St. Xavier's College (Autonomous), Ahmedabad-9
Syllabus under Autonomous system for BSc. Chemistry
(2015-2017)

Semester I Chemistry
CORE Paper: General Chemistry (Theory)
Course Code: CH 1501
No. of Credits: 04
Learning Hours: 60 hrs

Course Overview & Course Objectives

The main objective of the course will be to build the basic foundation for studying chemistry.
By the end of the paper, a student should be able to:

a. To learn preparations reactions and properties of alkane, alkene and alkynes.
b. To learn estimation of nitrogen and molecular weight determination of organic acids and bases
c. To learn basics of selected organic reactions and mechanisms
d. To understand the atomic structure
e. To learn the applications of wave mechanics
f. To understand the nature of chemical bonding and different geometrical shapes of inorganic molecules based on V B and VSEPR theories.
g. To learn fundamentals of thermodynamic chemistry and Chemical kinetics.

Thus, the knowledge from the course can help in the following:

a. Basic knowledge of chemistry is important for higher study in the subject.
b. The students could pursue a career in chemistry, Industrial chemistry and Post-graduation in the field of Chemistry.
c. Various aspects of organic , inorganic and physical chemistry can help for the research specialization at higher study.

Course Content

Unit-1: Organic Chemistry-I **(15L)**

(Prerequisites or topics for Self Study: (i) Nomenclature of aliphatic compounds, (ii) Source Importance and applications of alkane, alkene, and alkynes. (iii) Classification of hydrocarbons (iv) physical properties of alkane, alkene and alkynes.)

1. Alkane: **(4 Marks)**

Methods of formation:-Wrutz reaction, Corey–House Synthesis (*Gilmanreagent*) Hydrolysis of R-Mg-X, Decarboxylation of carboxylic acids and Kolbe electrolysis.
Mechanism of free radical halogenation of alkanes: orientation, reactivity and selectivity(with Energy considerations), Nitration of alkane (only reaction).

2. Alkene: **(6 Marks)**

Methods of Preparation:- Dehydration of alcohols (with mechanism), regioselectivity in alcohol dehydration, dehalogenation, dehydrogenation, dehydrohalogenation of alkyl halides, The Saytzeff rule, Hofmann elimination (Only introduction, without mechanism).

Mechanisms involved in hydrogenation, electrophilic and free radical additions, Markownikoff's rule, peroxide effect, hydroboration-oxidation, and oxymercuration-reduction. Epoxidation, ozonolysis, hydration, hydroxylation and oxidation with $KMnO_4$and OsO_4.Polymerization of alkenes, substitution at the allylic and vinylic positions of alkenes.

3. Alkynes: **(4 Marks)**

Methods of Preparation: Dehydrohalogenation, dehalogenation, Acidity of Alkynes (Na, Ag,Cu), Mechanism of electrophilic and nucleophilic addition reactions, hydroboration-oxidation, metal-ammonia and metal reductions (cis and trans), and polymerization.

Unit-2: Organic Chemistry-II **(15L)**

(Prerequisites or topics for Self Study:- (i) Importance and application of qualitative and quantitative analysis (ii) Brief study of various methods of qualitative and quantitative analysis, (iii) Understanding reactions and reagents (iv) Understanding different types of bonds)

1. Quantitative Analysis and Determination of Molecular Formula: (7 Marks)

Determination of Nitrogen by Kjeldahl's method and Kjeldahl's method modified with boric acid. Molecular weight of organic acid by Ag-salt method and organic base by Chloroplatinate method, Numerical based on empirical and molecular formula.

2. Fundamentals of Organic Reactions **(7 Marks)**

Curved arrow notation, drawing electron movements with arrows, half-headed and double-headed arrows, type of reagent (electrophile, nucleophile, free radical), Reactive intermediates - carbocations, carbanions, free radicals, carbenes, nitrenes and arynes (only one example).

Types of reaction, Addition (electrophilic, nucleophilic, free radical addition, Substitution reaction: S_N1 and $S_N2$nucleophilic substitutions with mechanism. Elementary treatment of (free radical substitution reaction (*cf.* Alkane), Electrophilic substitution reaction (*cf.* Nitration), Elimination reaction: E1 and E2 reactions, Rearrangement reactions, Inter and intramolecular rearrangement.1,2- rearrangement, pericyclic reaction, olefin metathesis (one example of each)

Unit-3: Inorganic Chemistry **(15L)**

(Prerequisites or topics for Self Study: (i) Aufbau and Pauli's exclusion principle (ii) Hund's multiplicity rule, (iii) electronic configure of elements up to atomic number 30 (iv) effective nuclear charge and shielding) (Self-study (B) I :- Properties of Ionic structures, radius ratio effect

and Co- ordination numbers.)(Self Study (B) II:-Partial ionic character of covalent bond, bond moment, dipole moment, electro negativity difference, concept of resonance, resonance energy and resonance structures.)

1. Atomic Structure and ware Mechanics: **(7 Marks)**

Idea of de–Broglie's matter wave (dual nature) and Heisen Berg's uncertainty principle Schrodinger wave equation, Normalized and Orthogonal wave, quantum numbers and their significance, radial and angular wave functions, shapes of s, p and d orbitals and characteristics.Variation of orbital energies with atomic number and energy level diagram.

2. Chemical Bonding **(7 Marks)**

A) Ionic bonding: Lattice energy :-Definition, Born–Lande equation (derivation not required), factor's affecting lattice energy, Solvation energy and solubility of ionic solid , covalent nature of ionic compound, Polarizing power and Polarisability of ions, Fajan's rule.

B) Covalent boning: Valance bond theory and its Limitations (2)Various types of hybridization and shapes of simple inorganic molecules and ions (such as NH_3 , H_3O^+ , SF_4 , SF_6, PCl_5 , ClF_3 , I_3^-, NH_4^+ , BF_4^-, XeF_4 , XeF_6) by Valence Shell Electron pair Repulsion (VSEPR) Theory.

Unit-4: Physical Chemistry **(15L)**

(Prerequisites or topics for Self Study: Basic terms related to thermodynamics done in previous standard and first law , its derivation. Basic terms like rate of reaction with units, molecularity and order of reaction, derivation of first order rate constant and its half life.)

1. Thermodynamics **(7 Marks)**

Limitations of first law and need for the second law, Entropy- its physical significance, entropy of gas and calculation of entropy for different processes. Entropy change during phase change, entropy of mixing of ideal gases, entropy change in reversible and irreversible process.

2. Chemical kinetics **(7 Marks)**

Derivation of second order rate reaction constant for (a=b) and (a≠b). Derivation of third order equation (a=b=c), Determination of half life time for the 2^{nd} and 3^{rd} order reaction.
Kinetics of opposing and consecutive reaction.

Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

Reference books: CH 1501: General Chemistry (Theory)

1. "Elements of Quantum Mechanics" by Michael D. Fayer, Oxford University Press, Indian Edition.
2. "Concise Inorganic Chemistry" by J. D. Lee, 5/E, Oxford University Press, Indian Edition.
3. "Basic Inorganic Chemistry" by F. A. Cotton and G. Wilkinson, Wiley publication.
4. "Inorganic Chemistry" by Shriver & Atkins, 4/E, Oxford University Press, Indian Edition.
5. "Introductory Quantum Chemistry" by A. K. Chandra , 4/E , Tata McGraw Hill Publishing Company Limited, New Delhi.
6. "Organic Chemistry" by G. Marc Loudon, 4/E, 2010, Oxford University Press, Indian Edition,
7. "Organic Chemistry" by Robert Thornot Morrison, Robert Neilson Boyd, 6/E, 1992, Prentice Hall of India Pvt Ltd, New Delhi.
8. "Text book of Organic Chemistry" by P. L. Soni and H. M. Chawla, 26/E, 1995, Sultan Chand & Sons Publication, New Delhi.
9. "Text book of Organic Chemistry" by P. S. Kalsi, 1999, MacMillan of India Pvt. Ltd.
10. "Organic Chemistry" by Bhupinder Mehta, Manju Mehta, Prentice Hall of India Pvt. Ltd, New Delhi.
11. "Elements of Physical Chemistry" by Peter Atkins & Julio De Paula, 5/E, Oxford University Press, Indian Edition.
12. "Physical Chemistry" by P. W. Atkins, 7/E, 2002, Oxford University Press, Indian Edition.
13. "Physical Chemistry" by W. J. Moore, 1996, 6/E,MacGraw Hill Publication.
14. "Principle of Physical Chemistry" by Puri, Sharma &Pathania, 41/E, Vishal Publishers.
15. "Essentials of Physical Chemistry" by Bahl & Tuli. 22/E, S. Chand publication New Delhi
16. "Advanced Physical Chemistry" by Gurdeep Raj, 19/E, Goel Publishing House Meerut.

Semester I Chemistry
CORE Paper: General Chemistry Practical
Course Code: CH 1502L
No. of Credits: 04
Learning Hours: 60 hrs

Volumetric Analysis (Acid and Base)

1. Preparation and Standardization of NaOH and HCl
2. Succinic Acid ---------NaOH
3. Oxalic Acid ---------- NaOH (Hydrated and/or Anhydrous)
4. Na_2CO_3(Anhydrous)------HCl

Inorganic Qualitative Analysis (Two Radicals) (Minimum Eight Salts)

Water Soluble and Insoluble Inorganic salts of following cations and anions:

Cations : K^+, NH_4^+ , Mg^{2+}, Ba^{2+}, Ca^{2+}, Sr^{2+}, Fe^{2+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^2+, Mn^{2+}, Co^{3+}, Pb^{2+}, Cu^{2+}.

Anions : S^{2-}, SO_4^{2-} , CO_3^{2-} , PO_4^{3-} , CrO_4^{2-} , Cl^- , Br^-, I^- , NO_3^- , O^{2-}

Inorganic Preparation of (i) Ferrous ammonium sulphate (ii) $Na_2S_2O_3$, (iii) Potash Alum

Reference books: CH 1502L: Chemistry (Practicals)

1. "Vogel's Textbook of Quantitative Chemical analysis" Revised by G. H. Jeffery, J. Bassett, J. Mendham & R. C. Denney, 5/E , ELBS (English Language Book Society) Longman.
2. "Analytical Chemistry" by DhrubaCharan Dash, PHI Learning Private Ltd, 2011 New Delhi.
3. "Analytical Chemistry" by Gary D. Christian , 4/E, John Wiley & Sons.
4. "Advanced Practical Inorganic Chemistry" by Gurdeep Raj, 9/E, GoelPublishing House, Meerut.
5. "Vogel's Textbook of Macro and Semimicro Qualitative Inorganic Analysis", 5/E, Orient Longman Ltd.

EG 1301: Separation methods in chemistry
CORE Paper: Separation methods in chemistry (Theory)
Course Code: EG 1301
No. of Credits: 02
Learning Hours: 30 hrs

Course Overview & Course Objectives

The main objective of the course will be to build the basic foundation for studying chemistry. By the end of the paper, a student should be able to:

a. To learn various types of Distillation methods for Physical separation of chemicals.
b. To learn principle of Solvent Extraction method.
c. To learn basics of chromatography and types of chromatography.
d. To learn about TLC, ion Exchange Chromatography and their applications.

Thus, the knowledge from the course can help in the following:

a. Basic knowledge of separation methods in chemistry which is important for practical and industrial applications
b. The students could pursue a career in chemistry, Industrial chemistry and Post-graduationand also in the field of research in Chemistry.

Course Content

Unit-1: Physical Methods of separation (Distillation) (8L)

(Prerequisites or topics for Self Study: Basic terms related to physical separation of chemicals and distillation)

Distillation and types of distillations, (1) Simple Distillation (2) Fractional Distillation (3) Steam Distillation

Unit-2: Introduction to Solvent Extraction (7L)

(Prerequisites or topics for Self Study: Basic terms related to extraction, types of extraction.) Principle of solvent extraction, Partition Ratio, Distributer Coefficient, Illustrations of Solvent Extraction.

Unit-3: Introduction to chromatography (7L)

(Prerequisites or topics for Self Study: Basic terms related to Chromatographic Techniques) **(**Classification of Chromatographic Techniques, (based on mobile phase and type of equilibria) Basic Principles of Elution Chromatographic terms like eluent, eluate, partition ratio, retention time etc.

Unit-4: Specific Chromatographic techniques (8L)

(Prerequisites or topics for Self Study: Basic terms related to TLC, Ion exchange chromatography techniques)

1. Paper Chromatography: Nature of Stationary Phase, Development of Chromatograph.
2. TLC: Nature of separation, technique of TLC, Process of development of plate, quantitative determination.
3. Introduction to ion Exchange Chromatography: Principle, Classification of Ion exchange resins, Properties of ion exchange resins, Factors affecting ion exchange separations, Applications of Ion exchange resins.

Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

Semester I

Reference books: EG 1301: Separation methods in chemistry (Theory)

1. Separation Science by Khopker
2. Separation methods by H Kaur
3. Instrumental methods of chemical analysis by Chatwal and Anand.

