St Aloysius College (Autonomous)

Mangaluru

Re-accredited by NAAC "A" Grade

Course structure and syllabus of

B.Sc.

CHEMISTRY

CHOICE BASED CREDIT SYSTEM

(2019 – 20 ONWARDS)

ಸಂತ ಅಲೋಶಿಯಸ್ ಕಾಲೇಜು

(ಸ್ವಾಯತ್ತ)

ಮಂಗಳೂರು– ೫೭೫ ೦೦೩

ST ALOYSIUS COLLEGE
(Autonomous)
P.B.No.720
MANGALURU- 575 003, INDIA
Phone:+91-0824 2449700,2449701
Fax: 0824-2449705
Email: principal_sac@yahoo.com
principal@staloysius.edu.in
Website: www.staloysius.edu.in

Re-accredited by NAAC with 'A' Grade - CGPA 3.62
Recognised by UGC as "College with Potential for Excellence"
College with 'STAR STATUS' conferred by DBT, Government of India
3rd Rank in "Swacch Campus" Scheme, by MHRD, Govt of India

No: SAC 40/Syllabus 2019-20 Date: 18-07-2019

NOTIFICATION

Sub: Syllabus of **B.Sc. Chemistry** under Choice Based Credit System.

Ref: 1. Decision of the Academic Council meeting held on 02-05-2019 vide Agenda No: 20(2019-20)
2. Office Notification dated 18-07-2019

Pursuant to the above, the Syllabus of **B.Sc. Chemistry** under Choice Based Credit System which was approved by the Academic Council at its meeting held on 02-05-2019 is hereby notified for implementation with effect from the academic year **2019-20**.

PRINCIPAL **REGISTRAR**

To:

1. The Chairman/Dean/HOD.
2. The Registrar Office
3. Library

ಸಂತ ಅಲೋಶಿಯಸ್ ಕಾಲೇಜು

(ಸ್ವಾಯತ್ತ)

ಮಂಗಳೂರು– ೫೭೫ ೦೦೩

ST ALOYSIUS COLLEGE
(Autonomous)
P.B.No.720
MANGALURU- 575 003, INDIA
Phone:+91-0824 2449700,2449701
Fax: 0824-2449705
Email: principal_sac@yahoo.com
principal@staloysius.edu.in
Website: www.staloysius.edu.in

Re-accredited by NAAC with 'A' Grade - CGPA 3.62
Recognised by UGC as "College with Potential for Excellence"
College with 'STAR STATUS' conferred by DBT, Government of India
3rd Rank in "Swacch Campus" Scheme, by MHRD, Govt of India

Date: 25-06-2020

NOTIFICATION

Sub: Syllabus of **B.Sc. Chemistry** under Choice Based Credit System.

Ref: 1. Decision of the Academic Council meeting held on 09-06-2020 vide Agenda No: 19(2020-21)
2. Office Notification dated 25-06-2020

Pursuant to the above, the incorporation of CBCS III & IV Semester to the Syllabus of **B.Sc. Chemistry** under Choice Based Credit System which was approved by the Academic Council at its meeting held on 09-06-2020 is hereby notified for implementation with effect from the academic year **2020-21**.

PRINCIPAL **REGISTRAR**

To:

1. The Chairman/Dean/HOD.
2. The Registrar Office
3. Library

COURSE PATTERN

Course No & Paper / Practical	Teaching Hours per week	Duration of Exam (Hours)	Marks			Credits
			I A	Exam	Total	
FIRST SEMESTER						
G502.1: Chemistry Paper I	4	3	20	80	100	2
G502.1P: Chemistry Practical I	3	3	10	40	50	1
G502.1E: Essentials of Practical Chemistry	2	2	10	40	50	1
SECOND SEMESTER						
G502.2: Chemistry Paper II	4	3	20	80	100	2
G502.2P: Chemistry Practical II	3	3	10	40	50	1
G502.2E: Food and Industrial Chemistry	2	2	10	40	50	1
THIRD SEMESTER						
G502.3: Chemistry Paper III	4	3	20	80	100	2
G502.3P: Chemistry Practical III	3	3	10	40	50	1
G502.3E: Environmental Chemistry	2	2	10	40	50	1
FOURTH SEMESTER						
G502.4: Chemistry Paper IV	4	3	20	80	100	2
G502.4P: Chemistry Practical IV	3	3	10	40	50	1
G502.4E: Chemistry in Everyday Life	2	2	10	40	50	1
FIFTH SEMESTER						
G502.5a : Chemistry Paper V	3	3	20	80	100	2
G502.5b: Chemistry Paper VI	3	3	20	80	100	2
G502.5P: Chemistry Practical V	4	4	20	80	100	2
SIXTH SEMESTER						
G502.6a: Chemistry Paper VII	3	3	20	80	100	2
G502.6b: Chemistry Paper VIII	3	3	20	80	100	2
G502.6P: Chemistry Practical VI	4	4	20	80	100	2

