysis: Langmuir-Hinselwood model, clays, zeolites and their use as catalysts in cracking of petroleum.	**12**

III	**Adsorption and Aggregation** Adsorption of gases on solid surfaces: Langmuir's theory and its limitations, derivation of BET equation: determination of surface area of an adsorbent, adsorption in liquid systems: Gibbs adsorption isotherm. Colloidal system, optical, kinetic and electrical properties of colloids, electrophoresis, electro-osmosis, size determination of colloidal particles, coagulation of colloidal solutions. Surface active agents and their classifications, aggregation /micellization of surfactants, hydrophobic interaction, critical micellar concentration (CMC), factors affecting the CMC of surfactants, thermodynamics of micellization: phase separation and mass action models, microemulsion, reverse micelles.	**12**
IV	**Macromolecules** Polymers and degree of polymerization, classification of polymers, mechanism of polymerization, concept of number average and mass average molecular weight of a polymer, methods of determining molecular weights (osmometry, viscometry, light scattering and sedimentation equilibrium methods), chain configuration of macromolecules: root mean square end to end distance and radius of gyration.	**12**
Total		

Text Books:

1. *Physical Chemistry;* Atkins, P.W. and Paula, J. de; 10th edition; 2014; Oxford University Press
2. *Principles of Physical Chemistry*; Puri, B.R.; Sharma, L.R.; Pathania, M.S.; 47th edition; 2016; Vishal Publishing Company

Reference Books:

1. Glasstone, S.; *Text book of Physical Chemistry;* 11th edition; 2011; Van Nostrand company.
2. Atkins, P.W. and Paula, J. de; *Elements of Physical Chemistry;* 6th edition, 2012; Oxford University Press.
3. Kapoor, K. L.; *A textbook of Physical chemistry*; 6th edition,; 2011; Macmillan, India Ltd.
4. Levine, I.; *Physical Chemistry;* 6th edition; 2008; McGraw–Hill Science
5. Billmeyer, F.W.; *Text Book of Polymer Science*; 2rd edition; 1971, John.Wiley, London
6. Gowariker, V.R.; Viswanathan, N.V.; Sreedhar, T.; *Polymer Science;* 1st edition; 1986; Wiley Eastern, New Delhi
7. Mishra, G.S.; *Introductory Polymer Chemistry*; 5th edition; 2007; New Age International
8. Gates, B.C.; *Catalytic Chemistry*; 1st edition; 1992; John Wiley & Sons, New York

Course Outcomes:

The students will

1. be able to understand reaction kinetics, theories of reaction rate and reaction mechanisms.
2. be able to understand the mechanisms of catalysis and properties of different catalysts.
3. be able to explain the adsorption of gases on solid and liquid surfaces.
4. be able to define colloids and micelles and can explain their properties.
5. know the mechanism of polymerizations and different techniques involved in polymerization.

Teaching Learning Process:

- Lectures in class rooms
- Traditional teaching using board and markers.
- Power-point presentation
- Assignments
- Group discussions

Assessment methods:

- Semester End Examination: 70 marks
- Internal Assessment: 30 marks (Mid semester examination: 10, Assignment: 05, Viva: 5, Class test: 5, Attendance: 05)

SYLLABUS (2nd SEMESTER)

Paper II/Subject Name: Inorganic Chemistry I **Subject Code: CHY014C202**
L-T-P-C – 4-0-0-4 **Credit Units: 4** **Scheme of Evaluation: (T)**

Objective: The objectives of **Inorganic Chemistry I** are

- To provide an understanding of the details of molecular orbital theory of homo and hetero nuclear diatomic and polyatomic molecules
- To get details of weak chemical forces with special emphasis on hydrogen bonding and Van der Waal's forces
- To provide a detailed discussion of structure and properties of coordination compounds
- To provide an elaborated discussion on non-transition elements including preparation, properties, bonding and structure of some important compounds
- To put light on acid-base and redox chemistry

Prerequisites:

- Concept of chemical bonding and coordination chemistry from B.Sc. level
- Concept of chemistry non transition elements and acid base chemistry

Detailed Syllabus:

Modules	Topics & Course content	Periods
I	**Chemical Bonding** Chemical bonding of simple inorganic covalent compounds-molecular orbital treatments, hybridization, understanding molecular properties from bonding, molecular orbital theory of homo and heteronuclear diatomic, molecular orbitals of polyatomic molecules, molecular shape in terms of molecular orbitals – Walsh diagrams, atomic and ionic radii, bond length, bond strength, van der Waals forces, effect of hydrogen bonding and other chemical forces on melting and boiling points and solubility**.**	**12**
II	**Coordination Chemistry I** Crystal field theory, ligand field theory, splitting of d-orbitals, crystal filed stabilization energies in weak filed and strong field, octahedral site preference energy, tetragonal distortion and Jahn-Teller effect, lattice energy, hydration enthalpy and stability of complexes (Irving-Williams order).	**12**
III	**Acid Base and Redox Chemistry** Hard and soft acid-base concept, strength of oxo acids and halo acids, strength of inorganic bases, periodic trends in acidity and basicity of hydrides, oxides, oxyacids of non-transition elements. Standard electrode potentials, pH dependence of electrode potentials, redox stability of metal ions in water, Latimer and Frost diagrams.	**12**

IV	**Non-Transition Metal Chemistry** **S**ynthesis, properties, structure and bonding of nitrogen, phosphorous, sulfur, pseudohalogen, interhalogen and xenon compounds, boranes, carboranes, metallocarboranes, borazines, phosphazenes, sulfur-nitrogen compounds, silicates, silicones.	**12**
Total		**48**

Text Books:

1. *Concise Inorganic Chemistry*; Lee, J.D.; 5th edition; 2013; John Wiley and Sons Ltd.; Indian Edition.
2. *Inorganic Chemistry*; Atkins, P., Overtone, T., Rourke, J., Weller, M. and Armstrong, F.; 6th edition; 2014; Oxford University Press; Indian edition.
3. *Inorganic Chemistry Principles of Structure and Reactivity*; Huheey, J.E, Keiter, E. A., Keiter, R. L and Medhi, O. K. ; 4th edition; 2007; Pearson Education.

Reference Books:

1. Wells, A.F.*; Structural Inorganic Chemistry*; 3rd edition; 2012; Oxford Science Publishers.
2. Cotton, F.A., Wilkinson, G., Murillo, A., Bochmann M.; *Advanced Inorganic Chemistry;* 6th edition; 1999; Wiley Interscience; New York.

Course Outcomes: The students will

1. be able to understand the detailed idea of molecular orbital theory of homo and hetero nuclear diatomic and polyatomic molecules.
2. be able to know the details of weak chemical forces including hydrogen bonding Van der Waal's forces.
3. be able to get the details of structure and properties of coordination compounds by using valence bond theory and molecular orbital theory.
4. be able to know the chemistry of non transition elements and preparation, properties, bonding and structure of some non transition elements of importance.
5. be able to get the idea of acid-base chemistry with special emphasis on HSAB concept.
6. know the details of redox chemistry and their application.

Teaching Learning Process:

- Lectures in class rooms
- Traditional teaching using board and markers.
- Power-point presentation
- Assignments
- Group discussions

Assessment methods:

- Semester End Examination: 70 marks
- Internal Assessment: 30 marks (Mid semester examination: 10, Assignment: 05, Viva: 5, Class test: 5, Attendance: 05)

SYLLABUS (2nd SEMESTER)

Paper III/Subject Name: Spectroscopy-I **Subject Code: CHY014C203**
L-T-P-C – 4-0-0-4 **Credit Units: 4** **Scheme of Evaluation: (T)**

Objective: The objectives of **Spectroscopy-I** are

- To provide a thorough background those are particularly important to analytical chemistry
- To provide the knowledge, techniques and principles of spectroscopy and to develop the ability to apply skills in the proper handling of apparatus
- To develop problem solving skills

Prerequisites:

- Concept of basic theory and principle of quantum chemistry, electro-magnetic radiation

Detailed Syllabus:

Modules	Topics & Course content	Periods
I	**Basic theory of spectroscopy** Electromagnetic spectrum, interaction of electromagnetic radiation with molecular systems. Spectroscopic transition- absorption, emission, reflection, polarization and scattering processes. Natural line width and broadening- intensity of spectral transitions, selection rules; sampling techniques in different branches of spectroscopy. Electronic transitions, the Frank-Condon principle, ground and first excites states of diatomic molecules, selection rules on the basis of the symmetry properties of the electronic states; vibronic transitions.	**12**
II	**Basic theory of UV-Visible and IR spectroscopy with its application** UV- Visible spectroscopy: Basic principle, process of electronic excitation n-p and p-p transitions, transition probability, solvent effect, factors affecting position and intensity of absorption bands, spectra of dienes, polyenes and unsaturated ketones, calculation of λ_{max}, Woodward –Fieser rules. IR Spectroscopy: Stretching vibrations, Hooke's Law, stretching and bending vibrations. Application of IR spectroscopy: Identity of samples, effects of substitution, conjugation, bond angle, and hydrogen bonding on vibrational frequencies. Detection of inter-and intra-molecular hydrogen bonding.	**12**

III	**Basic theory of ^{1}H and ^{13}C NMR spectroscopy and its application** Nuclear Magnetic Spectroscopy: Basic instrumentation, nuclear spin, nuclear resonance, chemical shift and its measurements, shielding and deshielding, spin-spin interaction, coupling constant, Karplus equation. Simplification of spectra by use of Lanthanide shift-reagents and high magnetic fields. Deuterium exchange technique in the determination of labile hydrogen, spin decoupling, Nuclear overhauser effect (NOE). Two dimensional NMR spectroscopy: COSY, NOESY, DEPT. ^{13}C NMR spectra: Basic theory of ^{13}C NMR spectroscopy. Application of ^{1}H and ^{13}C NMR spectroscopy in structure elucidation of simple molecules.	**12**
IV	**Basic theory of Mass spectroscopy and its application** Mass Spectroscopy: Basic instrumentation, molecular ion peak, ion production-EI, CI, MALDI techniques. Mass spectral fragmentation of typical organic compounds, common functional groups, Mc-Lafferty rearrangement. Application of Mass spectroscopy, examples of mass spectral fragmentation of organic compounds with respect to their structure determination.	**12**
Total		**48**

Text books:

1. *Organic spectroscopy*; Kemp W.; 3rd edition; 1993; ELBS with Mcmillan.

Reference books:

1. Dyer J. R.; *Application of spectroscopy in organic compounds*; 1994; Prentice Hall; New Delhi.
2. Silverstein Robert M., Webster Francis X., Kiemle David J.; *Spectrometric identification of organic compounds*; 8th edition; 2017; Wiley

Course Outcomes:

The student will

- be able to know those laboratory skills that will give students confidence in their ability to obtain high quality analytical data.
- be able to develop an appreciation for difficult task of judging the accuracy and precision of experimental data.
- be able to know the techniques that are useful in modern analytical Chemistry.
- learn about application of Spectroscopy.