Semester II Chemistry

CORE Paper: General Chemistry (Theory)

Course Code: CH 2501

No. of Credits: 04

Learning Hours: 60 hrs

Course Overview & Course Objectives

The main objective of the course will be to build the basic foundation for studying chemistry. By the end of the paper, a student should be able to:

a. To understand the concept of isomerism and represent the structure of organic compounds.
b. To understand general characteristics of transition metal elements, electronic configuration and their properties.
c. To learn rules and nomenclature of co-ordinated compounds, Werner's theory of co-ordination compounds and types of isomerism in co-ordination compounds.
d. To understand the nature of bonding in co-ordination compounds and application of co-ordination compounds in our day to day life.
e. To learn about fundamental chemistry of Ionic equilibrium and Catalysis
f. To understand some of the basics of analytical chemistry
g. To apply theoretical concepts in order to solve numerical problems.

Thus, the knowledge from the course can help in the following:

a. Basic knowledge of chemistry is important for higher study in the subject.
b. The students could pursue a career in chemistry, Industrial chemistry and Post-graduation in the field of Chemistry.
c. Various aspects of organic , inorganic and physical chemistry can help for the research specialization at higher study.

Course Content

Unit-1: Organic Chemistry (15L)

(Prerequisites or topics for Self Study:- (i) Understanding stereochemistry and its importance, (ii) Introduction of isomers, (iii) Types of isomerism (iv) Isomers of aliphatic hydrocarbons)

Stereochemistry of organic compounds (Total 14 Marks)

1. Optical isomerism — elements of symmetry, molecular chirality, enantiomers, stereogeniccentre, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogeniccentres, diastereomers, threo and erythrodiastereomers, meso compounds, resolution of enantiomers, inversion, retention and racemization.
   Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature.

2. Geometric isomerism — determination of configuration of geometric isomers. E & Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds.

3. Conformational isomerism — Difference between configuration and conformation. conformational analysis of ethane and n-butane; conformations of cyclohexane, axial and

equatorial bonds, conformation of mono substituted cyclohexane derivatives (only one example). Newman projection and Sawhorse formulae, Fischer and flying wedge formulae.

Unit-2: Inorganic Chemistry (15L)

(Prerequisites or topics for Self Study (A):- Electronic configuration of 3d, 4d, and 5d transition metal elements) (Self-study (B):- Important application of co-ordination compound. (Sedgwick Effective Atomic Number (EAN) Rule.)

1. Transition Metals (7 Marks)

Characteristic properties of 3d elements, Ionic radii, oxidation states, complexation tendency, Magnetic behavior and electronic spectral properties, Spectrophotometric estimation of metal ions.

2. Co-ordination compounds (7 Marks)

A) Werner's theory, nomenclature, chelates
B) Valence Bond theory of co-ordination compounds, stereochemistry of numbers 4, 5 and 6.
C) Various types of isomerism in co-ordination complexes.

Unit-3: Physical Chemistry (15L)

(Prerequisites or topics for Self Study:- Electrolytes, introduction to electrolytic conducatance, definitions and units of basic terms: electrical conducatance, specific conductance, molar conductance , cell constants and degree of dissociation.)

1. Ionic equilibrium (08 Marks)

Definition ionic equilibrium, Ostwald's dilution law and its limitations, ionic product of water (K_w), pH scale, hydrolysis reaction and relations between K_w , K_a, K_b , and K_h for all types of salts, Buffer solution (Handerson- Hasselbalch equation), buffer capacity. Indicator theories- Oswald's and modern quinonoid theory.

2. Catalysis (06 Marks)

Characteristics of catalysis, Types of catalysis, homogeneous and heterogeneous catalysis, enzyme catalyzed reaction and derivation mechanism.

Unit-4: Analytical Chemistry (15L)

(Prerequisites or topics for Self Study:- Fundamental terms and definitions of analytical chemistry)

General Introduction of analytical chemistry (14 Marks)

Introduction, Types of titrations. Requirements for titrimetric analysis. Concentration systems: molarity, formality, normality, wt% ppm, milliequalence and millimoles-problems. Primary and

secondary standards, criteria for primary standards.preparation of standard solutions, standardization of solutions. Limitation of volumetric analysis, endpoint and equivalence point.

Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

Reference books: CH 2501: General Chemistry (Theory)

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15. "Essentials of Physical Chemistry" by Bahl&Tuli. 22/E, S. Chand publication New Delhi .
16. "Advanced Physical Chemistry" by Gurdeep Raj, 19/E, Goel Publishing House, Meerut.

Semester II
Paper: Chemistry (Practicals)
Course Code: CH 2502L
No. of Credits: 04
Sessions: Two X 2 hrs

A) Volumetric Analysis:-

Redox Titrations:-

i. $KMnO_4$…… $FeSO_4.7H_2O$

ii. $K_2Cr_2O_7$……$FeSO_4(NH_4)_2SO_4.6H_2O$

Complexometric Titration by EDTA:-

i. Estimation of Ca^{+2} / Mg^{+2}…….. EDTA

ii. Iodimetry Titration $Na_2S_2O_3$----------I_2

B) Organic Spotting :- (06 Solids and 04 Liquids).

List organic compounds having different mono functional groups:

Solids : Acids : (i) Benzoic acid (ii) Oxalic acid (iii) Succinic acid (iv)

Phenols : (i) β-Napthol (ii) α-Napthol (iii) Resorcinol (iv) Phenol

Neutral : (i) Urea (ii) Thiourea (iii) Benzamide (iv) Napthalene

Liquids : (i) Aniline (ii) Nitrobenzene (iii) Benzaldehyde (iv) Ethanol

(v) Ethylacetate (vi) Chloroform (vii) Chlorobenzene (viii) Acetone

Semester II

Reference books: CH 2502L Chemistry (Practicals)

1. "Vogel's Textbook of Quantitative Chemical analysis" Revised by G. H. Jeffery, J. Bassett, J. Mendham & R. C. Denney, 5/E, ELBS (English Language Book Society) Longman.
2. "Analytical Chemistry" by DhrubaCharan Dash, PHI Learning Private Ltd, 2011,New Delhi,
3. "Analytical Chemistry" by Gary D. Christian , 4/E, John Wiley & Sons.
4. "Comprehensive Practical Organic Chemistry – Qualitative Analysis" by V. K. Ahluwalia, Sunita Dhingra, First Indian Reprint 2010, University Press (India) Private Limited, Hyderabad,
5. "Organic Analytical Chemistry theory and Practice" by Mohan Jag, Narosa.

Semester III

CORE Paper: Organic Chemistry (Theory)

Course Code: CH 3501

No. of Credits: 04

Learning Hours: 60 hrs

Course Overview & Course Objectives

The main objective of the course will be to build the basic foundation for studying chemistry.

By the end of the paper, a student should be able to:

a. To learn preparations reactions and properties of Carbohydrates and Amino acids.
b. To learn electrophilic aromatic substitution and polynuclear hydrocarbons
c. To learn basics of selected heterocyclic compounds and β -dicarbonyl compounds
d. To understand the chemical reactivity and molecular Structure in context of acid- base properties

Thus, the knowledge from the course can help in the following:

a. Basic knowledge of chemistry is important for higher study in the subject.
b. The students could pursue a career in chemistry, Industrial chemistry and Post-graduation in the field of Chemistry.
c. Various aspects of organic , inorganic and physical chemistry can help for the research specialization at higher study.

Course Content

Unit-1: (Prerequisites or topics for Self Study (A):- Basic terms related to Carbohydrate chemistry) (Self-study (B) :- Basic terms related to Amino acid chemistry)

1. **Carbohydrates (8L) (8 Marks)**
   Introduction, classification of carbohydrates, osazone formation, epimerization, step up and step down reactions of monosaccharides, simple structures of glucose and fructose, Fischer's proof of configuration of D-glucose. Haworth Presentation of Glucose, Mutarotation.

2. **Amino acid (7L) (6 Marks)**
   Introduction of amino acid, Classification and properties of amino acids, Zwitter ion , Isoelectric point, Strecker's and Gabreil pthalimide synthesis of amino acids. Reactions of amino acids, Ninhydrin test.

Unit-2: (Prerequisites or topics for Self Study (A):- Fundamentals and definitions related to Electrophilic aromatic Substitution)(Self-study (B):- Fundamentals and definitions related to Polynuclear hydrocarbon.)

1. **Electrophilic aromatic Substitution (8L) (8 Marks)**
   Introduction, effect of substituent groups, determination of orientation and relative reactivity, classification of substituent groups, electrophilic substitution (ES) reactions. (Nitration, Sulfonation, Halogenation, Friedel Craft alkylation and acylation), Orientation in mono and disubstituted benzene.

2. **Polynuclear hydrocarbon (7L) (6 Marks)**
   Nomenclature, structure and synthesis of Naphthalene and its derivatives. Reactions (oxidation, reduction and electrophilic substitution reaction (ESR)) of naphthalene. Preparation and reactions of anthracene and phenanthrene.

Unit-3: (Prerequisites or topics for Self Study (A):- Basic terms related to Heterocyclic Compounds) (Self-study(B):- Fundamentals and definitions related to β -dicarbonyl compounds.)

1. **Heterocyclic Compounds (8L) (8 Marks)**

Introduction, Three and four membered ring with one hetero atom: Preparation of azirine (Neber rearrangement), oxirane (oxidation of alkenes), azitidine (cyclization of γ haloalkylamines), Five membered ring with one hetero atom: Structure and preparation of Pyrrole (Knorr synthesis, Paal Knorr synthesis, Hantzsch synthesis), Furan (synthesis from carbohydrates, Paal-Knorr synthesis) and Thiophene (Paal-Knorr synthesis, Hinsberg method); Nitration, sulfonation, halogenations and Friedel Crafts reaction for pyrrole, furan and thiophene, Six membered ring with one heteroatom: Structure and preparation of pyridine(Hantzsch synthesis, cyclization of acetylene with hydrogen cyanide) and piperidine (from 1,5 diamine hydrochloride salt); Nitration, sulfonation, halogenations and Chichibabin reaction for pyridine, Five and six membered rings with two heteroatoms: Preparation of Pyrazoles(From1,2 dicarbonyl compound with hydrazine) and Pyrimidines (From 1,3 dicarbonyl compound with amidines)

2. β -dicarbonyl compounds (7L) (6 Marks)

Introduction, synthesis of Ethyl acetoacetate (EAA) and Diethylmalonate. Acidic and ketonic hysrolysis of β-dicarbonyl compounds. Synthetic applications of β -dicarbonyl compounds. (i) Crotonic acid from EAA (ii) Valeric Acid from diethyl malonate

Unit-4: Chemical Reactivity and Molecular Structure: (Acid- Base Properties)

(15L) (14Marks)

(Prerequisites or topics for Self Study: Basic terms related to chemical reactivity and molecular structure and acid- base concepts.)

Acid-Bases, scale of acidity-basicity, Resonance effect, drawing of structures and the condition for resonance, Effect of change of hybridization on acidity and basicity, Inductive and electronic effects, steric effect and hydrogen bonding, Lewis acid and bases, Keto – enol tautomerism. Difference between resonance and tautomerism.

Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

Reference books: CH 3501: Organic Chemistry (Theory)

1. "Organic Chemistry" by Robert Thornot Morrison and Robert Neilson Boyd,Prentice Hall of India Pvt Ltd, New Delhi, Sixth Edition, 1992.
2. "Organic Chemistry", by Bhupinder Mehta, Manju MehtaPrentice Hall of India Pvt Ltd, New Delhi, 2005.
3. "Organic Chemistry", by James B Hedrickson Donald J. Cram and George S. Hammond, Mc-Graw-Hill Kogakusha,Ltd., Third Edition.

4. "Advance Organic Chemistry", by Arun Bahl, B. S. Bahl, S. Chand & Company Ltd., New Delhi, First Edition, 2003.
5. "Organic Chemistry", by I. L. Finar, Pearson Education Pet Ltd, New Delhi, First Edition, 2002.
6. "Organic Chemistry", by G. Marc Loudon, Oxford University Press, Forth Indian edition, 2010.

"Text book of Organic Chemistry" by P.S.Kalsi, , MacMillan of India Pvt. Ltd., 1999.

7. "Text book of Organic Chemistry" by P.L. Soni and H.M. Chawala, Sultan Chand & Sons Publication, New Delhi, 26th Edition, 1995.
8. "Heterocyclic chemistry" by Raj K. Bansal, New Age International (P) Ltd Publishers, Fourth Edition, 2008.
9. "Heterocyclic Chemistry in Drug Discovery", Edited by Jie Jack Li (Editor), Wiley Publishers, New Jersey 2013.

Semester III Chemistry
CORE Paper: Physical Chemistry (Theory)
Course Code: CH 3502
No. of Credits: 04
Learning Hours: 60 hrs

Course Overview & Course Objectives

The main objective of the course will be to build the basic foundation for studying chemistry. By the end of the paper, a student should be able to:

a. To learn various aspects of thermodynamics and chemical kinetics.
b. To learn understand some of the concepts of electrochemistry and phase rule
c. To learn basics of adsorption and colloids
d. To understand the polymer chemistry and nuclear chemistry.

Thus, the knowledge from the course can help in the following:

a. Basic knowledge of chemistry is important for higher study in the subject.
b. The students could pursue a career in chemistry, Industrial chemistry and Post-graduation in the field of Chemistry.
c. Various aspects of organic , inorganic and physical chemistry can help for the research specialization at higher study.

Course Content

Unit-1: (Prerequisites or topics for Self Study (A): Fundamentals and definitions related to Thermodynamics) (Self-study (B) :- Basic terms related to Chemical Kinetics.)