PATTERN OF THEORY QUESTION PAPERS

- Question Papers shall consist of Parts A, B and C
- The Syllabus of each paper shall be grouped into four (4) units (I,II,III,IV semester) and (3) units (V and VI semester)
- The question papers shall consist of Parts A, B and C containing questions drawn equally from each unit.
- Part A shall contain twelve short answer (1 to 3 sentences) type questions carrying 2 marks each drawn equally from each unit of the syllabus. Ten questions are to be answered.
- Part B shall contain twelve questions (to be answered in 2 to 5 sentences) carrying 3 marks each drawn equally from each unit of the syllabus. Ten questions are to be answered.
- Part C shall contain 12 questions carrying 5 marks each drawn equally from each unit. Ten questions are to be answered.

PATTERN OF QUESTION PAPER (Open Elective Paper)

- Question paper shall consist of Parts A, B and C containing questions drawn equally from each unit of the syllabus.
- Part A shall contain 6 short answer (1 to 3 sentences) type questions carrying 2 marks each drawn equally from each unit of the syllabus. 5 questions are to be answered.
- Part B shall contain 6 questions (to be answered in 2 to 5 sentences) carrying 3 marks each drawn equally from each unit of the syllabus. 5 questions are to be answered.
- Part C shall contain 6 questions carrying 5 marks each drawn equally from each unit of the syllabus. 5 questions are to be answered.

COURSE CONTENTS

FIRST SEMESTER	
G502.1: Chemistry Paper I	
UNIT I:	
Liquid state, liquid crystals, gaseous state	**12Hours**
UNIT II:	
Chemical Bonding , VBT, VSEPR and MOT	**12Hours**
UNIT III:	
Structure and bonding in organic molecules	**8Hours**
Dienes	**4Hours**
UNIT IV:	
Errors in Chemical Analysis General purification techniques	**3Hours** **9Hours**
G502.1P: Chemistry Practical I	
SECOND SEMESTER	
G502.2: Chemistry Paper II	
UNIT I:	
Solvents Solid state Catalysis	**4Hours** **6Hours** **2Hours**
UNIT II:	
s-block elements p-block elements	**6Hours** **6Hours**
UNIT III:	
Organic halogen compounds	**6Hours**
Dihydric alcohols	**3Hours**
Ethers and epoxides	**3Hours**
UNIT IV:	
Methods of Analysis	**12Hours**
G502.2P: Chemistry Practical II	

THIRD SEMESTER	
G502.3: Chemistry Paper III	
UNIT I:	
Chemical Kinetics Chemical Equilibrium Nuclear and Radiation Chemistry	**5 Hours** **4 Hours** **3 Hours**
UNIT II:	
d-block elements f-block elements	**12 Hours**
UNIT III:	
Mechanisms of organic Reactions	**12 Hours**
UNIT IV:	
Flame Photometry, Plasma Emission Spectroscopy, AAS, Thermal Analysis, TGA, DTA and DTG	**12 Hours**
G502.3P: Chemistry Practical III	
FOURTH SEMESTER	
G502.4: Chemistry Paper IV	
UNIT I:	
Thermodynamics	**12 Hours**
UNIT II:	
Coordination compounds Pseudo halogens Silicates	**8 Hours** **2 Hours** **2 Hours**
UNIT III:	
Mechanisms of organic Reactions	**12 Hours**
UNIT IV:	
Photochemistry	**12 Hours**
G502.4P: Chemistry Practical IV	