Teaching Learning Process:

- Lectures in class rooms
- Traditional teaching using board and markers.
- Power Point presentation
- Assignments
- Group discussions

Assessment methods:

- Semester End Examination: 70 marks
- Internal Assessment: 30 marks (Mid semester examination: 10, Assignment: 05, Viva: 5, Class test: 5, Attendance: 05)

SYLLABUS (2nd SEMESTER)

Paper IV/Subject Name: Organic Chemistry Laboratory **Subject Code: CHY014C214**
L-T-P-C – 0-0-8-4 **Credit Units: 4** **Scheme of Evaluation: (P)**

Objective: The objectives of **Organic Chemistry Laboratory** are

- To provide knowledge of organic chemistry in scientific and technological aspects
- To help students in the development of curiosity and interest in organic chemistry
- To improve the understanding of the concepts and application of organic chemistry since the practical course is in relevance to the theory courses

Prerequisites:

- Concept of properties of various chemical reagents, reaction intermediates, etc.
- Concept of chemistry laboratory course from B.Sc. level

Detailed Syllabus:

List of Experiments:

1) Qualitative analysis of binary mixtures of organic compounds
   A. Detection of special elements (N, Cl, S)
   B. Solubility and Classification
   C. Detection of the functional groups by systematic chemical tests
   D. Preparation of derivative of each functional group, purification of crude product by crystallization.
   E. Determination of melting point of the given samples and derivatives
2) Determination of equivalent mass of an acid by direct titration method
3) Determination of saponification equivalent of ester
4) Estimation of alcohol content in a sample using UV-visible spectrometer
5) Separation techniques of organic compounds by coloumn chromatography and their spectroscopic identification
6) Synthesis of organic compounds with biological activity using common reagents: Involving more than three steps using following representative reactions: (a) Oxidation reaction (b) Reduction reaction (c) Nucleophilic substitution; (d) Cycloaddition reaction; (e) Condensation reaction; (f) Aromatic electrophilic substitution; (g) Preparation of dyes, (h) Heterocyclic synthesis, etc. (e.g., Synthesis of antibacterial compound such as Sulphanilamide, synthesis of p-Amino Benzoic Acid)

7) Green experiments:

(i) Microwave assisted synthesis of some organic compounds

(ii) Coenzyme catalysed benzoin condensation (thiamine hydrochloride catalysed synthesis of benzoin)

(iii) Nitration of phenol using calcium nitrate tetrahydrate, acetic acid and salicylic acid

(iv) Acetylation of primary amine (Preparation of acetanilide) using aniline,acetic acid and zinc dust.

Text books:

1. V*ogel's Textbook of Practical Organic Chemistry*, Vogel A.I., Aurther I., 5th Edition, 2005, Pearson.
2. *Advanced Practical Organic Chemistry*, Agarwal O. P., 2nd Edition, 2014, Goel Publishing.
3. *Green Chemistry Experiments: A Monograph;* Sharma R.K., Sidhwani I.T., Choudhuri M.K.; 1stedition (December, 2012) ;I K International Publishing House.

Course Outcomes:

The student will

be able to know the techniques that are useful in modern applied chemistry field.

- be able to develop analytical abilities for independent thinking.
- be able to do the functional group analysis of simple organic compounds and to synthesize different derivatives of simple organic molecules.

Teaching Learning Process:

- Demonstration in class rooms
- Execution of experiments
- Recording of data/observation
- Regular evaluation of lab copy
- Group discussions

Assessment methods:

- Semester End Examination: 70 marks
- Internal Assessment: 30 marks (Copy: 10, Skill test: 05, Viva: 10, Attendance: 05)

SYLLABUS (2nd SEMESTER)

Paper DSE I/Subject Name: Biochemistry **Subject Code: CHY014D201**
L-T-P-C – 4-0-0-4 **Credit Units: 4** **Scheme of Evaluation: (T)**

Objective: The objectives of this course are:-

1) Information about living systems in terms of Chemistry
2) Knowledge about chemical reactions happening in biological systems

Prerequisites: Preliminary concept of chemical applications in biological systems

Detailed Syllabus:

Modules	Topics & Course content	Periods
I	**Essential elements and metals in biological system** Essential and trace elements in the biological systems, metals in life, basic reactions in the biological systems and the roles of metal ions in biological processes. Ion transport (active) across biological membrane and its significance, mechanism of Na+/K+ -ion pump. Transport and storage of dioxygen: active site structures and bio functions of O_2-uptake proteins: hemoglobin, myoglobin, hemocyanin and hemerythrin, model synthetic dioxygen complexes. Electron transfer in biology (respiratory electron transport chain): active site structures and functions of cytochromes, cytochrome c. Iron-sulfur proteins: ferredoxines, rubredoxin, cytochrome c oxidase and model systems.	**12**
II	**Photosynthetic pathways and metal toxicity** Photosynthetic electron transport chain, chlorophyll, PS-I, PS-II. Biological nitrogen fixation and abiological nitrogen fixation. Toxic effects of metal ions, metal dependent diseases: Wilsons, Alzheimer. Detoxification by chelation therapy, metal complexes in therapeutic use.	**12**
III	**Chemistry of proteins, nucleic acids and enzymes** Proteins: Classification, Amino acid, property, peptide, general method of peptide synthesis, primary, secondary, tertiary and quaternary structure of protein. Determination of primary structure. Nucleic Acids: DNA and RNA. Type of RNA and their function.	**12**

	Property of DNA in solution. Watson-Crick Model of DNA structure. Replication, Transcription and translation, (in detail). Regulation of gene expression Enzyme: Classification, nomenclature, Kinetics of enzyme action, competitive, uncompetitive and non-competitive inhibition, Michales-Menten and Lineweaver-Burk plots. Allo enzyme, isozymes.	
IV	**Biological aspects of vitamins, lipids and carbohydrates** Vitamins and Hormones: Fat soluble and water soluble vitamins .Vitamins as coenzymes and co-factors, prosthetic groups. NAD, FAD, TPP, Folic acid, Ascorbic acid, Vit.B_6, Vit.B_2, biotin (vitamin H), Vit E, Lipoic acid, Co ASH, Epinephrine, nor epinephrine, Steroid. Chemistry of lipids: Structure and function of bio membranes. Structure and function of lipids. Chemistry of carbohydrates: Types of naturally occurring sugars: Deoxy sugar, amino sugar, branched chain sugar. General method of structure and ring size determination with particular reference to maltose, sucrose, cellulose. Killiani-Fischer synthesis, Ruff's degradation, osazone formation, mutarotation. Metabolism of glucose. Bioenergetics: The ATP cycle.	**12**
Total		**48**

Text books:

1. *Principles of biochemistry*; Lehninger A. L.; 6th edition; 2012; W. H. Freeman and company.
2. *Outlines of biochemistry*; Conn and Stumph; 5th edition; 1987; Wiley and sons, New York.
3. *Organic chemistry*; Solomon T. W. Graham; 12th edition; 2015; Wiley.

Reference books:

1. Palmer Trevor; *Understanding Enzymes*; 4th edition; 1995; Prentice Hall; UK.
2. Williams R. J. P. and Salvia F. R. De; *Biological chemistry of elements*; 2nd edition; 2001; Oxford University Press.

Course outcomes:

Students will learn

1. about the application of Chemistry in biological system
2. Effect of Biology-Chemistry interaction on living organisms.

Teaching Learning Process:

- Lectures in class rooms
- Traditional teaching using board and markers.
- Hands-on learning using different three-dimensional models
- Assignments
- Group discussions

Assessment methods:

- Semester End Examination: 70 marks
- Internal Assessment: 30 marks (Mid semester examination: 10, Assignment: 05, Viva: 5, Class test: 5, Attendance: 05)

SYLLABUS (2nd SEMESTER)

Paper DSE II/Subject Name: Chemistry of Macromolecules **Subject Code: CHY014D202**
L-T-P-C – 4-0-0-4 **Credit Units: 4** **Scheme of Evaluation: (T)**

Objective: The objectives of **Chemistry of Macromolecules** are

- to provide the idea of macromolecules, their structure and properties
- to provide the knowledge of commercial polymers and processing of macromolecules

Prerequisites:

- Concept of B.Sc knowledge of macromolecules

Detailed Syllabus:

Modules	Topics & Course content	Periods
I	**Basics** Importance of polymers. Basic concepts: Monomers, repeat units, degree of polymerization. Linear, branched and network polymers. Classification of polymers. Polymerization: condensation, addition, radical chain-ionic and co-ordination and copolymerization. Polymerization conditions and polymer reactions. Polymerization in homogeneous and heterogeneous systems.	**12**
II	**Structure and Properties** Morphology and order in crystalline polymers-configurations of polymer chains. Crystal structure of polymers. Morphology of crystalline polymers, strain-induced morphology, crystallization and melting. Polymer structure and physical properties-crystalline melting point Tm - melting points of homogeneous series, effect of chain flexibility and other steric factors, entropy and heat of fusion. The glass transition temperature, Tg-Relationship between Tm and Tg, effects of molecular weight, diluents, chemical structure, chain topology, branching and cross linking. Property requirements and polymer utilization.	**12**
III	**Polymer Processing** Plastics, elastomers and fibres, compounding, processing techniques: calendering, die casting, rotational casting, film casting, injection moulding, blow moulding, extrusion moulding, thermoforming, foaming, reinforcing and fibre spinning.	**12**
IV	**Properties of Commercial Polymers** Polyethylene, polyvinyl chloride, polyamides, polyesters, phenolic resins, epoxy resins and silicone polymers. Functional polymers - Fire retarding polymers and electrically conducting	**12**

	polymers. Biomedical polymers -contact lens, dental polymers, artificial heart kidney, skin and blood cells.	
Total		**48**

Text Books:

1. *Textbook of Polymer Science; Billmeyer Jr, F.W.;* 2nd edition, 1972*;* Wiley.

Reference Books:

1. Gowarlker, V.R.; Viswanalhan, N.V.; Sreedhar, J.; *Polymer Science*; 1st edition; 1987; Wiley-Eastern.
2. Takemoto, K.; Raphael M.; Ottenbrite, M.K.*; Functional Monomers and Polymers*; 2nd edition; 1997; CRC Presee

Course Outcomes:

The students will

1. be able to understand basics and configurations of macromolecules.
2. be able to explain about commercial polymers and processing of macromolecules

Teaching Learning Process:

- Lectures in class rooms
- Traditional teaching using board and markers.
- Hands-on learning using different three-dimensional models
- Assignments
- Group discussions

Assessment methods:

- Semester End Examination: 70 marks
- Internal Assessment: 30 marks (Mid semester examination: 10, Assignment: 05, Viva: 5, Class test: 5, Attendance: 05)

SYLLABUS (3rd SEMESTER)

Paper I/Subject Name: Organic Chemistry II **Subject Code: CHY014C301**
L-T-P-C – 4-0-0-4 **Credit Units: 4** **Scheme of Evaluation: (T)**

Objective: The objectives of this course are:-

1. To provide the synthetic methodology of organic compounds
2. To cover the reagents used in organic synthesis
3. To throw some lights on rearrangement reactions
4. To discuss about Organometallic reactions

Prerequisites: Concept of synthetic methodology, reaction and mechanisms

Detailed Syllabus:

Modules	Topics & Course content	Periods
I	**Reagents in organic synthesis** Complex metal hydrides, DIBAL-H, Gilman's reagent, LDA, DCC, 1,3-propane dithiane, Trimethyl-silyl-tin hydride, Tri-n-butyl-tin hydride, Woodwords and Prevost hydroxylation, DDQ, SeO_2, PPC, PDC, Merifield resins, Peterson's synthesis, Baker's yeast, Chromic acid, Potassium dichromate, Jones reagent, Collins reagent, Birch reduction, Periodic acid, Lead tetra acetate, Osmium tetra oxide, Ozonolysis, m-CPBA, Wittig reagent	**12**
II	**Selective Name Reactions** Aldol, Perkin, Stobbe, Dieckmann condensation, Diels-Ader reactions, Robinson annulation, Michael, Mannich, Stork enamine, Sharpless asymmetric epoxidation, Barton, Ene, Hoffman-Loffler-Freytag, Shapiro, Chichibabin, Cannizaro, Bayer-Hilman, Darens, Benzoin condensation, Knoevenegel, Reimer-Tieman reaction, Wolf-Kishner reduction, Clemmenson reduction, Moningo reduction, Meerwein-Pondorf-Verley reduction, Oppenauer oxidation, Dess-Martin oxidation, Swern oxidation .	**12**
III	**Rearrangement reactions** Wagner-Meerwein, Pinacol-pinacolone, Wolff, Arndt-Eistert synthesis, Hofmann, Curtius, Schmidt, Lossen, Beckmann, Bayer-Villiger, Favorski, Benzillic acid rearrangement, Stevens, Wittig, Claisen, Cope.	**12**
IV	**Ylides and organometallic chemistry:** Methods of generation, properties and reactions of organo magnesium, lithium, cadmium, zinc, copper, boron. Grignard reagent and its application, Reformatsky reaction and its application. Phosphorous and sulfur ylides: methods of generation, properties and reactions.	**12**
Total		**48**

Text books:

1. *Advanced organic chemistry: Reactions, mechanism and structure;* March Jerry; 7th edition; John Wiley.
2. *Advanced organic chemistry*; Carey F. A. and Sundberg R. J.; 5th edition; Plenum.
3. *Principle of Organic Synthesis*; Norman R.O.C. and Coxon J. M.; 3rd edition; Blackie academic professional.
4. *A guide book to mechanism in organic chemistry*; Sykes Peter; 6th edition; 2013, Longman.

Reference books:

1. Carruthers W., *Some modern methods of organic synthesis*; 4th edition; Cambridge University press.

2. Clayden J., Greeves N. and Warren S., *Organic chemistry*; 2nd edition; Oxford University press.

Course outcomes:

Students will

1. learn about synthetic methods
2. have information about reagents
3. have some idea about construction of a new reaction

develop concept about metal-organic

Teaching Learning Process:

- Lectures in class rooms
- Assignments
- Group discussions
- Industry visit

Assesment methods:

- Semester End Examination: 70 marks
- Internal Assessment: 30 marks (Mid semester examination: 10, Assignment: 05, Viva: 5, Class test: 5, Attendance: 05)

SYLLABUS (3rd SEMESTER)

Paper II/Subject Name: Inorganic Chemistry II **Subject Code: CHY014C302**

L-T-P-C – 4-0-0-4 **Credit Units: 4** **Scheme of Evaluation: (T)**

Objective: The objectives of **Inorganic Chemistry II** are

- To provide an understanding of the details of inorganic reaction mechanism by giving emphasis on substitution reaction, electron transfer reaction and photochemical reactions
- To get details of spectral and magnetic properties of coordination compounds
- To provide a detailed discussion of organmetallic compounds including their bonding and properties
- To provide an elaborated discussion on organometallic reactions and catalysis
- To get details of chemistry of lanthanides and actinides

Prerequisites:

- Concept of coordination chemistry and basic inorganic reaction mechanism form B.Sc. level.
- Concept of elementary organometallic chemistry
- Basic of solid structure and elementary idea of lanthanides and actinides

.

Detailed Syllabus:

Modules	Topics & Course content	Periods
I	**Inorganic Reaction Mechanism** Substitution in octahedral and square planar complexes, lability, trans-effect, conjugate base mechanism, racemisation, electron transfer reactions: inner sphere and outer sphere mechanism, Marcus theory, inorganic photochemistry: Photo substitution and photo redox reactions of chromium, cobalt and ruthenium compounds, Adamson's rules..	**10**
II	**Coordination Chemistry II** Interpretation of the general features of the electronic absorption spectra including the charge transfer spectra of the transition metal complexes in aqueous solutions, spin-orbit coupling constant and interelectronic repulsion parameters in complex ion terms-vs-free ion terms, vibronic coupling, intensity stealing, band broadening, spectrochemical series, nephelauxetic series, structural distortion and lowering of symmetry, electronic, steric effect on energy levels, magnetic properties, quenching of orbital moment and spin only formula.	**10**

III	**Organometallics** 18 electron rule, metal carbonyls, nitrosyls, cabonyl hydrides, isolobal analogy, dioxygen and dinitrogen compounds, metal alkyls, carbenes, carbynes, alkenes, alkynes, and allyl complexes, hydrides, metallocenes, metal arene complexes, carbonylate anions, oxidative addition and reductive elimination, insertion and elimination reactions, homogeneous and heterogeneous catalysis, fluxional molecules.	**10**
IV	**Symmetry and Structure** Symmetry elements and operations, equivalent symmetry elements and equivalent atoms, symmetry point groups with examples from inorganic compounds, groups of very high symmetry, molecular dissymmetry and optical activity, systematic procedure for symmetry classification of molecules and illustrative examples, molecular symmetry for compounds having co-ordination numbers 2 to 9.	**10**
Total		**40**

Text Books:

1. *Concise Inorganic Chemistry*; Lee, J.D.; 5th edition; 2013; John Wiley and Sons Ltd.; Indian Edition.
2. *Inorganic Chemistry*; Atkins, P., Overtone, T., Rourke, J., Weller, M. and Armstrong, F.; 6th edition; 2014; Oxford University Press; Indian edition.
3. *Inorganic Chemistry Principles of Structure and Reactivity*; Huheey, J.E, Keiter, E. A., Keiter, R. L and Medhi, O. K. ; 4th edition; 2007; Pearson Education.

Reference Books:

1. Wells, A.F.*; Structural Inorganic Chemistry*; 3rd edition; 2012; Oxford Science Publishers.
2. Cotton, F.A., Wilkinson, G., Murillo, A., Bochmann M.; *Advanced Inorganic Chemistry;* 6th edition; 1999; Wiley Interscience; New York.

Course Outcomes:

The students will

1. be able to understand the details of inorganic reaction mechanism by giving emphasis on substitution reaction, electron transfer reaction and photochemical reactions.
2. know how to analysis the spectral and magnetic properties of coordination compounds.
3. be able to get detailed idea of organmetallic compounds including their bonding and properties.
4. be able to have a view of an organometallic reactions including oxidative addition and reductive elimination, insertion and elimination reactions
5. be able to understand the basics of organometallic catalysis.
6. know details of chemistry of lanthanides and actinides.

Teaching Learning Process:

- Lectures in class rooms
- Traditional teaching using board and markers.
- Hands-on learning using different three-dimensional models
- Assignments
- Group discussions

Assessment methods:

- Semester End Examination: 70 marks
- Internal Assessment: 30 marks (Mid semester examination: 10, Assignment: 05, Viva: 5, Class test: 5, Attendance: 05)

SYLLABUS (3rd SEMESTER)

Paper III/Subject Name: Physical Chemistry Laboratory		**Subject Code: CHY014C313**
L-T-P-C – 0-0-8-4	**Credit Units: 4**	**Scheme of Evaluation: (P)**

Detailed Syllabus:

Note: The students shall complete 14 experiments, 7 instrumental and 7 non-instrumental. In the semester end examination, students shall perform 2 experiments.

Unit 1: Chemical kinetics

1) Determine the temperature coefficient and energy of activation of acid hydrolysis of methyl acetate, using least-square calculation.

2) Study the kinetics of the reaction between iodine and acetone in acidic medium by half-life periodmethod and determine the order with respect to iodine and acetone.

3) Study the saponification of ethyl acetate by sodium hydroxide and determine the order of the reaction and energy of activation.

4) Study the autocatalytic reaction between oxalic acid and $KMnO_4$ and determine the order of the reaction.

5) Determine the inversion of sucrose in presence of two acids polarimetrically using Guggenheim plots and hence determine the relative strengths of the acids.

Unit 2: Conductometry

1) Determine the equivalent conductivity of acetic acid at infinite dilution by Kohlrausch's method and hence find out the degree of dissociation of the acid.

2) Find out the relative strength of acetic acid and monochloroacetic acid by conductance measurement.

2) Determine the strength of the components of the following mixtures by conductometric titration.

(a) Hydrochloric acid and acetic acid.
(b) Sulphuric acid and copper sulphate.

Unit 3: *pH*-metry and potentiometry

1) Determine the dissociation constant of acetic acid/ oxalic acid using Hendersen's equation.
2) Find the amount of the components of the following mixtures using pH - metric titration.
a) Hydrochloric acid + acetic acid
b) Hydrochloric acid + oxalic acid

Unit 4: Spectrophotometry

1) Verify Beer's law and determine the concentration of solutions like $KMnO_4$ / $K_2Cr_2O_7$/ $CuSO_4$
2) Determine the composition of iron-thiocyanate complex spectrophotometrically by Job's methodof continuous variation.

Unit 5: Miscellaneous experiments

1) Determine the molar mass of a polymer by viscometric method.
2) Perform theoretical calculations using a computer on potential energy diagram of hydrogen molecule ion.
3) Determine the coefficient of viscosity of a liquid by Ostwald's viscometer.
4) Determine the surface tension of a liquid by Stalagmometer.

Text Book:

1. *Advanced Practical Physical Chemistry*; Yadav, J.B.; 28th edition; 2009; Goel Publishing House

Reference Books:

1. Gurtu, J.N., Gurtu, A.; *Advanced Physical Chemistry Experiments*, 6th edition, 2014, Pragati Prakashan
2. Halpern, M.; *Experimental Physical Chemistry*, 2nd edition, 1988, Prentice Hall, Upper Saddle River, NJ 07458

Course Outcomes

1. be able to handle different instruments important in physical and material sciences.
2. be able to get the detailed concepts of kinetics of different reactions, autocatalytic reaction and volumetric chemical analysis by doing iodometric titration.
3. be able to understand the applications of conductivity, pH-metry and spectrophotometry.