1. Thermodynamics (8L)(8 marks)

Physical significance of entropy; Entropy change during phase change - solid to liquid and liquid to vapor; Entropy of mixing of ideal gases; Entropy change in reversible and irreversible process; Work and free energy functions; Helmoltz function and variation of free energy change with temperature and pressure; Gibbs Helmoltz equation, derivation. Numericals based on theory.

2. Chemical Kinetics (7L)(6 marks)

Theories of reaction rates: Collision theory of bimolecular gaseous reactions and Activated Complex theory of bimolecular reactions; Effects of temperature on reaction rates; Derivation of Arrhenius equation.

Unit-2: (Prerequisites or topics for Self Study (A):- Basic terms related to Electrochemistry) (Self-study (B):- Fundamentals and definitions related to Phase Rule)

1. Electrochemistry (8L)(8 marks)

Transport number; Determination of transport numbers by moving boundary method; Conductometric titrations: Principle and advantages; Titration of Strong acid against strong base (HCl vs NaOH); Titration of Weak acid against strong base (CH_3COOH vs NaOH); Titration of Strong acid against weak base (HCl vs NH_4OH); Titration of very weak acid against strong base (H_3BO_3 vs NaOH); Titration of mixture of acids against strong base (HCl + CH_3COOH vs NaOH); Activity and activity coefficient; Ionic strength.

2. Phase Rule (7L) (6 marks)

Theoretical derivation of phase rule; One component system : water system and sulphur system; Condensed phase rule; Silver – lead (Ag-Pb) system; Zn-Cd system, Freezing mixture (salt-H_2O) system, Congruent melting point.

Unit-3: (Prerequisites or topics for Self Study (A):- Various fundamental aspects of Adsorption) (Self-study (B):- Basic terms related to Colloids)

1. Adsorption (8L)(8 marks)

Definition of terms, Types of adsorption (physical, chemical and their difference), Types of adsorption isotherms (5 types), Derivation of Freundlich adsorption isotherm, Derivation of Langmuir adsorption isotherm, Applications of adsorption.

2. Colloids (7L)(6 marks)

Colloidal Systems; Preparation of Colloidal Solutions; General Properties of Colloidal Systems; Properties of hydrophobic Colloidal Systems.

Unit-4: (Prerequisites or topics for Self Study (A):- Fundamentals and definitions related to Polymer Chemistry) (Self-study(B) :- Various fundamental aspects of Nuclear Chemistry.)

1. **Polymer Chemistry** **(8L)(8 marks)**
   Definition: Monomer, Polymer, Polymerization, Classification of Polymers; Chain polymerization:Free radical and Ionic polymerization (cationic and anionic), Co-ordination polymerization, Step polymerization: Polycondensation and Polyaddition and Ring Opening Polymerization.

2. **Nuclear Chemistry** **(7L)((6 marks)**
   Particle acceleration –linear accelerator, Cyclotron, Geiger-Muller counter, proportional counter, scintillation counter.

Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

Reference books: CH 3502: Physical Chemistry (Theory)

1. "Principles of physical chemistry",by B.R. Puri, L.R. Sharma, Madan S. Pathania, Vishal publishing-Jalandhar, 44th Edition, 2010-2011.
2. "Thermodynamics for chemistry" by S. Glasstone, Affiliated East-West Press Pvt. Ltd,New Delhi.
3. "An introduction to electrochemistry", by S. Glasstone, Affiliated East-West press Pvt. Ltd, New Delhi.
4. "Essential of physical chemistry", B.S.Bahl, G.D.Tuli and Arun Bahl, S.Chand-New Delhi, Reprint, 2006.
5. "Polymer chemistry", by V.R. Gowarikar, New Age International(P) Ltd, Fifteen Reprint, Sep.,1999.

Semester III
Paper: Inorganic & Physical Chemistry (Practicals)
Course Code: CH 3503L
No. of Credits: 04
Sessions: Two X 3 hrs

Course Content

1. **Inorganic Mixture**
   Semi micro method of analysis of inorganic mixture containing four radicals (excluding phosphate, arsenite, arsenate and borate) Minimum eight mixtures should be performed. Mixture may be water soluble, or partly water soluble, or insoluble in water

2. **Physical Experiment**
   - **B)** To determine the relative strength between HCl and H_2SO_4 by studying hydrolysis of methyl acetate.
   - **C)** To determine the temperature coefficient and energy of activation of hydrolysis of methyl acetate catalyzed by acid.
   - **D)** To study the adsorption of an organic acid by Animal Charcoal. (Acetic acid /Oxalic acid).
   - **E)** Conductometric titration.
     - (i) Strong acid Strong Base (HCl, NaOH)
     - (ii) Weak acid Strong base (CH_3COOH, NaOH)
     - (iii) Mixture of acids Strong base (HCl + CH_3COOH, NaOH)
   - **E)** To determine specific refraction and molar refraction of liquid A,B and its Mixture
   - **F)** To determine absolute viscosities of liquid A, B and its Mixture

Teaching methodologies: Practical work, problem solving, and group discussion etc.

Reference books: CH 3503L: Inorganic & Physical Chemistry (Practicals)

1. "Textbook of Quantitative chemical Analysis", by Vogel's Pearson Education Ltd. Sixth Edition, 2008.
2. "Qualitative Inorganic Analysis", by Vogel's Pearson Education Ltd. Seventh Edition, 2009.
3. "Advanced Inorganic Chemistry", by Gurdeep Raj, Goel Publishing House, Meerut, Volume –I, 24th Revised Edition,1998.
4. "Advance Physical Practical Chemistry", by J .B.Yadav , Goel Publishing House, Meerut
5. "Experiments in Physical Chemistry",by P.H.Parsania, Neminath Printers Rajkot First Edition 2004.
6. "Practical Physical Chemistry", by A.M.. James and F.E.Prichard Longman Group Limited London Third Edition Reprinted 1979.

CORE Paper: Green Chemistry (Theory)
Course Code: EG 3301
No. of Credits: 02
Learning Hours: 30 hrs

Course Overview & Course Objectives

The main objective of the course will be to build the basic foundation for studying chemistry.
By the end of the paper, a student should be able to:

a. To learn fundamentals of green chemistry.
b. To learn Reagents and catalysts in green synthesis:
c. To learn basics of Green solvents and selected techniques in green chemistry
d. To learn about Comparative study of selected green processes.

Thus, the knowledge from the course can help in the following:

a. Basic knowledge of Green chemistry which is important for practical and industrial applications
b. The students could pursue a career in chemistry, Industrial chemistry and Post-graduation and also in the field of research in Chemistry.

Course Content

Unit-1: Fundamentals of green chemistry (8L) (14 marks)

(Prerequisites or topics for Self Study :- Basic terms related to Green chemistry chemistry)

Introduction, basic principles of green chemistry. Designing a green synthesis: Green starting materials, green reagents, green solvents and reaction conditions, green catalysts.

Unit-2: Reagents and catalysts in green synthesis (7L) (14 marks)

(Prerequisites or topics for Self Study: - Basic terms related to Reagents and catalysts)

a. Green reagents: dimethyl carbonate, polymer supported reagents.
b. Green catalysts: Acid catalysts, oxidation catalysts, basic catalysts, phase transfer catalysts-Tetra-n-butyl

Unit-3: Green solvents and selected techniques in green Chemistry (8L) (14 marks)

(Prerequisites or topics for Self Study :- Basic terms related to solvents and green solvents)

a. Water, ionic liquids, deep eutectic solvents, supercritical carbon dioxide.
b. Solid state reactions: solid phase synthesis, solid supported synthesis.
c. Microwave assisted synthesis: reactions in water, reactions in organic solvents, solvent free reactions.
d. Ultrasound assisted reactions.

Unit-4: Comparative study of selected green processes (7L) (14 marks)

(Prerequisites or topics for Self Study: - Basic terms related to green processes chemistry)

Comparison of traditional processes versus green processes in the syntheses of Ibuprofen, adipic acid, 4-aminodiphenylamine, p-bromotoluene and benzimidazole.

Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

Reference books: EG 3301: Green chemistry (Theory)

1. "Green Chemistry: An Introductory Text", by Mike Lancaster, RSC Publishing, Cambridge, UK, 2nd Edition, 2010
2. "New trends in green chemistry" by V. K. Ahluwalia, M. Kidwai, Anamay Publishers, New Delhi, (2004)
3. "Green Chemistry: Environmentally Benign Reactions", Editor: V. K. Ahluwalia, University of Delhi, India Publication 2007.
4. "Green Chemistry: Greener Alternatives to Synthetic Organic Transformations" by V.K. Ahluwalia, Narosa Publishing House, 2011
5. "Green Chemistry: Environmentally Benign Reactions" by V. K. Ahluwalia, Ane Books India, 2011

Semester IV Chemistry
CORE Paper: Inorganic Chemistry (Theory)
Course Code: CH 4501
No. of Credits: 04
Learning Hours: 60 hrs

Course Overview & Course Objectives
The main objective of the course will be to build the basic foundation for studying chemistry. By the end of the paper, a student should be able to:

a. To learn wave –mechanics and terms related to wave –mechanics.
b. To learn various aspect of coordination chemistry.
c. To learn basics of coordination compounds
d. To understand the Chemical Bonding
e. To learn organometallic chemistry and applications of catalysis

Thus, the knowledge from the course can help in the following:
a. Basic knowledge of chemistry is important for higher study in the subject.
b. The students could pursue a career in chemistry, Industrial chemistry and Post-graduation in the field of Chemistry.
c. Various aspects of organic , inorganic and physical chemistry can help for the research specialization at higher study.

Course Content
Unit-1: Wave Mechanics (15L) (14Marks)
(Prerequisites or topics for Self Study: Various fundamental aspects and definitions related Wave –Mechanics)
Basic postulates of quantum mechanics (Postulates 1,2,3 and 4); Setting up of operators: commutator; Particle in a box (One dimensional); Zero potential energy; Characteristics of the wave functions; Electron in a ring.

Unit-2: Coordination Compounds (15L) (14 Marks)

(Prerequisites or topics for Self Study (A):- Basic terms related to Crystal Field Theory) (Self-study (B):- Fundamentals and definitions related to Coordination Chemistry)

1. **Crystal Field Theory (8L)(8 Marks)**

   Crystal Field Theory ,Orientation of d-orbitals and Crystal Field Splitting of Energy levels; Crystal Field Splitting in Octahedral complexes; Crystal Field Stabilization Energy (CFSE); Crystal Field Splitting in Tetrahedral Complexes; Crystal Field Splitting in Tetragonal and square Planar Complexes; Magnetic Properties of Metal Complexes and Crystal Field Theory; Factors influences the magnitude of Crystal Field Splitting; Color of Transition Metal Complexes; Crystal Field Effects on Ionic Radii; Crystal Field Effects on Lattice Energies; Jahn- Teller Effect.

2. **Coordination Chemistry (7L) (6 Marks)**

   Coordination Chemistry: Lability, inertness, Stability, Instability, reaction, kinetics and mechanism, Trans effect and Influence

Unit-3: Chemical Bonding (15L)(14 marks)

(Prerequisites or topics for Self Study (A):- Fundamentals and definitions related to Chemical Bonding)

Introduction of AO's, MO's, Molecular orbital Theory; LCAO Molecular Orbital Theory; Energy Level Diagram for Molecular Orbitals; Mixing of Orbitals; Filling up of Molecular Orbitals; MO diagram of Heteronuclear Diatomic molecules (HF, HCl); Molecular orbitals of Polyatomic Species (BeH_2, CO_2, NH_3) (Excluding Walsh diagram); M.O. Theory of (Co $(NH_3)_6)^{3+}$ and $(CoF_6)^{3-}$; Molecular orbital or Band Theory for metals.

Unit-4: (Prerequisites or topics for Self Study (A):- Basic terms related to Organometallic Chemistry) (Self-study (B) :- Various fundamental aspects and applications of Catalysis)

1. **Organometallic Chemistry (8L)(8 marks)**

   Introduction, Bonding: Stable electron configurations, electron count preference, Electron counting and oxidation states.

   Ligands: Carbon monoxide, Phosphines, hydrieds and dihydride complexes, n'-Alkyl, alkenyl, alkynyl, and Aryl ligands. Types of organometallic reactions.

2. **Catalysis (7L)(6 marks)**

   General principle, The language of catalysis, hydrogenation of alkene. Heterogeneous catalysis: surfaces four interactions with adsorbates.

Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

Reference books: CH 4501: Inorganic Chemistry (Theory)

1. "Advanced Inorganic Chemistry", by Gurdeep Raj, Goel Publishing House, Meerut, Volume –I, 24th Revised Edition,1998.
2. "Modern Inorganic Chemistry', by R.D. Madan, S. Chand & Co. Ltd., New Delhi, 2nd Edition, 2006.
3. "Concise Inorganic Chemistry", by J.D. Lee, Wiley India Publication, 5th Edition, 1996, Reprint 2011.
4. "Selected Topics in Inorganic Chemistry", by W.V. Malik, G.D. Tuli, R.D. Madan, S.Chand & Co. Ltd., New Delhi, 7th Edition, 2007.
5. "Introductory Quantum Chemistry", by A.K. Chandra, Tata- McGraw Hill Pub. Co. Ltd., New Delhi, 4th Edition.
6. "Principles of Inorganic Chemistry", by Puri, Sharma, Kalia, Milestone Publishers & Distributors, New Delhi, 3rd Edition, 2006.
7. "Quantum chemistry", by R.K.Prasad, New Age International (P) Ltd., Publishers, 4th Edition, 2010.
8. "Shriver & Atkins' Inorganic Chemistry", Peter Atkins, Tina Overton, Jonathan Rourke, Mark Weller, Fraser Armstrong, Oxford University Press, 2011.
9. "Inorganic Chemistry", by Catherine E Housecroft and Alan G Sharpoe, 2nd edn.

Semester IV Chemistry
CORE Paper: Analytical Chemistry (Theory)
Course Code: CH 4502
No. of Credits: 04
Learning Hours: 60 hrs

Course Overview & Course Objectives

The main objective of the course will be to build the basic foundation for studying chemistry.
By the end of the paper, a student should be able to:

a. To learn basic concepts of acid-base titration and Precipitation Titration
b. To learn basics of Complexometric and Redox Titrations
c. To learn basic concepts of gravimetric analysis
d. To learn basic concepts of Solvent Extraction Separation and Organic reagents used in quantitative Analysis.

Thus, the knowledge from the course can help in the following:

a. Basic knowledge of chemistry is important for higher study in the subject.
b. The students could pursue a career in chemistry, Industrial chemistry and Post-graduation in the field of Chemistry.
c. Various aspects of organic , inorganic and physical chemistry can help for the research specialization at higher study.

Course Content

Unit-1: Acid Base and Precipitation Titrations (15L) (14 Marks)

(Prerequisites or topics for Self Study (A): Fundamentals and definitions related to qualitative and quantitative analysis e.g. Theory of acid-base titration) (Self-study (B):- Basic terms related to Precipitation Titration)

1. **Theory of acid-base titration: (8L) (8 marks)**
   Theory of acid-base titration, Ways of locating the end point of an acid-base titration, Titration of strong acid with strong base, Titration of weak acid with strong base, Titration of weak base with strong acid, Titration of weak base with weak acid, Factors determining the exact form of a pH curve.

2. **Precipitation Titration (7L) (6 marks)**
   Titration curves, Feasibility, Indicators, Mohr, Volhard and Fajans' Methods, Factors affecting solubility.

Unit-2: Complexometric and Redox Titrations (15L) (14 marks)

(Prerequisites or topics for Self Study (A): Fundamentals and definitions related to Complexometric titrations) (Self-study (B) :- Fundamental aspects of Redox titration)

1. **Complexometric Titration (8L) (8 Marks)**
   Theory of complexometric titration involving EDTA, Study of EDTA complex formation taking disodium salt of EDTA and effect of pH, Ways of locating the end point, Estimation of calcium and magnesium by complexometric titration by EDTA.

2. **Redox titration (7L)(6 marks)**
   Theory of redox titration, study of redox titration by electrochemical potential method, Ways of locating the end point for redox titration.

Unit-3: Gravimetric analysis (15L)(14 Marks)

(Prerequisites or topics for Self Study (A):- Fundamentals and definitions related to gravimetric analysis)

Introduction, Precipitation, Digestion, Filtration, Washing of the precipitate, Drying and/or incineration of the precipitate, Weighing, Gravimetric factors, Specific and selective precipitation, Organic precipitants, Masking or sequestering agent, Problems involved in precipitation gravimetry.

Unit-4: Solvent Extraction and Organic reagents (15L)(14 Marks)

(Prerequisites or topics for Self Study (A): Fundamentals and definitions related to Solvent Extraction Separation) (Self-study (B) :- Fundamental aspects of Organic reagents used in quantitative Analysis)

1. **Solvent Extraction Separation (8L) (8 Marks)**
   Principles of solvent extraction, choice of solvent, distribution coefficient, distribution ratio, percentage, (%) extraction. The extraction process, solvent extraction of metals, selective extraction and separation efficiency.

2. **Organic reagents used in quantitative Analysis (7L) (6Marks)**
   Separation of methods with 8-Hydroxy Quinoline, Cupferron, DMG and *N*-benzoyl-*N*-phenylhydroxylamine.

Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

Reference books: CH 4502: Analytical Chemistry (Theory)

1. "Analytical Chemistry", by Dhruba Charan Dash, PHI Learning Pvt. Ltd., New Delhi, 2011.
2. "Quantitative Analysis", by R.A.Day, A.L.Underwood, Prentice-Hall of India Pvt.Ltd., New Delhi, 2004. (Sixth edition)
3. "Analytical Chemistry", by Gary D. Christian, John Wiely & Sons, INC, New York, 1994. (Fifth edition)
4. "Analytical Chemistry An Introduction", by Douglas A. Skoog, Donald M. West, F.James Holler, Saunders College Publishing, Harcourt Brace College Publishers, Philadelphia, 1994. 6th edn.
5. "A Textbook of Analytical Chemistry",by Y.Anjaneyulu, K.Chandrasekhar, Valli Manickam, Pharma Book Syndicate, Hyderabad, India, 2006.
6. "Instrumental Methods of analysis" by H. H . Willard, L. L. Mirrit, J.A. Dean, CBS Publications
7. **"**Solvent extraction in Analytical Chemistry" by G.H. Morrison, F. Frieiser, John Wiley & Sons, NY.
8. "Quantitative Chemical Analysis" by Daniel C. Harris, W H Freeman, New York.

9. "Ion exchange and solvent extraction of metal compounds' by Y. Macros, A.S.Kertes, Wiley, Interscience.

Semester IV Chemistry
Paper: Organic and Analytical Chemistry (Practicals)
Course Code: CH 4503L
No. of Credits: 04
Sessions: Two X 3 hrs

Course Content

1. **Organic Spotting and Estimation**
   Organic spotting minimum eight compounds (5 solids and 3 liquids)
   Acids: Salicylic acid, Cinnamic acid, Anthranilic acid, Sulfanilic acid
   Phenols: m-Nitrophenol, p-Nitrophenol, α- Naphthol ,β-Naphthol
   Bases: m and p – Nitroanilines, p-Toludine
   Neutral : Solids:- Acetanilide, Glucose
   Liquids:- Methanol Acetophenone, Carbon tetrachloride (CCl_4), Methylacetate
   Estimations: (1) Glucose
   (2)Acetamide
   (3)Phenol/Aniline

2. **Volumetric and Gravimetric Analysis**
   Volumetric Analysis :
   a. Nitrite by back titration.
   b. Determination of the available cholrine in Hypochorates
   c. Estimation of Ni by using EDTA , $MgCl_2$ (Back Titration)
   Gravimetric Analysis :
   a. Fe as Fe_2O_3
   b. Ba as $BaSO_4$
   c. Al as Al_2O_3

Teaching methodologies: Practical work, problem solving, and group discussion etc.

Reference books: CH 4503L: Organic and Analytical Chemistry (Practicals)

1. "Elementary Practical Organic Chemistry Part-II, Qualitative Organic Analysis", by I Vogel, CBS Publishers & Distributers, New Delhi, Second Edition, 2004.
2. "Elementary Practical Organic Chemistry Part III Quantitative Organic Analysis", by I Vogel, CBS Publishers & Distributers, New Delhi, Second Edition, 2004.
3. "Comprehensive Practical Organic Chemistry – Qualitative Analysis", by V.K. Ahluwalia, Sunita Dhingra, University Press (India) Private Limited, Hyderabad, First Indian Edition,

2010.
4. "Organic Analytical Chemistry theory and Practice", by Mohan Jag, Narosa Publication, New Delhi, 2003.
5. "Advanced Practical Organic Chemistry",by J Leonard, B Lygo, G Procter, Stanley Thornes (Publishers) Ltd., First Indian Edition, 2004.
6. "Analytical Chemistry : Practice", by John H. Kennedy, Saunders College Publishing, New York, Second Edition, 1990.
7. "Quantitative Analysis", by R.A.Day, A.L.Underwood, Prentice-Hall of India Pvt.Ltd., New Delhi, Sixth Edition, 2004.
8. "Analytical Chemistry", by Gary D. Christian, John Wiely & Sons, INC, New York, Fifth Edition, 1994.

Semester IV Chemistry Elective
CORE Paper: Soil Composition and Analysis (Theory)
Course Code: EG 4301
No. of Credits: 02
Learning Hours: 30 hrs

Course Overview & Course Objectives
The main objective of the course will be to build the basic foundation for studying chemistry.
By the end of the paper, a student should be able to:

a. To learn fundamentals of Soil Chemistry.
b. To learn analysis of primary nutrients of soil
c. To learn analysis of secondary nutrients of soil
d. To learn analysis of micro nutrients of soil.

Thus, the knowledge from the course can help in the following:
a. Basic knowledge of Soil chemistry is important for theoretical and practical applications
b. The students could pursue a career in applied chemistry and also in the field of research in soil chemistry.

Course Content
Unit-1: Introduction to Soil Chemistry (8L) (14 Marks)
(Prerequisites or topics for Self Study: - Basic terms related to Soil Chemistry)
Importance of soil, soil formation, composition of soil, the soil profile, types of soil, micro and macro plant nutrients.

Unit-2: Analysis of Primary Soil Nutrients (7L) (14 Marks)
(Prerequisites or topics for Self Study: - Basic terms related to Analysis of Primary Soil Nutrients)

Soil fertility and productivity, techniques for the analysis of soil, soil reaction, determination of total nitrogen in soil, determination of phosphorus in soil, determination of potassium in soil by flame photometry.

Unit-3: Analysis of Secondary Soil Nutrients (8L) (14 Marks)

(Prerequisites or topics for Self Study: - Basic terms related to Analysis of Secondary Soil Nutrients)

Determination of total sulphur in soil, determination of calcium in soil determination of magnesium in soil, determination of lime and liming material in soil. Mechanical analysis of soil.

Unit-4: Analysis of Micro Soil Nutrients (7L) (14 Marks)

(Prerequisites or topics for Self Study: - Basic terms related to Analysis of Micro Soil Nutrients)

Determination of total manganese in soil, determination of Fe (II) and Fe (III) in soil, determination of silica in soil, determination of soluble salts in soil, determination of sodium in soil by flame photometry.

Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

Reference books: EG 4301: Soil Composition and Analysis (Theory)

1. "Environmental Chemistry" by H. Kaur, Pragati Prakashan, 2nd Edition.
2. "Soils in our Environment" by Raymond W. Miller, Duane T. Gardiner, Prentice Hall, 8th Edition.
3. "Principles of Soil Chemistry", by Kim H. Tan , 4th Edi.CRC Press, Taylor and Francis Group, United States of America
4. "Text book of Soil Science", by T D Biswas, S K Mukherjee, Tata McGraw-Hill Publishing Company Ltd., New Delhi, Second edition, 2006.

Semester V

CH 5501 Organic Chemistry
CH 5502 Inorganic Chemistry
CH 5503 Physical Chemistry
CH 5504 Analytical Spectroscopic Techniques
CH 5401 Subject Elective (Nanomaterials and Nanotechnology)
CH 5505L Practical:

a. Inorganic Qualitative Analysis

&

Physical Chemistry (Kinetics, Solubility and Instruments)

b. Organic Preparation

&

Analytical Chemistry (Estimations and Chromatography)

Course Structure with respect to credit, hours and marks

Type of Course	Paper No.	Credit	Total Marks	Internal	External	No. of hours per week	Exam hours
General English	GE 5052	2	100	30	70	3	3
Core Course	CH 5501	4	100	30	70	4	3
	CH 5502	4	100	30	70	4	3
	CH 5503	4	100	30	70	4	3
	CH 5504	4	100	30	70	4	3
Subject Elective Course (SEC)	CH 5401	2	100	30	70	3	3
Practical Core Course – I and II	CH 5505L	5	200	60	140	12	12
Total Credit		25					

N.B.**:** The practical batch should be maximum of 10 students with respect to the credit.

Semester V
CORE Paper: Organic chemistry (Theory)
Course Code: CH 5501
No. of Credits: 04
Learning Hours: 60 hrs

Course Overview & Course Objectives

The main objective of the course will be to build the basic foundation for studying chemistry.
By the end of the paper, a student should be able to:

a. To learn fundamentals of stereoselectivity, stereospecificity and stereo chemistry.
b. To learn selected inorganic reagents, molecular rearrangements and name Reactions:

c. To learn about chemistry of Nucleophilic Substitution reactions.
d. To learn about disaccharides and synthesis of Purine and Pyrimidines.

Thus, the knowledge from the course can help in the following:
a. Basic knowledge of these topics in organic chemistry which is important for practical and industrial applications
b. The students could pursue a career in chemistry, Industrial chemistry and Post-graduation and also in the field of research in Chemistry.

Course Content

Unit-1: Stereo Chemistry-I (15L) (14 marks)

(Prerequisites or topics for Self Study :- Basic terms related to Stereo Chemistry, Understanding Stereoselectivity and Stereospecificity)

1. Stereo Chemistry (I) (07 Marks)

Optical activity in the absence of chiral carbon (Biphenyls, Allenes and Spirans)

2. Stereoselectivity and Stereospecificity (07 Marks)

Stereoselective and stereospecific reactions.Mechanism "Addition of halogens to alkenes". Stereochemistry of E2 reaction (syn and anti elimination).