Teaching Learning Process:

- Theoretical explanation in class rooms.
- Execution of experiments
- Recording of data and observation of result
- Regular evaluation of lab copy
- Group discussions

Assessment methods:

- Semester End Examination: 70 marks
- Internal Assessment: 30 marks (Copy: 10, Skill test: 05, Viva: 10, Attendance: 05)

SYLLABUS (3rd SEMESTER)

Paper DSEI /Subject Name: Chemical Kinetics and Electrochemistry Subject Code: CHY014D301

L-T-P-C – 4-0-0-4 Credit Units: 4 Scheme of Evaluation: T

Objective: The objectives of **Chemical Kinetics and Electrochemistry** are

- To study the details of kinetics of fast reactions, unimolecular reaction and reaction in solutions
- To acquire the knowledge of photochemical reactions and kinetics of different photochemical reactions.
- To understand the theories of electrical interface and different electrochemical methods used in electrode kinetics

Prerequisites:

- B.Sc knowledge of chemical kinetics, photochemistry and electrochemistry

Detailed Syllabus:

Modules	Topics & Course content	Periods
I	**Chemical Kinetics** *Study of fast reactions*: Stopped flow technique, temperature and pressure jump methods. NMR studies in fast reactions, shock tube kinetics, relaxation kinetics. Linearized rate equation, relaxation time in single step fast reactions, determination of relaxation time. *Theories of unimolecular reactions:* Limitations of Hinshelwood's treatment, RRK theory, Slater's treatment, RRKM theory. *Kinetics of reactions in solution:* Diffusion controlled, TST of reactions in solution, Bronsted and Bjerrum equation, effect of ionic strength, kinetic salt effect, Effect of dielectric constant on reaction rate in solution, electron transfer reactions in solution, linear free energy relationship, Hammett equation.	**10**
II	**Photochemical reactions** *Photochemical reactions*: Photophysical kinetics- state energy diagrams. Delayed fluorescence- the mechanism and kinetics of fluorescence quenching – Stern-Volmer equation. *Chemical kinetics in the elucidation of reaction mechanism*: Reaction in compounds containing carbonyl groups: photo reduction and related reaction, photocycloaddition reactions, transition metal complexes	**10**

III	**Electrochemistry-I** *Theories of electrical interface:* Electrocapillary phenomena-Lippmann equation. Electron transfer at interfaces- polarisable and non-polarisable interfaces, Kinetics of electrode reactions: Butler-Volmer equation, Tafel Plots. *Systems for Electro-chemical Energy Storage & Conversion*: Batteries: Types of Batteries, Lead- acid batteries, Nickel-cadmium batteries and Li-ion batteries, Supercapacitors: Electrical double layer capacitor, Pseudo-capacitor, Fuel Cells	**10**
IV	**Electrochemistry-II** *Electrochemical methods used in electrode kinetics*: Polarography-rotating disc electrode (RDE) – chronopotentiometric method, elucidation of mechanism of multi-step electrode reactions. Electrodeposition on metals, convective diffusion-applications in electrode processes.	**10**
Total		**40**

Text Books:

1. *Chemical Kinetics*; Laidler, K.J.; 3rd Edition; 2012; Pearson
2. *Fundamental of Photochemistry*; Mukherjee-Rohatgi, K.K.; 3rd edition, 2014, New age international (P) Ltd
3. *Electrochemical Methods: Fundamental and Applications*; J.B. Allen and Faulkner, L.R.; 2nd edition, 2000, Wiley

Reference Books:

1. Atkins P. W. and Paula J. de; *Physical Chemistry;* 10th edition; 2014; Oxford University Press
2. Levine, I.; *Physical Chemistry*; 6th edition; 2011; Tata McGraw Hill
3. Puri, B.R.; Sharma, L.R.; Pathania, M.S.; *Principles of Physical Chemistry*; 47th edition; 2016; Vishal Publishing Company
4. J.O. Bockris, A. K. N. Reddy; *Modern Electrochemistry Part 1, 2A and 2B*; 2nd Edition, Springer

Course Outcomes:

The students will

1. be able to understand different techniques used to study fast reactions.
2. be able to understand the kinetics of unimolecular reactions.
3. be able to explain the kinetics of reactions in solutions.
4. be able to acquire knowledge of different photochemical reactions
5. know the theories of electrical interface and electrochemical methods used in electrode kinetics

Teaching Learning Process:

- Lectures in class rooms
- Traditional teaching using board and markers.
- Power point presentation
- Assignments
- Group discussions

Assessment methods:

- Semester End Examination: 70 marks
- Internal Assessment: 30 marks (Mid semester examination: 10, Assignment: 05, Viva: 5, Class test: 5, Attendance: 05)

SYLLABUS (3rd SEMESTER)

Paper DSE II /Subject Name: Heterocyclic Compounds and Natural products
Subject Code: CHY014D302

L-T-P-C – 4-0-0-4 **Credit Units: 4** **Scheme of Evaluation: T**

Objective: The objectives of **Heterocyclic Compounds and Natural products** are

1. To provide the synthetic methodology of heterocyclic compounds
2. To cover the heterocyclic reagents used in organic synthesis
3. To throw some lights on the use of heterocyclic compounds
4. To understand the importance and application of natural products
5. To help students to understand the structure and reactions of biological molecules

Prerequisites:

- Concept of organic synthesis, alicyclic compounds
- Concept of Organic Chemistry from B.Sc. level

Detailed Syllabus:

Modules	Topics & Course content	Periods
I	**Chemistry of Quinolines, Isoquinolines and Indoles** *Quinoline and Isoquinoline*: Electrophilic addition to nitrogen, electrophilic substitution at carbon, nucleophilic substitution, nucleophilic addition to quinolinium/isoquinolinium salts, Palladium(0)-catalysed reactions, oxidation and reduction, alkyl substituents, oxygen substituents, *N*-Oxides. Synthesis of quinolines from anilines, from *ortho*-aminoaryl ketones or aldehydes, synthesis of isoquinolines from 2-arylethamines, from aryl-aldehydes and an aminoacetaldehyde acetal, from ortho-alkynyl aryl-aldehydes or corresponding imines. *Indole*: Electrophilic substitution at carbon, Palladium(0)-catalysed reaction, oxidation and reduction, pericyclic reactions, reactivity of side-chain substituents, oxygen substituents. Synthesis of indoles from arylhydrazones, from *ortho*-nitrotoluenes, from *ortho*-aminoaryl alkynes, from *ortho*-alkylaryl isocyanides, from *ortho*-acyl anilides, synthesis of isatins from anilines, synthesis of oxindoles from anilines.	**10**
II	**Chemistry of Pyryliums, Benzopyryliums, Pyrones, Benzopyrones and Diazines** Pyrylium salts, electrophiles, nucleophilic addition. Ring-opening reactions of 2*H*-pyrans, oxygen substituents – pyrones and benzopyrones. Ring synthesis of pyryliums from 1,5-diketones, ring synthesis of 4-pyrones from 1,3,5-triketones, ring synthesis of 2-pyrones from 1,3-keto-aldehydes, ring synthesis of 1-benzopyryliums,	**10**

	coumarins and chromones. Electrophilic addition to nitrogen, electrophilic substitution at carbon, nucleophilic substitution, radical substitution, *C*-metallated diazines, Palladium(0)-catalysed reactions, pericyclic reactions, oxygen substituents, *N*-Oxides, amine substituents. Ring synthesis – disconnections, synthesis of pyridazines from 1,4-dicarbonyl compounds, synthesis of pyrimidines from 1,3-dicarbonyl compounds, synthesis of pyrazines from 1,2-dicarbonyl compounds, synthesis of pyrazines from α-amino-carbonyl compounds, benzodiazines.	
III	**Basic Chemistry of Alkaloids and Terpenoids** Source, structural types of alkaloids, classification, structure elucidation, reactions and synthesis of representative examples (Nicotine, Atropine, Coniine and Papaverine). Isoprene rule, structure elucidation and synthesis of representative examples of acylic, monocylic and bicyclic monoterpens. Structural types; general introduction to sesqui-, di- and tri- terpenoids.	**10**
IV	**Reaction and Synthesis of Some Special Natural Products** Stereochemistry, reaction and synthesis of terpenoids and carotenoids: Zingiberine, Santonin, Abietic acid, β-carotene. Stereochemistry, reactions and synthesis of alkaloids: Quinine, Morphine. Reaction and synthesis of Steroids: Cholesterol, Bile acid, Testosterone, Estrone, Progesterone. Structure and synthesis of Prostaglandins: PGE_2, $PGF_{2\alpha}$.	**10**
Total		**40**

Text Books:

1. *Heterocyclic Chemistry*; Joule J. A., Mills K.; 5th Edition; Jun 2010; Wiley-Blackwell.
2. *Principles of Modern Heterocyclic Chemistry*; Paquette L. A.; Jan 2010; University of Minnesota.
3. *Advanced organic chemistry*; Carey F. A. and Sundberg R. J.; 5th edition; Plenum.
4. *Chemistry of Plant Natural Products:Stereochemistry, Conformation, Synthesis, Biology, and Medicine*; Talapatra S.K., Talapatra B.; 2nd edition; 2017; Springer-Verlag Berlin and Heidelberg GmbH & Co. KG; Berlin, Germany.
5. *Chemistry of Natural Product Vol. I*; K. Nakanishi.

Reference books:

1. Carruthers W., *Some modern methods of organic synthesis*; 4th edition; Cambridge University press.
2. Clayden J., Greeves N. and Warren S., *Organic chemistry*; 2nd edition; Oxford University press.
3. Mann J., Davidson Fl.S., Hobbs J.B., Banthrope D.V. and Harborne J. B.; *Natural Products: Chemistry and Biological Significance;* Longman, Essex.

Course Outcomes:

The student will

- learn about synthetic methods involving heterocyclic chemistry.
- have information about heterocyclic reaction.
- have some idea about construction of reaction using heterocyclic compounds.
- be able to know the fundamental concepts of biological molecules.
- develop the fundamental concepts to predict the structure of an unknown drug.

Teaching Learning Process:

- Lectures in class rooms
- Traditional teaching using board and markers.
- Hands-on learning using different three-dimensional models
- Assignments
- Group discussions

Assessment methods:

- Semester End Examination: 70 marks
- Internal Assessment: 30 marks (Mid semester examination: 10, Assignment: 05, Viva: 5, Class test: 5, Attendance: 05)

SYLLABUS (3rd SEMESTER)

Paper DSE III /Subject Name: Bio-inorganic Chemistry **Subject Code: CHY014D303**

L-T-P-C – 4-0-0-4 **Credit Units: 4** **Scheme of Evaluation: (T)**

Objective: The objectives of **Bioinorganic Chemistry** are

- To provide an understanding of scope of bioinorganic chemistry.
- To provide an emphasis on biochemistry of iron.
- To put light on chemistry of metalloenzymes.
- To cover the idea of metals in medicine

Prerequisites:

- Concept of bio-inorganic chemistry from B.Sc level.

Detailed Syllabus:

Modules	Topics & Course content	Periods
I	**Scope of Bioinorganic Chemistry** Inorganic elements in biological systems, cells, biologically important compounds amino acids, proteins, nucleotides, carbohydrates and lipids, basic bioenergetics, classification of enzymes. Biochemistry: Distribution, biological roles, active transport of cations across membranes, the sodium pump, biology of calcium carriers, role in muscle contraction, enzyme stabilization, blood clotting and biological calcification.	**12**
II	**Biochemistry of Iron** Structure and optical spectra; haeme proteins: magnetic susceptibility, epr and electronic spectra; haemoglobin and myoglobin: molecular structures, thermodynamics and kinetics of oxygenation, electronic and spatial structures, synthetic oxygen carriers, model systems; iron enzymes, peroxidase, catalase and cytochrome P-450; iron storage, transport, biomineralization and siderophores, ferritin and transferrins.	**12**
III	**Metalloenzymes** Copper enzymes, superoxide dismutase, cytochrome oxidase and ceruloplasmin; Coenzymes; molybdenum enzyme: xanthine oxidase; Nitrogenase and nitrogen fixation, zinc enzymes: carbonic anhydrase, carboxypeptidase and interchange ability of zinc and cobalt in enzymes; Vitamin B12 and B12 coenzymes; Iron storage, transport, biomineralization and siderophores, ferritin and transferrins.	**12**
IV	**Metals in Medicine** Metal deficiency and disease; toxicity of mercury, cadmium, lead, beryllium, selenium and arsenic; biological defence mechanisms;	**12**

	chelation therapy; metals used for diagnosis and chemo- therapy, platinum complexes as anticancer drugs, Pt-DNA binding, complexes of gold, copper, zinc, mercury, arsenic and antimony as drugs.	
Total		**48**

Text Books*:*

1. *Principles of Bioorganic Chemistry*, Lippard S.J.; Berg J.M,; 2nd edition, 2005; Panima Publ. Corpn

Reference Books*:*

1. Kraatz H. & Metzler-Nolte N; *Concepts and Models in Bioinorganic Chemistry*, 3rd edition; 2006; Wiley.
2. Bertini I, Gray H. B., Dippard S. J., Valentine, J. S. ; *Bioinorganic Chemistry*; 3rd edition; 2004; Viva Books Pvt. Ltd.