Unit-2: Inorganic reagents, organic rearrangements and name reactions (15L)(14 marks)

(Prerequisites or topics for Self Study: - Basic terms related to Inorganic reagents for organic synthesis, Understanding Molecular rearrangements and Name Reactions and their importance, definitions of carbocations, carbenes and nitrenes)

1. Inorganic reagents for organic synthesis (07 Marks)

Use of specific reagents and their synthetic applications with mechanism.
(i) Aluminium Isopropoxide (ii) Lithium Aluminium Hydride (iii) Adams's catalyst (PtO_2)
(iv) Selenium Dioxide (v) Osmium Tetroxide (vi) Lead Tetraacetate

2. Molecular rearrangements and Name Reactions (07 Marks)

Rearrangements occurring through carbocations, carbenes and nitrenes Principle, Mechanism and Synthetic applications of the reactions:
(i) Wolf rearrangement (ii) Fries migration (iii) Hoffmann reaction (iv) Oppenauer oxidation reaction (v) Diels-Alder reaction (vi) Birch Reduction

Unit-3: Nucleophilic Substitution reactions (15L) (14 marks)

(Prerequisites or topics for Self Study:-Fundamental terms and definitions related to Nucleophilic Substitution reactions)

1. Nucleophilic Substitution at a Saturated Carbon Atom (08 Marks)

Mechanism and scope of reaction-available mechanism, Kinetic Characteristics, Scope of reaction, Stereochemistry of S_N1 and S_N2 reactions, Relative reactivity in substitution, Solvent effect, variation at carbon site, Relative leaving group activity, S_Ni (substitution nucleophilic internal) Mechanism and Neighboring group participation. Elimination Reactions, E1, E2 and E1cB mechanism, Orientation E1and E2 reactions, Elimination Vs Substitution.

2. Nucleophilic Aromatic Substitution (06 Marks)

Nucleophilic aromatic substitution, Bimolecular displacement and its mechanism, Reactivity, Orientation, Electron withdrawal by resonance, Evidence for the two steps-mechanism, Elimination-addition mechanism-Benzyne.

Unit 4 Carbohydrate and Purine, Pyrimidines (15L) (14 marks)

(Prerequisites or topics for Self Study: - Basic terms related to Carbohydrates, Fundamental terms and definitions related to Purine, Pyrimidines)

1. Carbohydrates (06 Marks)

Disaccharides, structure of (+) maltose, (+) cellobiose, (+) lactose and (+) sucrose.

2. Purine and Pyrimidines (08 Marks)

A) Purines – Synthesis of Purines, Adenine and Guanine.
B) Pyrimidines – Synthesis of Pyrimidine, Uracil, Thymine and Cytosine.

Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

Reference books: CH 5501: Organic chemistry (Theory)

1. Organic Chemistry**:** I. L. Finar, Vol-II, 5th Edition, Pearson Education Ltd.
2. Organic Chemistry**:** Morrison & Boyd, 6th Edition, Prentice Hall of India Pvt. Ltd.
3. Stereochemistry of carbon compounds**:** E. L. Eliel, Wiley Eastern Ltd.
4. Stereochemistry and mechanism through solved problems**:** P. S. Kalsi, New Age International.
5. Stereochemistry of Organic Compounds: Principles and Applications**:** D. Nasipuri; New Academic Science; 4th Revised Edition.
6. Organic Chemistry**:** Hendrickson, Cram, Hammond, McGraw-Hill.
7. Organic Chemistry**:** 6th Edition, John Mcmurry, Brooks Cole, International Edition.
8. Organic Chemistry**:** T.W. Graham Solomons and Craig B. Fryhle Wiley, 8th Edition.
9. Organic Chemistry**:** Francis A. Carey, McGraw-Hill, 7th Edition.
10. Organic Chemistry**:** Leroy G.Wade, Prentice Hall, 6th Edition.

11. Organic Chemistry**:** Jonathan Clayden, Nick Greeves, Stuart Warren and Peter Wothers. Oxford University Press, USA.

B Sc Semester V Chemistry
CORE Paper: Inorganic chemistry (Theory)
Course Code: CH 5502
No. of Credits: 04
Learning Hours: 60 hrs

Course Overview & Course Objectives

The main objective of the course will be to build the basic foundation for studying chemistry.
By the end of the paper, a student should be able to:

a. To learn fundamentals of molecular symmetry.
b. To learn Chemistry of Metal – Ligand Bonding:
c. To learn basics of Reaction mechanism of transition metal complexes
d. To learn about inorganic polymers and mossbauer spectroscopy.

Thus, the knowledge from the course can help in the following:

a. Basic knowledge of these topics in inorganic chemistry is important for practical and industrial applications.
b. The students could pursue a career in chemistry, Industrial chemistry and Post-graduation and also in the field of research in Chemistry.

Course Content

Unit-1: Molecular symmetry (15L) (14 marks)

(Prerequisites or topics for Self Study: - Basic terms related to symmetry and its importance)
Molecular symmetry,
Introduction, symmetry operations and symmetry elements: Cn, σ, Sn, i and E.
Point groups for the molecules (excluding S_{2n} and I_h)
Multiplication tables of C_{2v}, C_{2h} and C_{3v} point groups.
Application of symmetry
- Polar molecule
- Chiral molecule

Unit-2: Metal – Ligand Bonding (15L) (14 marks)

(Prerequisites or topics for Self Study: - Basic terms related to crystal field theory, Fundamental terms and definitions of π- bonding and Molecular orbital theory)
Metal – Ligand Bonding**,**
Limitation of crystal field theory

Molecular orbital theory
Octahedral, tetrahedral and square planer complexes.
π- bonding and molecular orbital theory.

Unit-3: Reaction mechanism of transition metal complexes. (15L) (14 marks)
(Prerequisites or topics for Self Study: - Basic terms related to Reaction mechanism of transition metal complexes, Fundamental terms and definitions of VBT and CFT.)
Energy profile of a reaction
Kinetic application of VBT and CFT.
Kinetics of octahedral substitution
Acid hydrolysis
Factor affecting acid hydrolysis
Base hydrolysis, conjugate base mechanism
Substitution reaction in square planner complexes
Redox reaction:- electron transfer reaction: outer sphere and inner-sphere type reaction.

Unit-4: Inorganic polymers and Mossbauer Spectroscopy (15L) (14 marks)
(Prerequisites or topics for Self Study: -Basic terms related to Inorganic polymers, Fundamental terms and definitions related to Mossbauer Spectroscopy)

1. Inorganic polymers (07 Marks)
Classification of inorganic polymers.
Polymers containing boron and silicon**:** methods of preparation, physical and chemical properties, Structures and their uses.
Types of Inorganic polymers
Comparison with organic polymers
Synthesis, structural aspects and application of silicones, , Borazine, Silicates and phosphazines.

2. Mossbauer Spectroscopy (07 Marks)
Principle and Instrumentation.
Experimental technique
Application for iron and stanus (Tin) complexes

Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

Reference books: CH 5502: Inorganic chemistry (Theory)
1. Concise Inorganic Chemistry**:** J.D. Lee; Wiley India, 5th Edition (1996).

2. Shriver and Atkins' Inorganic Chemistry**:** Atkins, Overton, Rourke, Weller, Armstrong; Oxford University Press, 5th Edition (2011).
3. Advanced Inorganic Chemistry**:**.F.A. Cotton and Wilkinson G.; John Wiley, 5th Edition (1988).
4. Introductory Quantum Chemistry**:** A.K. Chandra; Tata- McGraw Hill, 4th Edition (1994).
5. Quantum chemistry**:** R.K. Prasad; New Age International, 4th Edition (2010).
6. Electron and chemical bonding**:** H. B. Grey, W.A.Benjamin. INC, New York.
7. Inorganic chemistry**:**. James E. Huheey, 4thEdition,Wesley Publishing Company.
8. Mechanism of Inorganic reaction**:**Basalo and Pearson, 2nd Edition, Wiley Eastern Pvt Ltd.
9. Introduction to Advanced Inorganic chemistry, Durrant and Durrant, John Wiley.
10. Advanced Inorganic chemistry**:** (Vol. 1) SatyaPrakash, Tuli, Basu and Madan; S. Chand
11. Advanced Inorganic chemistry**:** Gurdeep Raj; Goel Publishing House, 23rd Edition (1998).
12. Physical methods for chemists, 2nd edition by R S Drago.

Semester V
CORE Paper: Physical chemistry (Theory)
Course Code: CH 5503
No. of Credits: 04
Learning Hours: 60 hrs

Course Overview & Course Objectives
The main objective of the course will be to build the basic foundation for studying chemistry.
By the end of the paper, a student should be able to:

a. To learn fundamentals of thermodynamics in chemistry.
b. To learn important topics electrochemistry and Fuel Cell:
c. To learn basics of chemical kinetics and polymer chemistry
d. To learn about nuclear chemistry and molecular spectra.

Thus, the knowledge from the course can help in the following:
a. Basic knowledge of these topics in physical chemistry is important for practical and industrial applications.
b. The students could pursue a career in chemistry, Industrial chemistry and Post-graduation and also in the field of research in Chemistry.

Course Content
Unit-1: Thermodynamics (15L) (14 marks)
(Prerequisites or topics for Self Study: - Basic Fundamental terms and definitions relayed to Thermodynamics)

Thermodynamics

Thermodynamics, Clausius - Clapeyron equation, Trouton's Rule, Craft's equation, van't Hoff's isotherm and isochore equations.

Unit-2: Electrochemistry and Fuel Cell (15L) (14 marks)

(Prerequisites or topics for Self Study: - Basic terms related to Electrochemistry, Fundamental terms and definitions of Fuel Cell)

1. Electrochemistry (8 Marks)

Electrochemical cell and Electrolytic cell, Reversible and irreversible electrodes and cell, Poggendorff's compensation method and Weston cell, Reference electrodes (i) Saturated Calomel Electrode (ii) Standard Hydrogen Electrode (iii) Quinhydrone Electrode.

2. Fuel Cell (6 Marks)

Fuel Cell – their electrochemistry, H_2 - O_2 fuel cells, methanol fuel cells, Hydrogen fuel cell, Electrodes and electrolytes used in fuel cells.

Unit-3: Chemical Kinetics and Polymer Chemistry (15L) (14 marks)

(Prerequisites or topics for Self Study: - Basic terms related to **Chemical Kinetics**, Fundamental terms and definitions related to polymer chemistry)

1. Chemical Kinetics (07 Marks)

Prediction of reaction rate, Primary and secondary salt effect, Heterogeneous reactions, Retarded reaction.

2. Polymer Chemistry (07 Marks)

Polymerization and types of Polymerization, Co-polymers, Bio-polymers, Polymer additives, Thermodynamics of polymer solution, Molecular weight determination of polymers: Number average molecular weight, Weight average molecular weight, Viscosity and Osmotic pressure method.

Unit-4: Nuclear Chemistry and Molecular spectra (15L) (14 marks)

(Prerequisites or topics for Self Study: - Basic terms related to Nuclear Chemistry, Fundamental terms and definitions related to Molecular spectra)

1. Nuclear Chemistry (07 Marks)

Detection of isotopes, Velocity focusing mass spectrograph, Bainbridge and Neiers mass spectroscopy, Double focusing mass spectroscopy, Applications of isotopes and trace technique examples.

2. Molecular spectra (07 Marks)

Pure rotational spectra, Equation for frequency of pure rotational spectral line, Vibrational-Rotational spectra, Equation for frequency of vibrational-rotational spectral line, Ortho and Para

hydrogen.

Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

Reference books: CH 5503: Physical chemistry (Theory)

1. Physical Chemistry**:** G. M. Barrow, 5th Edition, McGraw-Hill education, India.
2. Advanced Physical Chemistry**:**Gurdeep Raj, 35th Edition (2009), Goel / Krshina Publishing House.
3. Principles of Physical Chemistry**:**Puri, Sharma and Pathania, 42nd Edition, Vishal Publishing Company.
4. Polymer Science**:**Gowariker, Viswanathan and Sreedhar, 1st Edition (2012 reprint) New Age International.
5. Essentials of Nuclear Chemistry**:**Arnikar, 4th Edition (2012 reprint), New Age International.
6. Physical Chemistry**:** Atkins, 9th Edition. Oxford University Press.
7. Advanced Physical chemistry**:**Gurtu and Gurtu, 11thEdition ,PragatiPrakashan.
8. Physical chemistry**:** Levine, 6th Edition, McGraw-Hill education, India.

Semester V
CORE Paper: Analytical chemistry (Theory)
Course Code: CH 5504
No. of Credits: 04
Learning Hours: 60 hrs

Course Overview & Course Objectives

The main objective of the course will be to build the basic foundation for studying chemistry.
By the end of the paper, a student should be able to:

a. To learn fundamentals of ultraviolet spectroscopy and problems on UV Spectroscopy.
b. To learn about Infrared Spectroscopy and Raman Spectra:
c. To learn basics of Nuclear Magnetic Resonance and Problems based on Spectral data
d. To learn about Visible Spectroscopy and Atomic Spectroscopy.

Thus, the knowledge from the course can help in the following:

a. Basic knowledge of these topics in chemistry is important for practical and industrial applications
b. The students could pursue a career in chemistry, Industrial chemistry and Post-graduation and also in the field of research in Chemistry.

Course Content

Unit-1: Ultraviolet Spectroscopy (15L) (14 marks)

(Prerequisites or topics for Self Study: - Fundamental terms and definitions related to ultraviolet spectroscopy)

1. Ultraviolet Spectroscopy (08 Marks)

Origin of UV Spectra, Principle, Electronic transition (σ-σ*, n-σ*, π-π* and n-π*), relative positions of λ max considering conjugative effect, steric effect, solvent effect, red shift (bathochromic shift), blue shift (hypsochromic shift), hyperchromic effect, hypochromic effect (typical examples). Aromatic and Polynuclear aromatic hydrocarbons.

2. Ultraviolet Spectroscopy (Problems) (06 Marks)

Problems of Dienes and enones using Woodward-Fieser rules.Problems of aromatic ketones, aldehydes and esters using empirical rules.

Unit-2: Infrared Spectroscopy and Raman Spectra (15L) (14 marks)

(Prerequisites or topics for Self Study: - Fundamental terms and definitions related to Infrared Raman Spectroscopy)

1. Infrared Spectroscopy (08 Marks)

Introduction, principle of IR spectroscopy, instrumentation, sampling technique, selection rules, types of bonds, absorption of common functional groups.Factors affecting frequencies, applications. Application of Hooke's law, characteristic stretching frequencies of O-H, N-H, C-H, C-D, C=C, C=N, C=O functions; factors affecting stretching frequencies (H-bonding, mass effect, electronic factors, bond multiplicity, ring size).

2. Raman Spectra (06 Marks)

Basic principal, Instrumentation, Application of Raman spectra, Comparison of IR and Raman spectra.

Unit-3: Nuclear Magnetic Resonance Spectroscopy (15L) (14 marks)

(Prerequisites or topics for Self Study: - Fundamental terms and definitions related to Nuclear Magnetic Resonance Spectroscopy)

1. Nuclear Magnetic Resonance (07 Marks)

Principal, Magnetic and non magnetic nuclei, absorption of radio frequency. Equivalent and non equivalent protons, chemical shifts, anisotropic effect, relative strength of signals, spin-spin coupling, long range coupling, coupling constant, Deuterium labelling, applications to simple structural problems.

2. Problems based on Spectral data (07 Marks)
Structural problems based on UV, IR and NMR

Unit-4: Visible and Atomic Spectroscopy (15L) (14 marks)
(Prerequisites or topics for Self Study: - Basic terms related to Visible Spectroscopy, Fundamental terms and definitions related to Atomic Spectroscopy)

1. Visible Spectroscopy (06 Marks)
Introduction, Beer Lambert's law, instrumentation (light source, optical system, wavelength selector, light sensitive device), Accuracy and error of Spectrophotometry.

2. Atomic Spectroscopy (08 Marks)
Introduction, Principle, Flame Emission Spectroscopy (FES) and Atomic adsorption Spectroscopy (AAS), Principal, comparison and applications, Burners (Total consumption burner and Premix burners), Inductively coupled plasma Emission Spectroscopy (ICPES)

Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

Reference books: CH 5504: Analytical chemistry (Theory)

1. Introduction to Spectroscopy**:** Donald L. Pavia, Gary M. Lampman, George S. Kriz Cengage Learning; 4th Edition.
2. Spectrometric Identification of Organic Compounds**:** Robert M. Silverstein, Francis X. Webster, David Kiemle Wiley; 7th Edition.
3. Infrared spectra of Complex molecules**:** J. Bellamy, John Wiley & Sons, Inc., 3rd Edition.
4. Spectroscopic Method in Organic Chemistry**:** Dudley Williams, Ian Fleming McGraw-Hill Education; 6th Edition.
5. Applications of spectroscopic techniques in Organic Chemistry**:** P.S. Kalsi, New Age International; 6th Edition.
6. Elementary Organic Spectroscopy; Principles And Chemical Applications**:** Y. R. Sharma, S. Chand & Co Pvt Ltd.
7. Fundamentals of Molecular Spectroscopy**:** C. M. Banwell and E. McCash, Tata McGraw Hill, 4th Edition.
8. Modern Raman Spectroscopy**:** A Practical Approach; Ewen Smith, Geoffrey Dent., Wiley; 1st Edition.

Semester V Chemistry
Chemistry Subject Elective Paper: (Nanomaterials and Nanotechnology) (Theory)
Course Code: CH 5401
No. of Credits: 02
Learning Hours: 30 hrs

Course Overview & Course Objectives
The main objective of the course will be to build the basic foundation for studying chemistry.
By the end of the paper, a student should be able to:

a. To learn fundamentals of nanomaterials and preparation of Nanomaterial
b. To learn about Nanostructured materials.
c. To learn basics of characterization techniques for nanomaterials.
d. To learn about Application of nanomaterials.

Thus, the knowledge from the course can help in the following:
a. Basic knowledge of Nanomaterials and Nanotechnology is important for practical and industrial applications
b. The students could pursue a career in chemistry, Industrial chemistry and Post-graduation and also in the field of research in Chemistry.

Course Content
Unit-1: Introduction and preparation of Nanomaterials (8L) (14 marks)
(Prerequisites or topics for Self Study: - Basic terms related to, , Fundamental terms and definitions of)

Introduction to Nanomaterials, Optical, magnetic and chemical properties of Nanomaterials, Preparation of Nanoparticles: Chemical Approaches: Chemical reduction; Sonochemical synthesis; Sol-Gel Synthesis; Self-assembly. Physical Approaches: Aerosol spray; Gas condensation; Laser vaporization and vapour deposition; Sputtering.

Unit-2: Nanostructured materials (7L) (14 marks)
(Prerequisites or topics for Self Study: - Fundamental terms and definitions related to Nanostructured materials)
Quantum dots, wells & wires; Carbon Nanotubes (CNTs): Single walled carbon nanotubes (SWNTs), Multiwalled carbon nanotubes (MWNTs), Graphenes, Fullerenes, Metal/Oxide nanoparticles (NPs), Nanorods, Nanotubes and Nanofibres, Semiconductor quantum dots, Polymer NPs.

Unit-3: Characterization techniques for Nanomaterials (8L) (14 marks)

(Prerequisites or topics for Self Study: - Basic terms related to Characterization techniques for Nanomaterials)

Characterization techniques for Nanomaterials-I (07 marks)

Particle size Analyser (Laser scattering), Optical Microscopy: Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Scanning Tunnel Microscopy (STM).

Characterization techniques for Nanomaterials-II (07 marks)

X-ray Diffraction (XRD), Auger Emission Spectroscopy, Electron Spectroscopy for Chemical analysis (ESCA)

Unit-4: Application of Nanomaterials: (7L) (14 marks)

(Prerequisites or topics for Self Study: - Basic terms related to Application of Nanomaterials and understanding the applications of Nanomaterials)

Applications Solar energy conversion and catalysis, Polymers with a special architecture, Liquid crystalline systems, Applications in displays and other devices, Advanced organic materials for data storage, Photonics, Chemical and biosensors, Nanomedicine and Nanobiotechnology.

Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

Reference books: CH 5505: Organic chemistry (Theory)

1. Introduction to Nanotechnology**:** Charles P. Poole, Jr. and Frank J. Owens; Wiley Student Edition, 2008
2. Nanostructures and Nanomaterials: Synthesis, Properties and Applications**:** G. Cao, ICP, London, 2004.
3. Nanobiotechnology, Concepts, Applications and perspectives**:** C. M. Niemeyer and C. A. Mirkin, WILEY-VCH, Verlag GmbH & Co, 2004.
4. Nanotechnology - Molecularly Designed Materials**:** G. M. Chow and K. E. Gonslaves; (American chemical society)
5. Optical Properties of semiconductor nanocrystals**:** S. P. Gaponenko, Cambridge University Press, 1980.
6. Nanostructures &Nanomaterials: Synthesis, Properties & Applications**:** G. Cao, Imperial College Press, 2004.
7. Nano - The essentials**:** T. Pradeep, Tata McGraw Hill, New Delhi, 2007. Nano materials**:** J. Dutta& H. Hofman.
8. "NANOTECHLOGY-basic science and emerging technologies**:** Mick Wilson,

KamaliKannagaraet.al., University of new south wales press ltd,2008.
9. Nanotechnology**:** Mark Ratner and Daniel Ratner, Pearson Education. Nanomaterials**:** A.K. Bandyopadhyay; New Age International Publishers.

Semester V
Paper: Chemistry (Practicals)
Course Code: CH 5505 L Practical –(I)
No. of Credits: 02
Sessions: Two X 3 hrs

Practical (I) (Inorganic and Physical Practicals)

1. **Inorganic Qualitative Analysis:** Inorganic Qualitative Analysis of mixture containing six radicals only. (Minimum 08 mixtures to be done)

2. **Physical Chemistry (Kinetics, Solubility & Instruments)**
   A) Kinetics and solubility:
   Investigate the order of reaction in experiments no. 1, 2 and 3 by graphical method.
   Exp 1: Reaction between $K_2S_2O_8$ and KI (a □ b)
   Exp 2: Reaction between $KBrO_3$ and KI (a = b)
   Exp 3: Reaction between H_2O_2 and HI (a □ b)

   B) Instruments:
   Exp 1: Determine dissociation constant of monobasic acid (CH_3COOH) using pH meter.
   Exp 2: Determine the amount of bases in given mix ($NaOH+NH_4OH$) conductometrically using standard solution of HCl
   Exp3: Determine the amount of ferrous in the given solution of Ferrous Ammonium Sulphatepotentiometerically using standard $KMnO_4$ solution.
   Exp 4: Determine the concentration of Cu^{2+} and Fe^{3+} in the given solution by Colourimetry.

Reference books: CH 5505 L: Chemistry (Practicals)

1. Vogel's "Textbook of Quantitative Chemical Analysis"**:** Pearson Education Ltd. 6th Edition, 2008.
2. Vogel's "Qualitative Inorganic Analysis"**:** Pearson Education Ltd. 7th Edition, 2009.
3. Gurdeep Raj, "Advanced Practical Inorganic Chemistry"**:** Krishna Prakashan, Meerut, 21st Edition, 2009.
4. J. B. Yadav, "Advanced Practical Physical Chemistry"**:** Krishna Prakashan, Meerut, 29th Edition, 2010.
5. P. H. Parsania, "Experiments in Physical Chemistry"**:**Neminath Printers Rajkot 1st Edition 2004.
6. M. James and F. E. Prichard, "Practical Physical Chemistry"**:** Longman Group Limited

London 3rd Edition Reprinted 1979.

Paper: Chemistry (Practicals)
Course Code : CH 5505 L – Prcatical – (II)
No. of Credits: 02
Sessions: Two X 3 hrs

Practical (II) (Organic and Analytical Practicals)

1. **Organic Preparation:**
   a. Nitration of Acetanilide
   b. Acetanilide from Aniline (Green Preparation)
   c. Benzilic Acid from Benzil (Green Preparation)
   d. 1,5-Diphenyl-penta-1,4-diene-3-one from Benzaldehyde and Acetone(Green Preparation)
   e. Diels-Alder reaction between furan and maleic acid (Green Preparation)

2. **Analytical:**
   A) Organic Estimation:
      a. Unknown Acid (e.g., Oxalic, Succinic, Citric, Tartaric, Benzoic, Phthalic and Cinnamic acid)
      b. Ketone (Acetone)
      c. Ester

   B) Chromatography (TLC): Analysis of the following drugs by Thin layer cromatography.
      a. Aspirin b. Paracetamol c. Ibuprofen

Reference books: CH 5505 L: Chemistry (Practicals)

1. Vogel, "Elementary Practical Organic Chemistry Part-II, Qualitative Organic Analysis"**:** CBS Publishers & Distributers, New Delhi, 2nd Edition, 2004.
2. Vogel, "Elementary Practical Organic Chemistry Part III Quantitative Organic Analysis"**:** CBS Publishers & Distributers, New Delhi, 2nd Edition, 2004.
3. Hand book of Organic qualitative analysis by H. T. Clarke.
4. Practical Organic Chemistry**:** F. G. Mann and B. C. Saunders. Low – priced Text Book. ELBS, Longman.
5. V.K. Ahluwalia, SunitaDhingra, "Comprehensive Practical Organic Chemistry – Qualitative Analysis"**:** University Press (India) Private Limited, Hyderabad, 1st Indian Edition, 2010.
6. "Advanced Practical Organic Chemistry"**:** Stanley Thornes Publishers Ltd., J Leonard, B Lygo, G Procter, 1st Indian Edition, 2004.
7. "Quantitative Analysis"**:**R. A. Day, A. L. Underwood, Prentice-Hall of India Pvt. Ltd.,New Delhi, 6th Edition, 2004.

CH 6501 Organic Chemistry

CH 6502 Inorganic Chemistry
CH 6503 Physical Chemistry
CH 6504 Analytical Chemistry
CH 6401 Subject Elective (Everyday Chemistry)
CH 6505L Practical:

(I) Inorganic Quantitative Analysis
&
Physical Chemistry (Kinetics and Instruments)

(II) Organic (Separation and Identification)
&
Analytical Chemistry (Volumetric Analysis)

Course Structure with respect to credit, hours and marks

Type of Course	**Paper No.**	**Credit**	**Total Marks**	**Internal**	**External**	**No. of hours per week**	**Exam hours**
General English	GE - 6052	2	100	30	70	3	3
Core Course	CH 6501	4	100	30	70	4	3
	CH 6502	4	100	30	70	4	3
	CH 6503	4	100	30	70	4	3
	CH 6504	4	100	30	70	4	3
Subject Elective Course (SEC)	CH 6401	2	100	30	70	3	3
Practical Core Course – I and II	CH 6505L	5	200	60	140	12	12
Total Credit		25					

N.B.**:** The practical batch should be maximum of 10 students with respect to the credit

Semester VI Chemistry
CORE Paper: Organic chemistry (Theory)
Course Code: CH 6501
No. of Credits: 04
Learning Hours: 60 hrs

Course Overview & Course Objectives

The main objective of the course will be to build the basic foundation for studying chemistry. By the end of the paper, a student should be able to:

a. To learn fundamentals of Stereochemistry of carbon and compounds other than Carbon.
b. To learn about alkaloids and isoprenoids (terpenoids):
c. To learn basics of synthetic dyes, explosives and pesticides chemistry
d. To learn about fundamentals and synthesis of drugs and vitamins.