Course Outcomes:

The students will
1. be able to understand the detailed idea of scope of bioinorganic chemistry..
2. be able to know the details of biochemistry of iron.
3. be able to get an idea of chemistry of mealloenzymes.
4. be able to get details of metals in medicine.

Teaching Learning Process:

- Lectures in class rooms
- Traditional teaching using board and markers.
- Hands-on learning using different three-dimensional models
- Assignments
- Group discussions

Assessment methods:

- Semester End Examination: 70 marks
- Internal Assessment: 30 marks (Mid semester examination: 10, Assignment: 05, Viva: 5, Class test: 5, Attendance: 05)

SYLLABUS (3rd SEMESTER)

Paper DSE IV /Subject Name: Supramolecular Chemistry **Subject Code: CHY014D304**

L-T-P-C – 4-0-0-4 **Credit Units: 4** **Scheme of Evaluation: T**

Objective: The objectives of **Supramolecular Chemistry** are:

- To provide the methodology of synthesis and characterization of macromolecular materials
- To throw some lights on synthetic strategies of Dendrimers
- To discuss about Principles of molecular association and organization.

Prerequisites:

- Concept of intermolecular forces, covalent bonds, macromolecules and synthetic methodology

Detailed Syllabus:

Modules	Topics & Course content	Periods
I	**Introduction to Supramolecular Chemistry** Properties of covalent bonds - bond length, bond angles, force constant, bond and molecular dipole moments, molecular and bond polarizability, bond dissociation enthalpy, entropy, intermolecular forces, hydrophobic effects, electrostatic induction, dispersion and resonance energy, magnetic interactions, magnitude of interaction energy, forces between macroscopic bodies, medium effects, hydrogen bond. Introduction to supramolecules, host and guest molecules Host-guest assembly and supramolecular assembly, selectivity of host molecules, introduction of cation and anion binding host molecules.	**10**
II	**Supramolecular Chemistry - I** Principles of molecular association and organization as exemplified in biological macromolecules like enzymes, nucleic acids, membranes and model systems like micelles and vesicles. Molecular receptors and design principles, Cryptands, cyclophanes, calixeranes, cyclodextrines, supramolecular reactivity and catalysis, molecular channels and transport processes, molecular devices and nanotechnology.	**10**
III	**Supramolecular Chemistry - II** Molecular recognition: Molecular receptors for different types of molecules including arisonic substrates, design and synthesis of coreceptor molecules and multiple recognition. Supramolecular reactivity and catalysis, transport processes and carrier design, supramolecular devices, supramolecular photochemistry, supramolecular electronic, ionic and switching devices.	**10**

IV	**Supramolecular Chemistry - III** Introduction of Dendrimers, synthesis and characterization of macromolecular materials, including linear, branched, dedrimetric and star polymers. Synthetic strategies and structural variations, mechanical and physiochemical properties of polymer types, kinetics of living polymerization; applications to nanostructures, templates and advanced devices, Competitive binding of guest molecules on the surface or in the interior of dendrimers, Supramolecular structure of dendrimer/surfactant aggregates, Biomedical applications.	**10**
Total		**40**

Text books:

1. *Supramolecular Chemistry (Concepts and Perspectives)*; Jean Marie Lehn, 1st edition, 2006, Wiley- VCH.
2. *The Physical Basis of Organic Chemistry*, H. Maskill, 2nd edition, 2004, Oxford University Press.
3. *A guide book to mechanism in organic chemistry*; Peter Sykes; 6th edition; 2003, Longman.

Reference books

1. Vogtle F., Richardt G., Werner N., Rackstraw A.J.; *Dendrimer Chemistry*, Wiley-VCH, 2009.
2. Steed J. and Atwood J.L., *Supramolecular Chemistry*, 2nd edition, 2001, Wiley.

Course outcomes:

Students will

- learn about synthetic methods of supramolecules
- have information about Dendrimers
- have some idea about molecular recognition
- develop concept about host-guest assembly and supramolecular assembly.

Teaching Learning Process:

- Lectures in class rooms
- Traditional teaching using board and markers.
- Hands-on learning using different three-dimensional models
- Assignments
- Group discussions

Assessment methods:

- Semester End Examination: 70 marks
- Internal Assessment: 30 marks (Mid semester examination: 10, Assignment: 05, Viva: 5, Class test: 5, Attendance: 05)

SYLLABUS (3rd SEMESTER)

Paper DSE V /Subject Name: Spectral Techniques in Inorganic Chemistry Subject Code: CHY014D305

L-T-P-C – 4-0-0-4 Credit Units: 4 Scheme of Evaluation: T

Objective: The objectives of **Spectral Techniques in Inorganic Chemistry** are

- To provide a detail idea of application of NMR and EPR to inorganic chemistry
- To provide an emphasis on CD/ORD, NQR and Mossbauer.
- To put light on Raman, Mass, PES, ESCA, IR and EPR

Prerequisites:

- Concept of basic spectral techniques.

Detailed Syllabus:

Modules	Topics & Course content	Periods
I	**NMR** ^{1}H, ^{11}B, ^{13}C, ^{14}N, ^{17}O, ^{19}F and ^{31}P-NMR: instrumentation, chemical shift and application; fluxionality, distortion and dynamic equilibria; long-range spin-spin interaction; Identification of compounds like H_3PO_3, H_3PO_2, HPF_2, P_4S_3 etc. Adduct formation reaction: AsF_3 with SO_3. Exchange reaction – exchange in H_2O, factors affecting line width, evaluation of thermodynamic parameter with NMR, determination of reaction order, rate constant etc. from NMR. NMR spectra of paramagnetic ions. Contact shifts. Factors contributing to the magnitude of chemical shift. Applications involving the magnitude of coupling constant – J_{13C-H}, J_{Pt-P}, J_{P-F} etc. NMR spectra of $B_3H_8^-$, $HP_2O_5^{3-}$, $TiF_4.2B$ (B as donor molecule); consequences of nucleii with quadrupole moment in NMR. Double resonance technique. Introduction to pulse and FT NMR, time domain vs. frequency domain, FID, CW vs. FT NMR, rotating frame of reference, relaxation time measurements instrumentation.	**12**
II	**CD/ORD , NQR and Mossbauer** **CD/ORD**: The symmetry origin of the optical activity of molecules, The phenomena of Optical Rotatory Dispersion (ORD) and Circular Dichroism (CD): principle, methodology and applications, molecular dissymmetry and chiroptical properties, Cotton effect, Faraday effect in magnetic circular dichroism (MCD) and application; **NQR**: Basic theory, effect of magnetic field in the spectra, relationship between 'q' and molecular structure. Structural information from NQR spectra, Applications. **Mössbauer**: Gamma ray emission and absorption by nuclei, Mossbauer effect, conditions, nuclear recoil, Doppler effect, instrumentation, chemical shift examples, quadrupole effect, effect of magnetic field, effect of simultaneous electric and magnetic fields, Use	**12**

	of Mössbauer spectra in chemical analysis, typical spectra of iron and tin compounds.	
III	**IR and EPR** **IR:** Origin, absorption of radiation by molecular vibrations in polyatomic molecules, effects giving rise to absorption bands, group vibration, limitation of the concept, FTIR, NDIR techniques **EPR:** Hyperfine splitting in various systems, factors affecting the magnitude of g-value, Anisotropy in the hyperfine coupling constants, zero-field splitting, Kramers' degeneracy, nuclear quadrupole interactions.	**12**
IV	**Raman, Mass, PES and ESCA** **Raman Spectrometry**: Theory, instrumentation, mechanism of Raman Effect, effect in solids, liquids and gases, Use of symmetry considerations to determine the number of active infra red and Raman lines, differences of IR and Raman spectra, Laser Raman spectra**.** **Application EI, CI, FD, FAB-Mass, MALDI-TOF;** isotropic effect, fragmentation patterns and application in structure elucidation; Photoelectron spectroscopy: Photo excitation and photo ionization, core level (XPS, ESCA) and valence level (UPS) Photoelectron spectroscopy, XPS and UPS experiment, chemical shift, detection of atoms in molecules and differention of same element in different environment from XPS, information about the nature of molecular orbital from UPS of simple diatomic molecule e. g. N_2, O_2, CO, HCl etc. ESCA: Introduction to Electron Spectroscopy for Chemical Analysis (ESCA), Application to the analysis of inorganic samples**.**	**12**
Total		**48**

Text Books:

1. *Infrared and Raman Spectra of Inorganic and Coordination Compounds;* Nakamoto K,; 5th edn.; 1997, John Wiley.
2. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, Parish, R. V. Horwood, E.; 3rd edition; 1990.

Reference Books:

1. Drago, R. S.; *Physical Methods in Chemistry*, 1st edition; 1977; Saunders College Publishers .
2. Banwell C. N., McCas, E. M; *Fundamentals of Molecular Spectroscopy*, 2nd edition, 2006, Tata McGraw Hill, New Delhi**.**

Course Outcomes:

The students will

1. be able to understand the detailed concept application of NMR and EPR to inorganic chemistry.

2. be able to know the details of CD/ORD , NQR and Mossbauer.

3. be able to get an idea of Raman, Mass, PES, ESCA, IR and EPR.