Thus, the knowledge from the course can help in the following:

a. Basic knowledge of these topics in organic chemistry is important for practical and industrial applications
b. The students could pursue a career in chemistry, Industrial chemistry and Post-graduation and also in the field of research in Chemistry.

Course Content

Unit-1: Stereo Chemistry (II) (15L) (14 marks)

(Prerequisites or topics for Self Study: - Fundamental terms and definitions related to Concept of prostereo isomerism and chiral synthesis and terns related to Stereo chemistry of compounds other than Carbon)

1. Stereo Chemistry (II) (08 Marks)

Concept of prostereo isomerism and chiral synthesis (Asymmetric Induction), Cram's rule, Prelog's generalization, Prelog's rule and assignment of configuration.

2. Stereochemistry of compounds other than Carbon (06 Marks)

Stereo chemistry of the compounds containing Nitrogen. Phosphorus and Sulphur

Unit-2: Alkaloids and Isoprenoids (Terpenoids) (15L) (14 marks)

(Prerequisites or topics for Self Study: -Fundamental terms and definitions of Alkaloids and Isoprenoids (Terpenoids))

1. Alkaloids (07 Marks)

Classification, General method of determining structure, analytical and synthetic methods, structure of Coniine, Nicotine, Atropine and Papaverine.

2. Isoprenoids (Terpenoids) (07 Marks)

Classification, General method of determining structure, Isoprene rule, Chemistry of Citral, α-Terpineol, Camphor and their synthesis, study of reactions of β-carotene (No Synthesis).

Unit-3: Basics aspects of Dyes, Explosives and Pesticides. (15L) (14 marks)
(Prerequisites or topics for Self Study: - Fundamental terms and definitions related to Dyes, Explosives, and Pesticides)

1. Synthetic Dyes (06 Marks)
Classification of Dyes- Anionic and Cationic dyes, Mordant and Vat dyes, Reactive and Dispersed dyes, Synthesis of Alizarin, Malachite green, Indigo, Congo red, Eosin.

2. Explosives (04 Marks)
Preparation of RDX, PETN, Nitroglycerine, Tetryl.

3. Pesticides (04 Marks)
Preparation of Aldrine, Malathion, Parathion, Methoxychlor.

Unit-4: Fundamentals of Drugs and Vitamins (15L) (14 marks)
(Prerequisites or topics for Self Study: - Basic terms related to Drugs and Vitamins)

1. Synthetic Drugs (08 Marks)
General Classification, Chemotherapy, Antipyretics, Analgesics, Hypnotics, Sedatives, Anaesthetics, Antimalerials, Antiseptics, Cardiovascular drugs. (Minimum two illustrations of each, only names without structures).Methods of preparation and uses of Antipyrine, Phenacetin, n-Hexyl resorcinol, Alprazolam, Zaleplon, Benzocaine, Lidocaine, Chloroquine, Atenolol, Sulphadiazine, Trimethoprim and Tolbutamide.

2. Vitamins (06 Marks)
Structure and Biochemistry of Vitamin-A (A_1) (Retinol), Vitamin-B_6 (Pyridoxine).

Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

Reference books: CH 6501: Organic chemistry (Theory)

1. Organic Chemistry**:** I. L. Finar, Vol-II, 5th Edition, Pearson Education Ltd.
2. Organic Chemistry**:** Morrison & Boyd, 6th Edition, Prentice Hall of India Pvt. Ltd.
3. Stereochemistry of carbon compounds**:** E. L. Eliel, Wiley Eastern Ltd.
4. Stereochemistry and mechanism through solved problems**:** P. S. Kalsi, New Age International.
5. Stereochemistry of Organic Compounds: Principles and Applications**:** D. Nasipuri; New Academic Science; 4th Revised Edition.

6. Organic Chemistry**:** Hendrickson, Cram, Hammond, McGraw-Hill.
7. Organic Chemistry**:** 6th Edition, John Mcmurry, Brooks Cole, International Edition.
8. Organic Chemistry**:** T.W. Graham Solomons and Craig B. Fryhle Wiley, 8th Edition.
9. Organic Chemistry**:** Francis A. Carey, McGraw-Hill, 7th Edition.
10. Organic Chemistry**:** Leroy G.Wade, Prentice Hall, 6th Edition.
11. Organic Chemistry**:** Jonathan Clayden, Nick Greeves, Stuart Warren and Peter Wothers. Oxford University Press, USA.

Semester VI
CORE Paper: Inorganic chemistry (Theory)
Course Code: CH 6502
No. of Credits: 04
Learning Hours: 60 hrs

Course Overview & Course Objectives
The main objective of the course will be to build the basic foundation for studying chemistry.
By the end of the paper, a student should be able to:

a. To learn fundamentals of term symbol and electronic spectra of metal complexes
b. To learn about Quantum chemistry:
c. To learn basics of Chemical bonding chemistry
d. To learn about metal carbonyls and organometallic compounds.

Thus, the knowledge from the course can help in the following:
a. Basic knowledge of these topics in inorganic chemistry is important for practical and industrial applications
b. The students could pursue a career in chemistry, Industrial chemistry and Post-graduation and also in the field of research in Chemistry.

Course Content
Unit-1: Term (state) symbol and Electronic spectra of metal complexes (15L) (14 marks)
(Prerequisites or topics for Self Study: - Basic terms related to Term (state) symbol, Fundamental terms and definitions related to Electronic spectra of metal complexes)

1. Term (state) symbol (07 Marks)
Term symbol , determination of term symbol of ground state
Russel – Saunders coupling
Calculation number of microstates
Pigeon hole diagram
P^2 and D^2 configuration
Hund's rule

Hole formation

2. Electronic spectra of metal complexes

Selection rule:-Laporte orbital and spin selection rule,
Rrelaxation in selection rules,
Vibronic of coupling
Jahn Teller distortion.
Orgel energy level diagram of d^5 and combined diagram of $d^1 – d^9$,$d^2 – d^8$, $d^3 – d^7$, $d^4 – d^6$ and their spectra.

Unit-2: Quantum chemistry (15L) (14 marks)

(Prerequisites or topics for Self Study: - Fundamental terms and definitions related to Quantum chemistry)
Hermitian operator, Theorems concerning Hermitian operator.
Particle in a three dimensional box
The rigid Rotator and rotation spectra
The Schrodinger equation in spherical polar coordinates for hydrogen atom.
Separation of variables
Solution of Φ equations.

Unit-3: Quantum chemistry for bonding (15L) (14 marks)

(Prerequisites or topics for Self Study: - Basic terms related to, , Fundamental terms and definitions related to Quantum chemistry for bonding)
The Huckl Moleculer orbital (HMO) Theory
Variation principle
Solution of secular equation
HMO treatment to ethylene molecule, allylic cation, allylic free radical and allylic anion
Hybridization:-
Hybridization wave functions of sp, sp^2 and sp^3.

Unit-4: Metal π – complexesand Reaction of organometalic compounds. (15L) (14 marks)

(Prerequisites or topics for Self Study: - Basic terms related to Metal π – complexes and Reaction of organometalic)

1. Metal π – complexes

Metal carbonyl structure and bonding of polynuclear metal carbonyls,
$Fe_2(CO)_9$, $Fe_3(CO)_{12}$, $Co_2(CO)_8$
$Mn_2(CO)_{10}$, $Ir_4(CO)_{12}$, $Co_4(CO)_{12}$
Vibrational spectra of metal carbonyl for bonding and structural illustration.
Structure and bonding of metal nitrosyl, metal carbonyl hydrides.

2. Reaction of Organometalic compounds (07 marks)

Ligand substitution

Oxidative addition and Reductive elimination.

σ (Sigma) bond metathesis

1, 2-Insertion and β- hydride elimination

α, γ and δ- hydride elimination and cyclometallation.

Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

Reference books: CH 6502: Inorganic chemistry (Theory)

1. Concise Inorganic Chemistry**:** J.D. Lee; Wiley India, 5th Edition (1996).
2. 'Shriver and Atkins' Inorganic Chemistry**:** Atkins, Overton, Rourke, Weller, Armstrong; Oxford University Press, 5th Edition (2011).
3. Advanced Inorganic Chemistry**:**. F.A. Cotton and Wilkinson G.; John Wiley, 5th Edition (1988).
4. Introductory Quantum Chemistry**:** A.K. Chandra; Tata- McGraw Hill, 4th Edition (1994).
5. Quantum chemistry**:** R.K. Prasad; New Age International, 4th Edition (2010).
6. Electron and chemical bonding**:** H. B. Grey, W.A.Benjamin. INC, New York.
7. Inorganic chemistry**:**. James E. Huheey, 4thEdition,Wesley Publishing Company.
8. Mechanism of Inorganic reaction**:**Basalo and Pearson, 2nd Edition, Wiley Eastern Pvt Ltd.
9. Introduction to Advanced Inorganic chemistry, Durrant and Durrant, John Wiley.
10. Advanced Inorganic chemistry**:** (Vol. 1) SatyaPrakash, Tuli, Basu and Madan; S. Chand
11. Advanced Inorganic chemistry**:**Gurdeep Raj; Goel Publishing House, 23rd Edition (1998).
12. Physical methods for chemists, 2nd edition by R S Drago.

CORE Paper: Physical chemistry (Theory)
Course Code: CH 6503
No. of Credits: 04
Learning Hours: 60 hrs

Course Overview & Course Objectives

The main objective of the course will be to build the basic foundation for studying chemistry.
By the end of the paper, a student should be able to:

a. To learn fundamentals of thermodynamics chemistry.
b. To learn about topics in electrochemistry:
c. To learn basics of phase rule and osmosis in chemistry

d. To learn about topics on photochemistry and metallic corrosion.

Thus, the knowledge from the course can help in the following:

a. Basic knowledge of these topics in physical chemistry is important for practical and industrial applications
b. The students could pursue a career in chemistry, Industrial chemistry and Post-graduation and also in the field of research in Chemistry.

Course Content

Unit-1: Thermodynamics (15L) (14 marks)

(Prerequisites or topics for Self Study: - Basic terms related to Thermodynamics)

Colligative properties: Boiling point elevation and freezing point depression. Molal elevation constant (K_b) and Molal depression constant (K_f), Calculation of absolute value of entropy using third law of thermodynamics, Law of mass action using chemical potential, Partial molar quantity.

Unit-2: Electrochemistry (15L) (14 marks)

(Prerequisites or topics for Self Study:-Fundamental terms and definitions related to Electrochemistry)

Concentration cell: Cell with and without-transference, Electrode concentration cell, Gas electrode concentration cell, Applications of EMF to determine K_{sp}, Valancy of ion, K_a, (hydrolysis constant) Activity and activity coefficient determination, Define liquid junction potential and how it can be avoided, Equation for liquid junction potential, Decomposition potential, Overvoltage, Tafel equation.

Unit-3: Phase Rule and Osmosis (15L) (14 marks)

(Prerequisites or topics for Self Study: - Basic terms related to Phase Rule, Fundamental terms and definitions related to electrochemistry)

1. Phase Rule (07 Marks)

Binary system: Zeotropic and azeotropic mixtures, Steam distillation, Zone refining, Numericals based on theory.

2. Applications of electrochemistry (07 Marks)

Desalination and reverse osmosis, Numerical based on electrochemical synthesis and corrosion.

Unit-4: Photochemistry and Metallic Corrosion (15L) (14 marks)

(Prerequisites or topics for Self Study: - Basic terms related to **Photochemistry**, Fundamental terms and definitions related to Metallic Corrosion)

1. Photochemistry (07 Marks)

Laws of Photochemistry :Grotthuss-Draper Law, Einstein Law, Quantum yield ,Reasons for high

and low quantum yield, Fluorescence and Phosphorescence, Chemiluminescence, Photosensitized reactions.

2. Metallic Corrosion (07 Marks)

Types of corrosion, Electrochemical series, Corrosion in acidic and neutral medium, Differential aeration principle, Atmospheric corrosion, Prevention of corrosion by various factor.

Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

Reference books: CH 6503: Physical chemistry (Theory)

1. Physical Chemistry**:** G. M. Barrow, 5th Edition, McGraw-Hill education, India.
2. Advanced Physical Chemistry**:** Gurdeep Raj, 35th Edition (2009), Goel / Krshina Publishing House.
3. Principles of Physical Chemistry**:**Puri, Sharma and Pathania, 42nd Edition, Vishal Publishing Company.
4. Polymer Science**:** Gowariker, Viswanathan and Sreedhar, 1st Edition (2012 reprint) New Age International.
5. Essentials of Nuclear Chemistry**:** Arnikar, 4th Edition (2012 reprint), New Age International.
6. Physical Chemistry**:** Atkins, 9th Edition. Oxford University Press.
7. Advanced Physical chemistry**:** Gurtu and Gurtu, 11thEdition ,Pragati Prakashan.
8. Physical chemistry**:** Levine, 6th Edition, McGraw-Hill education, India.

CORE Paper: Analytical chemistry (Theory)
Course Code: CH 6504
No. of Credits: 04
Learning Hours: 60 hrs

Course Overview & Course Objectives

The main objective of the course will be to build the basic foundation for studying chemistry.
By the end of the paper, a student should be able to:

a. To learn fundamentals of errors , treatment of analytical data and Solvent Extraction Separation
b. To learn about chromatographic methods, Ion exchange chromatography, Gas chromatography, HPLC, Instrumentation
c. To learn basics of Polarography and Potentiometry chemistry.
d. To learn about Acid Base Titrations, Redox titration, Complexometric titration.

Thus, the knowledge from the course can help in the following:

a. Basic knowledge of these topics in analytical chemistry is important for practical and industrial applications
b. The students could pursue a career in chemistry, Industrial chemistry and Post-graduation and also in the field of research in Chemistry.

Course Content

Unit-1: Errors and treatment and use of organic reagents in quantitative Analysis

(15L) (14 marks)

(Prerequisites or topics for Self Study: - Basic terms related to Errors and treatment of Analytical data and Fundamental terms and definitions related to Solvent Extraction Separation)

1. Errors and treatment of Analytical data (08 Marks)

Significant figures, Accuracy and precision, Types of errors and minimization of errors. Ways of expressing accuracy and precision. Rejection of a result, Test of significance (Q-Test, Student t-Test and F-Test) correlation coefficient. Literature of Analytical Chemistry.

2. Solvent Extraction Separation: (06 Marks)

The separation efficiency of metal chelates, Analytical separations,Multiple batch extractions, Counter current extractions ,Solid Phase extractions and Solvent extraction by Flow injection analysis.

Unit-2: Chromatographic methods and Solvent Extraction Separation (15L) (14 marks)

(Prerequisites or topics for Self Study: - Basic terms related to Chromatography , Fundamental terms and definitions related to Ion exchange chromatography, Gas Chromatography, HPLC)

1. Chromatographic methods (08 Marks)

General principle, classification of chromatographic separation.Ion exchange chromatography (Ion Exchange equlibria, Types of Ion Exchange capacity, Application of Ion Exchange resins).Gas Chromatography, Instrumentation and evolution of data.High Performance Liquid Chromatography (HPLC) Principle and Instrumentation.

2. Special Chromatographic techniques. (06 Marks)

Ion exchange chromatography (Ion Exchange equlibria, Types of Ion Exchangers and ion-exchange capacity, Application of Ion exchange chromatography). Gas Chromatography Principle and Instrumentation . High Performance Liquid Chromatography (HPLC) Principle and Instrumentation.

Unit-3: Electro analytical Techniques (15L) (14 marks)

(Prerequisites or topics for Self Study: - Basic terms related to Polarography, Fundamental terms

and definitions related to Potentiometry)

1. Polarography (07 Marks)

Introduction, Principle, electrode, Types of currents, Determination of half wave potential, Ilkovic equation, methods of determining concentration (Standard addition method and Calibration method)

2. Potentiometry (07 Marks)

The scope of potentiometric titrations, Precipitation and neutralization titrations, Graphical method including Gran's plot for selecting end point, Differential titration, Dead stop titration, Ion selective Electrode, various types of Ion selective Electrodes and use of Calcium ion selective electrode.

Unit-4: Acid Base Titrations and Redox titration (15L) (14 marks)

(Prerequisites or topics for Self Study: -Basic terms related to Acid Base Titrations, Fundamental terms and definitions related to Redox and Complexometric titrations)

1. Acid Base Titrations (07 Marks)

Titration of polyprotic acid and mixture of acids, titration of salts, Differential Alkali titration.

2. Redox titration (04 Marks)

Titration involving Iodine: iodimetry and iodometry, Titration with reducing agents and oxidising agents, metallic reductors.

3. Complexometric titration (03Marks)

EDTA titration techniques-Direct, Back, Displacement and Indirect Tititration, Masking, Demasking agent, ligand effect and Hydrolysis of EDTA complex, Auxiliary complexing agent-EDTA titration with an auxiliary complexing agent.

Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

Reference books: CH 6504: Analytical chemistry (Theory)

1. Analytical Chemistry**:** Gary D. Christian, 6th Edition; Wiley & Sons
2. Fundamentals of Analytical Chemistry**:** D. A. Skoog, D. M. West and F. J. Holler, 9th Edition, Cengage Learning.
3. Instrumental Methods of analysis**:** (CBS) H.H . Willard, L.L. Mirrit, J.A. Dean
4. Solvent extraction in Analytical Chemistry**:** G.H. Morrison, F. Frieiser, John Wiley &

Sons, NY.
5. Instrumental Methods of Inorganic Analysis**:** A.I. Vogel, ELBS
6. Chemical Instrumentation**:** A Systematic approach- H.A. Strobel
7. The principals of ion-selective electrodes and membrane transport**:** W.E.Morf
8. Principles of Instrumental Analysis**:** Douglas A. Skoog., F. James Holler, Stanley R. Crouch, Cengage Learning; 6th Edition.
9. Quantitative Chemical Analysis**:** Daniel C. Harris, W H Freeman, New York.
10. Ion exchange and solvent extraction of metal compounds**:** Y. Macros, A.S.Kertes, Wiley, Interscience.

Chemistry Subject Elective Paper: Everyday Chemistry (Theory)
Course Code: CH 6401
No. of Credits: 02
Learning Hours: 30 hrs

Course Overview & Course Objectives

The main objective of the course will be to build the basic foundation for studying chemistry.
By the end of the paper, a student should be able to:

a. To learn about Fertilizers.
b. To learn basics of Food chemistry
c. To learn about Adhesives
d. To learn about Basics of Oils, Fats, Waxes

Thus, the knowledge from the course can help in the following:
a. Basic knowledge of these selected topics is important for practical and industrial applications
b. The students could pursue a career in chemistry, Industrial chemistry and Post-graduation and also in the field of research in Chemistry.

Course Content

Unit-1: Fertilizers (15L) (14 marks)

(Prerequisites or topics for Self Study: - Basic terms related to Fertilizers)
Classification of Fertilizers, Nitrogen (Ammonia, ammonium nitrate and urea); phosphorous (phosphoric acid, DAP, rock phosphate); and potassium based (potassium nitrate and potash) fertilizers, composting, bio-fertilizer.

Unit-2: Food chemistry (15L) (14 marks)

(Prerequisites or topics for Self Study: - Fundamental terms and definitions related to Food chemistry)

Food additives: Enhancers, sugar substitutes, sweeteners, food colors, antioxidants, acids and bases used in food.
Food chelating agents, emulsifiers, thickening agents, gel builders, stabilizers, common food toxicants, flavors,
Biomaterial: Uses of bacteria, yeasts and molds in food industry

Unit-3: Adhesives (15L) (14 marks)

(Prerequisites or topics for Self Study: - Basic terms related to adhesives)
Types of Bonding, Classification of adhesive, Preparation of adhesive, Starch adhesive, Protein adhesive.
Synthetic resin adhesive, Rubber based adhesive, Use of Adhesive.

Unit-4: Oils, Fats, Waxes (15L) (14 marks)

(Prerequisites or topics for Self Study: - Fundamental terms and definitions related to Oils, Fats, Waxes)
Vegetable and animal oils and fats, extraction of vegetable oils, refining of edible oils, hydrogenation of oils, waxes and their applications.
Analysis of Oils, Fats and Wax, Ester value, acid value, Iodine Value and Saponification value.

Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

Reference books: CH 6401: Everyday Chemistry (Theory)

1. Industrial Chemistry by B.K.Sharma
2. Hand book of industrial chemistry Vol I & II K. H. Davis & F.S. Berner Edited by S.C. Bhatia, CBS publishers .
3. Polymer science, Bill meyer, F. W. Jr. John Wiely& sons
4. Chemical engineering vol.1 &2 by Coulson and Richardson's.(6^{th} Edition)
5. The chemistry of oils & fats,F.D.Gunstone,Blackwell Pub.
6. Baileys Industrial oils & fats products,Vol 1-5,John Wiley & Sons

Semester VI
Paper: Chemistry (Practicals)
Course Code: CH 6505 L (Prcatical I)
No. of Credits: 02
Sessions: Two X 3 hrs

Practical (I) (Inorganic and Physical Practicals)

1. **Inorganic Quantitative Analysis:**

A) Gravimetric determination of the radicals:

(After removal of interfering radicals in mixed solution)

(a) $BaCl_2$, $FeCl_3$ and HCl (Determination of Ba as $BaSO_4$)

(b) $CuCl_2$, $MnCl_2$ and HCl (Determination of Mn as $Mn_2P_2O_7$)

(c) $CuSO_4$, $FeSO_4(NH_4)_2$ SO_4 and H_2SO_4 (Determination of Fe as Fe_2O_3)

(d) $CuSO_4$, Al_2 $(SO_4)_3$ and H_2SO_4 (Determination of Al as Al_2O_3)

B) Analysis of Alloy:

(a) Brass (Cu → Volumetrically, Zn → Gravimetrically)

(b) German Silver (Cu → Volumetrically, Ni → Gravimetrically)

2. **Physical**: (**Kinetics and Instruments**)

A) Kinetics:

Investigate the order of reaction in the following experiments by graphical method, Exp 1: Reaction between $K_2S_2O_8$ and KI (a =b)

Exp 2: Reaction between $KBrO_3$ and KI (a□b)

Exp 3: Reaction between H_2O_2 and HI (a = b)

B) Instruments:

Exp 1: Titration of unknown strength of HCl with standard NaOH solution using pH meter.

Exp2 : To determine the concentration of CrO_4^{2-} and Ni^{2+} in solution by colourimetry.

Exp 3 : Titration of a mixture of HCl and CH_3COOH potentiometrically.

Exp 4 : Determination of normality and amount of given halide by conductometric titration.

Semester VI

Reference books: CH 6505 L: Chemistry (Practicals)

1. Vogel's "Textbook of Quantitative Chemical Analysis"**:** Pearson Education Ltd. 6th Edition, 2008.
2. Vogel's "Qualitative Inorganic Analysis"**:** Pearson Education Ltd. 7th Edition, 2009.
3. Gurdeep Raj, "Advanced Practical Inorganic Chemistry"**:** Krishna Prakashan, Meerut, 21st
a. Edition, 2009.
4. J. B. Yadav, "Advanced Practical Physical Chemistry"**:** Krishna Prakashan, Meerut, 29th Edition, 2010.
5. P. H. Parsania, "Experiments in Physical Chemistry"**:**Neminath Printers Rajkot 1st Edition 2004.
6. M. James and F. E. Prichard, "Practical Physical Chemistry"**:** Longman Group Limited London 3rd Edition Reprinted 1979.

Semester VI
Paper: Chemistry (Practicals)
Course Code: CH 6505 L (Prcatical II)
No. of Credits: 02
Sessions: Two X 3 hrs

Practical (II) (Organic and Analytical Practicals)

1. **Organic: Organic separation and Identification:**
   Separation of Binary Mixtures and Identification (Minimum 8 Mixtures)
   (i) Solid + Solid (4 Mixtures)
   (ii) Solid + Liquid (2 Mixtures)
   (iii) Liquid + Liquid (2 Mixtures)

One Mixture from each of the following should be given Acid-Base, Acid-Phenol, Acid-Neutral, Phenol-Base, Phenol-Neutral, Base-Neutral, and Neutral-Neutral. Water soluble compounds are included.
Identification of separated organic compound must be done by physical and chemical tests, sodium fusion test, M.P / B.P., derivatives and crystallization.

2. **Analytical: Volumetric Analysis:**
   (i) Estimation of Fe^{3+} by EDTA (Back Titration)
   (ii) Estimation of Bi^{3+} by EDTA
   (iii) Estimation of Chloride by silver nitrate (Mohr's Method)
   (iv) Estimation of Zn^{2+} and Cd^{2+} in a mixture by EDTA
   (v) Estimation of Ca^{2+} and Mg^{2+} in a mixture by EDTA
   (vi) Determination of percentage purity of H_2O_2 solution by Iodometry method.

Reference books: CH 6505 L: Chemistry (Practicals)

1. Vogel, "Elementary Practical Organic Chemistry Part-II, Qualitative Organic Analysis"**:** CBS Publishers & Distributers, New Delhi, 2nd Edition, 2004.
2. Vogel, "Elementary Practical Organic Chemistry Part III Quantitative Organic Analysis"**:** CBS Publishers & Distributers, New Delhi, 2nd Edition, 2004.
3. Hand book of Organic qualitative analysis by H. T. Clarke.
4. Practical Organic Chemistry**:** F. G. Mann and B. C. Saunders. Low – priced Text Book. ELBS, Longman.
5. V.K. Ahluwalia, SunitaDhingra, "Comprehensive Practical Organic Chemistry – Qualitative Analysis"**:** University Press (India) Private Limited, Hyderabad, 1st Indian Edition, 2010.
6. "Advanced Practical Organic Chemistry"**:** Stanley Thornes Publishers Ltd., J Leonard, B Lygo, G Procter, 1st Indian Edition, 2004.

7. “Quantitative Analysis”**:**R. A. Day, A. L. Underwood, Prentice-Hall of India Pvt. Ltd., New Delhi, 6th Edition, 2004.