Teaching Learning Process:

- Lectures in class rooms
- Traditional teaching using board and markers.
- Hands-on learning using different three-dimensional models
- Assignments
- Group discussions

Assessment methods:

- Semester End Examination: 70 marks
- Internal Assessment: 30 marks (Mid semester examination: 10, Assignment: 05, Viva: 5, Class test: 5, Attendance: 05)

SYLLABUS (3rd SEMESTER)

Paper DSE VI /Subject Name: Computer in Chemistry **Subject Code: CHY014D306**

L-T-P-C – 4-0-0-4 **Credit Units: 4** **Scheme of Evaluation: T**

Objective: The objectives of **Computer in Chemistry** are

- to provide the idea of applications of computer to solve different chemical problems

Prerequisites:

- Concept of linear algebra, differential equations, basic computer knowledge

Detailed Syllabus:

Modules	Topics & Course content	Periods
I	**Fortran/ C Programming** Basic computer architecture and data representation, binary arithmetic. Algorithm development and program design, introduction to Fortran language: data types, integer, complex, character, logical constants and variables, arithmetic statements, expressions, library function, relational operators, Input and output statements, I/O format statements, different types of control statements, loop structures, subscribed variables and arrays, writing, executing and running of simple FORTRAN programmes.	**10**
II	**Numerical Analysis** Data analysis, mean and standard deviation, absolute and relative errors, linear regression, covariance and correlation coefficient. Curve fitting, solution of polynomial equation, numerical integration (Trapezoidal Rule, Simpson's Rule, Gaussian Quadrature), solution of ordinary , differential equations (Euler's Method, Runge-Kutta methods, predictor-corrector method), matrix multiplication, inversion and diagonalization.	**10**
III	**Application of Fortran Programming to Chemical Problems** Development of small computer codes involving simple formulae in chemistry, such as van der Waals equation, pH titration, kinetics, radioactive decay, evaluation of lattice energy and ionic radii from experimental data, linear simultaneous equations to solve secular equations within the Hückel theory, elementary structural features such as bond lengths, bond angles, dihedral angles etc., of molecules extracted from a database such as Cambridge database.	**10**

IV	**Use of Computer Programmes** Execution of linear regression, X-Y plot, numerical integration and differentiation as well as differential equation solution programmes. Static properties of complex systems: Introduction to Monte Carlo as a way of averaging, dynamical properties of complex systems: Molecular Dynamics as a way of averaging.	**10**
Total		**40**

Text Books:

1. Computational Chemistry: An Introduction to Numerical Methods; Norris, A.C.; 2nd edition, 1981; John Wiley
2. Computer Programming in FORTRAN 77; Rajaraman, F. I.; Prentice Hall
3. Numerical Analysis; Frogberg, C.E.; Macmillan.

Reference Books:

1. Maron, M. J.; *Numerical Analysis - A Practical Approach*; 3rd edition; 1991; John Wiley
2. Antia, H. M.; *Numerical Methods for Scientists and Engineers*; 2nd edition; 2002; Springer Science & Business Media

Course Outcomes:

The students will

1. be able to understand about FORTRAN programming and construction of different algorithms
2. be able to apply the computer programming in chemical problems.

Teaching Learning Process:

- Lectures in class rooms
- Computational programming
- Use of quantum-chemical software to solve problem
- Use of molecular modelling software

Assesment methods:

- Semester End Examination: 70 marks
- Internal Assessment: 30 marks (Mid semester examination: 10, Assignment: 05, Viva: 5, Class test: 5, Attendance: 05)

SYLLABUS (4th SEMESTER)

Paper I /Subject Name: Environmental & Green Chemistry **Subject Code: CHY014C401**

L-T-P-C – 4-0-0-4 **Credit Units: 4** **Scheme of Evaluation: T**

Objectives: The objectives of **Environmental & Green Chemistry** are:

- To provide the knowledge of major pollutants
- To discuss different ways of Control of air, water and soil pollutions
- To discuss about principles and methodologies of green chemistry

Prerequisites:

- Concept of composition of atmosphere causes and effects of pollutions, different synthetic reagents, solvents etc.

Detailed Syllabus:

Modules	Topics & Course content	Periods
I	**Atmospheric Chemistry** Composition of atmosphere – major regions of atmosphere – Particles Ions and radicals in the atmosphere and their formation (formation of particulate matter, Ions and radicals), Air pollution – Major air pollutants – (Oxides of Carbon – Oxides of Nitrogen – Oxides of sulphur- Particulars – Smog and photochemical smog- Metallic pollutants –Radiation – Chemicals – Petroleum – Chlorofluorocarbons) – Effects of Airpollution (Acid rain, Green house effect, Global warming, Depletion of Ozone) –Control of air pollution.	**12**
II	**Hydrosphere** Chemistry Distribution of chemical species in water, Gases in water, alkalinity, organic matter in water, criteria and standards of water quality- safe drinking water, Types of water pollutants – (Biological agents , Chemical agents , Physical agents), Toxic metals in water, Waste water treatment processes, Water purification for drinking and industrial purposes, disinfection techniques, demineralization and reverse osmosis.	
III	**Soil Chemistry** Composition of soil, types of soil, Chemical properties – cation exchange capacity, p^H, macro and micro nutrients, Wastes from mining and metal production, Hazardous wastes and their disposal, Biodegradation of waste-anaerobic and aerobic treatment, Incineration, Pesticides and their role in the environment.	**12**

IV	**Green Chemistry** Principles of green chemistry, principles of green organic synthesis, green alternatives of organic synthesis-coenzyme catalysed reactions, green alternatives of molecular rearrangements, electrophilic aromatic substitution reactions, oxidation-reduction reactions, clay catalysed synthesis, condensation reactions, Green photochemical reactions, Green Solvents, Introduction to microwave assisted reactions.	**12**
Total		**48**

Text books:

1. *Air Pollution: its Origin and Control*; K. Wark, C. F. Warner & W. T. Davis, 3rd edition, 1997, Pearson
2. *Environmental Pollution*, A.K. De, 6th edition, 2006, New Age International, New Delhi.
3. *Environmental Chemistry*, B.K. Sharma & H. Kaur, 2nd edition, 2003, Goel Publishing house, Meerut

Reference books

1. Rao C.S., *Environmental Pollution Control Engineering*, 2nd edition, 2006, New Age International
2. Sanghi R. and Srivastava M. M., *Green Chemistry: Environment Friendly alternatives*, 2nd edition, 2008, Narosa Publishing House, New Delhi, India.

Course outcomes:

Students will

- learn about major air pollutants, effects of air pollution synthetic methods
- have information about metal toxicity
- have some idea about waste water treatment processes
- develop concept of green chemistry

Teaching Learning Process:

- Lectures in class rooms
- Assignments
- Group discussions
- Field trip

Assesment methods:

- Semester End Examination: 70 marks
- Internal Assessment: 30 marks (Mid semester examination: 10, Assignment: 05, Viva: 5, Class test: 5, Attendance: 05)

SYLLABUS (4th SEMESTER)

Paper II /Subject Name: Spectroscopy-II **Subject Code: CHY014C402**

L-T-P-C – 4-0-0-4 **Credit Units: 4** **Scheme of Evaluation: T**

Objectives: The objectives of **Spectroscopy-II** are

- To provide a thorough background those are particularly important to analytical chemistry
- To provide the knowledge, techniques and principles of spectroscopy and to develop the ability to apply skills in the proper handling of apparatus
- To develop problem solving skills

Prerequisites:

-
- Concept of basic theory and principle of quantum chemistry, electro-magnetic radiation

Detailed Syllabus:

Modules	Topics & Course content	Periods
I	**Rotational and Vibrational spectroscopy** Rotational spectroscopy: Classification of molecules based on their moment of inertia, rotational energy levels, molecular geometry determination, stark effect, molecular dipole moment. Rotational spectroscopy of symmetric and asymmetric top molecules. Vibrational spectroscopy: Harmonic and anharmonic oscillators. Morse potential, mechanical and electrical anharmonicity, selection rules. The determination of anharmoncity constant and equilibrium vibrational frequency from fundamental and overtones. Vibrational selection rules using symmetry, polarization of transitions. Normal modes analysis using group theory. Raman spectroscopy- polarizability tensor, Stokes and anti-Stokes lines, instrumentation and applications in chemical and biological systems.	**12**
II	**Principles behind CD/ORD spectroscopy and application** *CD/ORD:* symmetry origin of optical activity of molecules. Phenomenon of Optical Rotatory Dispersion (ORD) and Circular Dichroism (CD): principle, methodology and applications, molecular dissymmetry and chirooptical properties, Cotton effect, Faraday effect in magnetic circular dichroism. Application of CD/ORD spectroscopy for the study of metal-ligand equilibria	**12**

III	**Theory of Mössbauer and Electron Spin Resonance (ESR) spectroscopy with its application** Mössbauer spectroscopy: Gamma ray emission and absorption by nuclei, Mössbauer effect, conditions, nuclear recoil, Doppler effect, instrumentation, chemical shift, quadruple effect, effect of magnetic field, effect of simultaneous magnetic and electric fields. Electron Spin Resonance (ESR) spectroscopy: Introduction, behavior of a free electron in an external magnetic field, basic principle, hyperfine coupling in isotropic system. Factors affecting magnitude of g-values. Line width, double resonance. Application of Mössbauer spectroscopy to the study of high-spin and low-spin iron compounds and in coordination complexes. Application of ESR spectroscopy in transition metal complexes having one unpaired electron including biological systems and to inorganic free radicals.	**12**
IV	**NMR and Electronic spectroscopy in inorganic chemistry** Fluorescence and phosphorescence spectroscopy: Jablonski Diagram, origin of fluorescence and phosphorescence processes, quantum yield, fluorescence quenching-static and dynamic. Instrumentation and applications. NMR spectroscopy: Simple application to diamagnetic inorganic compounds; NMR paramagnetic shifts, simple application to paramagnetic compounds; NMR of ^{31}P and ^{19}F in inorganic compounds. Photoelectron spectroscopy: Basic principles and applications of PES (O_2, N_2 and N_3^- only); chemical information from ESCA.	**12**
Total		**48**

Text books:

1. *Fundamentals of molecular spectroscopoy*; Banwell Colin N., McCash Ellain M; 4th edition; 2001; Tata Macgraw-Hill.

Reference books:

1. Rao C. N. R. and Ferraro J. R.; *Spectroscopy in Inorganic Chemistry*; Vol. I & II; 1970 and 1971; Wiley; New York.
2. Greenwood N. N. and Gibb T. C.; *Mossbauer spectroscopy*; 1977; Chappman and Hall ltd; London.
3.

Course Outcomes:

The student will

- be able to know those laboratory skills that will give students confidence in their ability to obtain high quality analytical data.
- be able to develop an appreciation for difficult task of judging the accuracy and precision of experimental data.
- be able to know the techniques that are useful in modern analytical Chemistry application of Spectroscopy.

Teaching Learning Process:

- Lectures in class rooms
- Assignments
- Group discussions
- Technology driven teaching

Assesment methods:

- Semester End Examination: 70 marks
- Internal Assessment: 30 marks (Mid semester examination: 10, Assignment: 05, Viva: 5, Class test: 5, Attendance: 05)

SYLLABUS (4th SEMESTER)

Paper DSE I /Subject Name: Advanced Quantum Chemistry		**Subject Code: CHY014D401**
L-T-P-C – 4-0-0-4	**Credit Units: 4**	**Scheme of Evaluation: (T)**

Objectives: The objectives of **Advanced Quantum Chemistry** are

- to provide the idea about approximation methods of quantum chemistry and electronic structure of many electron atoms
- to discuss about different theorems of quantum mechanics
- to know details of semi-empirical methods and density functional theory

Prerequisites:

- Concept of linear algebra, differential equations both ordinary & partial, calculus and matrices.

Detailed Syllabus:

Modules	Topics & Course content	Periods
I	**Electronic Structure of Many-electron Atoms** Product wave functions- complete many-electron wave functions including electron spin. Pauli's anti-symmetry and exclusion principles. Spin states of a two-electron system- singlet and triplet states. Independent particle central field model of many-electron atoms- the helium atom, Slater type orbitals (STO); basis sets, minimal basis set: STO-3G, polarized basis sets, electron repulsion parameters, Spectroscopic term symbols for the s1, p1, p2 and d2configurations- splitting of term energies due to electron repulsion and magnetic effects- spin orbit coupling and Zeeman splitting	**10**
II	**Theorems in Molecular Quantum Mechanics** a) Born-Oppenheimer approximation, separation of electronic and nuclear motion b) Introduction to the molecular electronic virial theorem c) Hellmann-Feynman theorem and its chemical applications. d) The electrostatic theorem and the force field concept in chemistry	**10**
III	**Semi-Empirical and Ab-initio SCF Theories** Huckel, EHT and PPP treatments, ZDO approximation, treatment of CNDO and INDO theories, discussion of electronic energies and properties. Self-consistent-field (SCF) method, Hartree-Fock theory of closed shell electronic configuration of atoms and molecules, Koopman's theorem, Gaussian basis set.	**10**

IV	**Recent Advances in Quantum Chemistry** *Density Functional Theory*: Electron correlation and its treatment, basics of density functional theory, Hohenberg-Kohn theorem, Kohn-Sham formulation, treatment of chemical concepts with the density functional theory: DFT based reactivity descriptors and their uses in quantitative structure property relationship (QSPR) and quantitative structure activity relationship (QSAR). Overview of combined QM/MM method. Use of quantum chemistry and modelling software packages like GAMESS, GAUSSIAN, GaussView etc.	**10**
Total		**40**

Text Books:

1. *Quantum Chemistry*; Levine, I.N.; 7th edition, 2014; Prentice Hall of India
2. Modern Quantum Chemistry Szaboo, A. and Ostlund, N.S.; 1st edition; 2015

Reference Books:

1. *Quantum Chemistry;* Prasad, R.K.; 4th edition; 2009; New Age International Publishers Limited
2. Chandra, A.K.; I*ntroductory Quantum Chemistry*; 4th edition; 2006; Tata McGraw Hill
3. McQuarrie, D.A.; *Quantum Chemistry*; 2nd edition; 2011; Viva Books Pvt Ltd
4. Atkins, P.W and S.F. Ronald; *Molecular Quantum Mechanics;* 5th edition; Oxford University Press

Course Outcomes:

The students will

1. understand about the approximate methods for quantum chemical treatment of many electron system
2. be able to understand different theorem in molecular quantum mechanics
3. be able to know about semi empirical methods and brief idea about density functional theory

Teaching Learning Process:

- Lectures in class rooms
- Traditional teaching using board and markers.
- Assignments
- Use of computational techniques and quantum-chemical software

Assesment methods:

- Semester End Examination: 70 marks
- Internal Assessment: 30 marks (Mid semester examination: 10, Assignment: 05, Viva: 5, Class test: 5, Attendance: 05)

SYLLABUS (4th SEMESTER)

Paper DSE II /Subject Name: Catalysis and Surface Chemistry **Subject Code: CHY014D402**

L-T-P-C – 4-0-0-4 **Credit Units: 4** **Scheme of Evaluation: (P)**

Objective: The objectives of **Catalysis and Surface chemistry** are

- To know about the mechanisms of kinetics of heterogeneous catalysis
- To acquire the knowledge of zeolites and clay and their uses as heterogeneous catalyst
- To understand the properties of liquid-solid interface of surface chemistry
- To understand different techniques used in surface characterization

Prerequisites:

- Concept of heterogeneous catalyst, adsorption and basic knowledges of zeolites and clays

Detailed Syllabus:

Modules	Topics & Course content	Periods
I	**Kinetics of Heterogeneous Catalysis** Surface area determination from adsorption isotherms and point-B methods, porosity determination by volumetric and gravimetric methods. Chemisorption on metals, semi-conducting oxides and insulator oxides. Kinetics of heterogeneous catalysis, effect of temperature on rates of catalyzed reactions, Langmuir–Hinshelwood and Eley–Rideal mechanism, mass transport limitation of catalyzed reactions. Surface dependence of reaction rates, volcano principles.	**12**
II	**Zeolites and Clays** Zeolites (natural and systhetic)- shape selectivity properties- solid acids, acidity of zeolites and clays. Mesoporous materials, poorly crystalline silicates and aluminosilicates- MCM-41 type materials. Applications of zeolites and clays as heterogeneous catalysts in cracking, reforming and olefin reactions. Zeolites as catalyst supports	**12**
III	**Surface Chemistry: The Solid-Liquid Interface** Surface energy from solubility changes, surface energy from immersion, contact angle, contact angle hysteresis, experimental methods and measurement of contact angle, theories of contact	**12**

	angle phenomena, adsorption of non-electrolytes from dilute solutions, irreversible adsorption, adsorption in binary liquid systems, adsorption of electrolytes.	
IV	**Surface Characterization Techniques** Ultra-high vacuum for surface studies, Low energy electron diffraction, Photoelectron spectroscopy, Inverse photoemission spectroscopy, Scanning probe microscopy, Auger electron spectroscopy, Infrared spectroscopy, High resolution electron energy loss spectroscopy, Low energy ion scattering spectroscopy.	**12**
Total		**48**

Text Books:

1. *Heterogeneous Catalysis: Principles & Applications*, Bond, G.C.; 2nd edition, 1987, Oxford University Press
2. *Physical Chemistry of Surfaces;* Adamson, A.W. and Gast, A.P.; 6th edition; 1997; John Wiley and Sons, Canada

Reference Books:

1. Chakrabarty, D.K. and Viswanathan, B.; *Heterogeneous Catalysis*; 1st edition; 2011; New Age International (P) Limited
2. Thomas, M.; Thomas, W.J.; *Introduction to principles of heterogeneous catalysis*; 1st edition, 1967; Academic Press, New York
3. Somorjai, G.A.; *Introduction to surface chemistry and catalysis*, 2nd edition; 2010; Wiley-Blackwell,

Course Outcomes:

The students will

1. be able to understand reaction kinetics of heterogeneous catalysis.
2. be able to know about the properties of zeolites and clays and their industrial applications.
3. be able to explain surface phenomenon of solid-liquid interface.
4. be able to different techniques used in surface characterizations.

Teaching Learning Process:

- Lectures in class rooms
- Traditional teaching using board and markers.
- Assignments
- Power point presentation

Assesment methods:

- Semester End Examination: 70 marks
- Internal Assessment: 30 marks (Mid semester examination: 10, Assignment: 05, Viva: 5, Class test: 5, Attendance: 05)

SYLLABUS (4th SEMESTER)

Paper DSE III /Subject Name: Medicinal Chemistry		**Subject Code: CHY014D403**
L-T-P-C – 4-0-0-4	**Credit Units: 4**	**Scheme of Evaluation: (T)**

Objective: The objectives of **Medicinal Chemistry** are

.

- To help students in the development of curiosity and interest in Medicinal Chemistry
- To help students to understand the structure and reactions of biological molecules
- To provide the students the fundamental concepts required to rationalise and predict the structure of an unknown drug

Prerequisites:

- Concept of fat, carbohydrate, protein molecules
- Concept of Organic Chemistry from B.Sc. level

Detailed Syllabus:

Modules	Topics & Course content	Periods
I	**Drug Targets** Drug targets at molecular level: Lipids, carbohydrates, proteins as drug targets. Enzymes acting as drug targets: Reversible inhibitor, irreversible inhibitor, active site of an enzyme, competitive, non-competitive, mixed inhibitor, suicide substrates, and medicinal use of inhibitors. Receptor as drug targets: Role of a receptor, neurotransmitter and hormones, receptor types and subtypes, receptor activation, the change of shape of binding site, design of agonist, antagonist, partial agonist, inverse agonist; tolerance and dependence, affinity, efficacy and potency of a drug.	**12**
II	**Pharmacokinetics** The three phases of drug action, a typical journey for an orally active drug, drug absorption. Drug distribution: Distribution around the blood supply, distribution to tissues, distribution to cells, blood–brain barrier, drug–drug interactions. Drug metabolism: Phase-I and phase-II metabolism, metabolic stability, drug excretion. Drug administration: Oral administration, absorption through mucous membranes, rectal administration, topical administration, inhalation, injection, implants. Drug dosing: Drug half-life, drug tolerance, bioavailability.	**12**

III	**Drug Discovery and Design** Design and development of a drug: Choosing a disease, choosing a drug target, target specificity and selectivity, multi-target drugs. Identifying a bio-assay: Choice of bioassay, *in vitro* and *in vivo* tests, high through put screening. Finding a lead compound: Screening of natural products, synthetic compound library and existing drugs, combinatorial and parallel synthesis, computer-aided design of lead compounds, serendipity and the prepared mind; isolation and purification. Optimizing target interactions: Sturcure-activity relationship-binding role of different organic functional groups, identification of a pharmacophore. Different strategies in drug design: Variation of substituents, extension of the structure, chain extension/contraction, ring expansion/contraction, isosteres and bioisosteres, simplification of the structure, rigidification of the structure, conformational blockers. Prodrugs: Different roles of produgs.	**12**
IV	**Study of Antibacterial Agent and Anti-cancer Agent** History of Antibacterial agents, mechanism of action. Sulphonamides (Antimetabolite): History, mechanism of action, applications. Penicillin: History, structure and properties of benzylpenicillin, mechanism of action of penicillin, resistance to penicillin, methods of synthesizing penicillin analogues. Anticancer agents: An introduction, causes of cancer, genetic faults leading to cancer-protooncogenes and oncogenes, abnormal signalling pathways, insensitivity to growth-inhibitory signals, abnormalities in cell cycle regulation, telomeres, angiogenesis, tissue invasion and metastasis. Treatment of cancer: Drugs acting directly on nucleic acids-intercalating agents, non-intercalating agents which inhibit the action of topoisomerase enzymes on DNA, alkylating and metallating agents (Nitrogen mustards, Nitrosoureas, Busulfan, Cisplatin, Dacarbazine and Procarbazine, Mitomycin).	**12**
Total		**48**

Text Books:

1. *An Introduction to Medicinal Chemistry*; Patric G. L.; 6th edition; 2017; Oxford University Press.
2. *Fundamental of Medicinal Chemistry;* Thomas G.; 2nd edition, 2007; Wiley.

Reference Books:

1. King F. D.; *Medicinal Chemistry: Principles and Practice*; 2nd edition; Royal Society of Chemistry

Course Outcomes:

The student will

- be able to understand the drug targets and enzyme inhibition.
- be able to know the fundamental concepts of Pharmacodynamics and Pharmacokinetics.
- be able to apply the knowledge in Drug Discovery and Design.
- be able to understand the factors affecting the different types of mechanisms of drugs.

Teaching Learning Process:

- Lectures in class rooms
- Hands-on learning using different three-dimensional models
- Assignments
- Group discussions

Assessment methods:

- Semester End Examination: 70 marks
- Internal Assessment: 30 marks (Mid semester examination: 10, Assignment: 05, Viva: 5, Class test: 5, Attendance: 05)

SYLLABUS (4th SEMESTER)

Paper DSE IV /Subject Name: Organic Photochemistry and Pericyclic Reactions
Subject Code: CHY014D404

L-T-P-C – 4-0-0-4 **Credit Units: 4** **Scheme of Evaluation: (T)**

Objective: The objectives of **Organic Photochemistry and Pericyclic Reactions** are
.

- To help students in the development of curiosity and interest in the subject
- To help students to understand the photochemical reactions of organic molecules
- To provide the students the fundamental concepts required to rationalise and predict the products of a pericyclic reaction

Prerequisites:

- Concept of radical reactions
- Concept of Organic Chemistry from B.Sc. level

Detailed Syllabus:

Modules	Topics & Course content	Periods
I	**Photo Chemistry of Organic Molecules-I** Basic principles, Jablonsky diagram, exciplex. Photochemistry of alkenes: Intramolecular reactions of olefinic bond,geometrical isomerism.Cyclization reactions, rearrangements of 1,4 and 1,5 dienes. Photochemistry of carbonyl compounds intramolecular reactions of saturated, cyclic and acyclic, α,β-unsaturated and β, γ-unsaturated carbonyl compounds, cyclohexadienones.	**12**
II	**Photo Chemistry of Organic Molecules-II** Intramolecular cycloaddition reaction-dimerization and oxetane formation. Norrish type I and type II reactions, di-pi-methane rearrangements. Photochemistry of aromatic compounds: Isomerisation, addition and substitution reactions. Miscellaneous photochemical reactions. Photo-Fries reactions of anilides, Photo-Fries rearrangement, Barton reaction.	**12**
III	**Pericyclic Reactions-I** Molecular orbital symmetry, frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl systems. Classification of pericyclic reactions. Theory of pericyclic reactions (i) Frontier Molecular Orbital (FMO) approach, (ii) Concept of aromaticity of transition states (Huckel/Mobius systems). The Woodward-Hoffmann selection rules and general rules.	**12**
IV	**Pericyclic Reactions-II** Scope, reactivity and stereochemical features of electrocyclic reactions (4e, 6e, neutral systems). Cycloadditionreactions: thermal and photochemical ([4+2] and [2+2]) systems with special reference to Diels Alder reaction. Sigmatropic rearrangements ([1,3] and [1,5] H	**12**

	shifts, [3,3] rearrangements with special reference to Cope, Claisen and aza-Cope rearrangements.	
Total		**48**

Text Books:

1. *Molecular reactions and Photochemistry;* Dupey Charles and Chapman O.; Prentice Hall.

2. *Physical Organic Chemistry*; Hine Jack, 2nd edition; Mc. Graw Hill.

Reference Books:

1. Lowery T.H. and Richardson K.S.; *Mechanisms and Theory in Organic Chemistry*; 3rd edition;

Benjamin-Cummings Publishing Company.

2. Coxon J. M. and Halter B.; *Organic Photochemistry*; 2nd edition; 1987; Cambridge University

Press, New York.

Course Outcomes:

The student will

- be able to understand the photo induced reaction.
- be able to know the fundamental concepts of pericyclic reaction.
- be able to apply the knowledge in synthetic methodology.

Teaching Learning Process:

- Lectures in class rooms
- Hands-on learning using different three-dimensional models
- Assignments
- Group discussions

Assessment methods:

- Semester End Examination: 70 marks
- Internal Assessment: 30 marks (Mid semester examination: 10, Assignment: 05, Viva: 5, Class test: 5, Attendance: 05)

SYLLABUS (4th SEMESTER)

Paper DSE V /Subject Name: Chemistry of Materials **Subject Code: CHY014D405**

L-T-P-C – 4-0-0-4 **Credit Units: 4** **Scheme of Evaluation: (T)**

Objective: The objectives of **Chemistry of Materials** are

- To provide an understanding of the basics of structure of atom and idea leading to the concept of atomic orbitals.
- To provide an emphasis on the periodic table and trend in periodic properties.
- To put light on chemical bonding concept including detailed discussion on ionic bonding and covalent bonding.
- To cover the idea of acid base concept and their various applications.

Prerequisites:

- Concept of basic atomic structure and periodic table.
- Concept of elementary idea of chemical bonding and acid-base from HS (10+2) level

Detailed Syllabus:

Modules	Topics & Course content	Periods
I	**Glasses, Ceramics, Composites and Nanomaterials** Glassy state, glass formers and glass modifiers, applications. Ceramic structures, mechanical properties, clay products. Refractories, characterizations, properties and applications. Microscopic composites; dispersion-strengthened and particle-reinforced, fibre-reinforced composites, macroscopic composites. Nano-crystalline phase, preparation procedures, special properties, applications.	**12**
II	**Thin films, Langmuir-Blodgett films and Liquid Crystals** **Preparation techniques**; evaporation/sputtering, chemical processes, MOCVD, sol-gel etc, Langmuir-Blodgett (LB) film; growth techniques; photolithography; properties and applications of thin and LB films. **Liquid Crystals**: Mesmorphic behaviour, thermotropic liquid crystals, positional order, bond orientational order, nematic and smectic mesophases; smectic - nematic transition and clearing temperature- homeotropic, planar and schlieren textures, twisted nematics, chiral nematics, molecular arrangement in smectic A and smectic C phases, optical properties of liquid crystals, dielectric susceptibility and dielectric constants. Lyotropic phases and their description of ordering in liquid crystals.	**12**

III	**Polymeric Materials, Ionic Conductors and High Tc materials** **Polymeric Materials:** Molecular shape, structure and configuration, crystallinity, stress-strain behaviour, thermal behaviour, polymer types and their applications, conducting and ferro-electric polymers. **Inonic Conductors**: Types of ionic conductors, mechanism of ionic conduction, interstital jumps (Frenkel); vacancy mechanism, diffusion superionic conductors; phase transitions and mechanism of conduction in superionic conductors, examples and applications of ionic conductors. **High Tc materials** : Defect perovskites, high Tc superconductivity in cuprates, preparation and characterization of 1-2-3 and 2-1-4 materials, normal state properties; anisotropy; temperature dependence of electrical resistance; optical phonon modes, superconducting state; heat capacity; coherence length; elastic constants, position lifetimes, microwave absorption pairing and multi gap structure in high Tc materials, applications of high Tc materials	**12**
IV	**Materials for solid state devices, Organic Solids, Fullerenes, Molecular Devices** Rectifiers, transistors, capacitors -IV-V compounds, low-dimensional quantum structures; optical properties. Organic Solids, Fullerenes, Molecular Devices Conducting organics, organic superconductors, magnetism in organic materials. Fullerenes doped, fullerenes as superconductors. Molecular rectifiers and transistors, artificial photosynthetic devices, optical storage memory and switches; sensors. Nonlinear optical materials: nonlinear optical effects, second and third order - molecular hyper polarisability and second order electric susceptibility - materials for second and third harmonic generation.	**12**
Total		**48**

Text Books:

1. *Solid State Physics*; Ashcroft N.W. , N.D. Mermin; 1st edition, 1976, Saunders College.
2. *Material Science and Engineering, An Introduction*; Callister, W.D., 8th edition, 2017 Wiley and sons.
3. *Handbook of Liquid Crystals*, Kelker and Hatz, Chemie Verlag.; 2nd edition, 2014

Reference Books:

1. Keer, H.V.; *Principles of the Solid State,* 4th edition, 1974; Wiley Eastern.
2. Anderson, J.M. Leaver, K.D., Rawlings, R.D.; *Materials Science*, 4th edition, 2003; ELBS

Course Outcomes:

The students will
1. be able to understand the detailed idea and structure of atom starting from basic idea including black body radiation up to Schrödinger's wave equation and orbital concept.
2. be able to know the details of periodic table and variation of different periodic properties across the modern periodic table.
3. be able to get an idea of chemical bonding including details of both ionic and covalent bonding
5. be able to get details of acid and base concept and their application in practical field

Teaching Learning Process:

- Lectures in class rooms
- Hands-on learning using different three-dimensional models
- Assignments
- Group discussions

Assessment methods:

- Semester End Examination: 70 marks
- Internal Assessment: 30 marks (Mid semester examination: 10, Assignment: 05, Viva: 5, Class test: 5, Attendance: 05)

SYLLABUS (4th SEMESTER)

Paper DSE VI /Subject Name: Organometallic Chemistry and catalysis

Subject Code: CHY014D406

L-T-P-C – 4-0-0-4 **Credit Units: 4** **Scheme of Evaluation: (T)**

Objective: The objectives of **Organometallic Chemistry** are

- To provide an understanding of the details of main group organometallic chemistry.
- To provide an emphasis on the metal-carbon σ- and π-bond
- To put light on syntheses and reactions of cyclopentadienyl and arene metal analogues
- To cover the idea of application of organometallic compounds to organic synthesis and catalysis.

Prerequisites:

- Concept of structure and reactivity of simple organometallic compounds.

Detailed Syllabus:

Modules	Topics & Course content	Periods
I	**Main Group Organometallics** Synthesis and reactions of organolithium compounds; Synthesis and reactions of organomagnesium compounds; Organometallics of zinc and mercury: preparation, structure, bonding and reactions of aluminum organyls; Thallium(I) organyls (synthesis of TlCp); Organyls of sodium, synthesis of NaCp; Silicon and tin organyls of coordination number 4.	**12**
II	**Transition Metal–Carbon Bond** Transition Metal–Carbon σ-Bond: Brief review of metal alkyl compounds; transition metal carbene and transition metal-carbyne compounds; transition metal vinylidene and transition metal allenylidene compounds. Transition Metal-Carbon π-Bond: Cyclopropenyl cation ($C_3R_3^+$) as a ligand; C_4R_4 as a ligand (R = H, Me, Ph)	**12**
III	**Syntheses and reactions of Cyclopentadienyl and Arene Metal Analogues** Synthesis and reactions of cyclopentadienyl metal carbonyls, cyclopentadienyl metal hydrides, cyclopentadienyl metal halides, arene metal carbonyls, η6-arene-chromium tricarbonyl in organic synthesis.	**12**
IV	**Applications to Organic Synthesis and Homogeneous Catalysis** **In Organic Synthesis**: Hydrozirconation of alkenes and alkynes;	**12**

	Carbonylation of Colman's reagent; η4-diene iron-tricarbonyls in organic synthesis **In Catalysis**: Asymmetric hydrogenation; synthesis of acetic acid and glycol (Monsanto acetic acid process); arylation/vinylation of olefins (Heck reaction); Wacker process (olefin oxidation); Asymmetric epoxidation	
Total		**48**

Text Books:

1. *Organometallics*; *Elschenbroich.C*; 3rd edn.,2006; Wiley-VCH Publication.
2. *Advanced Inorganic Chemistry*; Cotton F. A. & Wilkinson. G.; 5th edn.; 1988, John Wiley

Reference Books:

1. Crabtree, R. H.; *The Organometallic Chemistry of the Transition Metals*; 4th edn.; 2005; John Wile.
2. Bochmann.M; *Organometallics-I Complexes with Transition Metal-Carbon σ-Bonds*, 3rd edition, 1994; Oxford Chemistry Primers.
3. Bochmann.M; *Organometallics-2 Complexes with Transition Metal–Carbon π-bonds*; , 3rd edition, 1994; Oxford Chemistry Primers.

Course Outcomes

The students will
1. be able to understand the detailed idea of main group organometallic compounds.
2. be able to know the details of the transition metal-carbon bond including both metal-carbon σ- and π-bond
3. be able to get an idea of syntheses and reactions of cyclopentadienyl and arene metal analogues
4. be able to get details of application of organometallic compounds to organic synthesis and catalysis.

Teaching Learning Process:

- Lectures in class rooms
- Traditional teaching using board and markers.
- Hands-on learning using different three-dimensional models
- Assignments

Assessment methods:

- Semester End Examination: 70 marks
- Internal Assessment: 30 marks (Mid semester examination: 10, Assignment: 05, Viva: 5, Class test: 5, Attendance: 05)