FIFTH SEMESTER	
G502.5a : Chemistry Paper V	
UNIT I:	
Dilute solutions and Colligative properties	**5 hour**
Binary mixtures	**5Hours**
Nano chemistry	**3 Hours**
UNIT II:	
Oxidation and reduction	**5 Hours**
Applications of metal complexes and complexation	**3Hours**
Electronic spectroscopy	**5 Hours**
UNIT III:	
Heterocyclic compounds	**10 Hours**
Bioinorganic chemistry	**3 Hours**
G502.5b: Chemistry Paper VI	
UNIT I:	
Quantum mechanics	**7 Hours**
Rotational Spectroscopy	**6 Hours**
UNIT II:	
Magnetic properties of transition metal complexes	**5 Hours**
Electronic spectra of transition metal complexes	**5 Hours**
Inorganic polymers	**3 Hours**
UNIT III:	
Carbohydrates	**6Hours**
Amino acids and proteins.	**4 Hours**
Mass Spectroscopy.	**3 Hours**
G502.5P: Chemistry Practical V	

SIXTH SEMESTER	
G502.6a: Chemistry Paper VII	
UNIT I:	
Infra-red spectroscopy	**5Hours**
Raman Spectroscopy	**4Hours**
Phase diagrams and Applications of Phase Rule	**4Hours**
UNIT II:	
Thermodynamics and Kinetic aspects of metal complexes	**5Hours**
Organometallic Chemistry	**4Hours**
Metal carbonyls	**4Hours**
UNIT III:	
Stereochemistry of organic compounds	**8Hours**
Organic Synthesis via enolates	**5Hours**
G502.6b: Chemistry Paper VIII	
UNIT I:	
Electrochemistry	**13Hours**
UNIT II:	
Environmental chemistry	**4Hours**
Industrial chemistry	**6Hours**
Green chemistry	**3Hours**
UNIT III:	
NMR spectroscopy and applications	**7Hours**
Dyes and colouring agents	**3 Hours**
Chemistry of Natural products	**3 Hours**
G502.6P: Chemistry Practical VI	

FIRST SEMESTER

G502.1: Chemistry Paper I

UNIT I: Liquid state, liquid crystals, gaseous state **12 Hours**

Liquid State: **5 Hours**

(Self Study: Differences between Solids, Liquids and Gases.)

Structure of Liquids-Qualitative description. Properties of liquids- Viscosity -Definition, SI Unit, Principle and method of determination. Surface tension-Definition, SI unit, Principle and method of determination. Parachor-Expression, Definition, application in deciding the structures of organic compounds (Vogel's method only). Vapour Pressure: Definition, Effect of temperature on vapour pressure, Vapour pressure and boiling point.

Liquid crystals: Explanation, difference between liquid crystal, solid and liquid. Classification-smectic, nematic, cholestric and disc shaped -examples.

Gaseous State: **7 Hours**

(Self study: Molecular velocities: root mean square velocity, average velocity and most probable velocities-definition and calculation Relation between RMS, average and most probable velocities.)

Critical phenomena: PV isotherms of real gases, Andrew's isotherms of carbon dioxide-continuity of states. Isotherms of van der Waal's equation, Relationship between critical constants and van der Waal's constants- derivation of the expressions for Tc, Pc and Vc based on vanderwal's constants. Boyle's temperature, inversion temperature. The law of corresponding states: Statement, reduced equation of state- derivation of the equation. Qualitative discussion of the Maxwell's distribution of molecular velocities-explanation with graph. Collision number, mean free path and collision diameter-definitions.

Liquefaction of Gases- by Joule Thomson effect, Definition of Boyle's temperature and inversion temperature.

UNIT II: Chemical Bonding, Covalent Bonding, VBT, VSEPR and MOT **12 Hours**

Chemical Bonding- Self study -Definition, types-ionic, covalent, coordinate covalent and hydrogen bonding –inter and intra molecular hydrogen bonding

Covalent Bonding- (Self study : Definition, atomic orbital overlap concept of covalency, formation of H_2, F_2 ,O_2, HF. **VBT**- Postulates (paulings approach)

Hybridisation : Types with examples**,** methods to predict the types of hybridisation

VSEPR Theory- Postulates, Geometry of molecules - BeF_2 , BF_3, CH_4,PF_5,SF_6 , NH_3, H_2O, SF_4, ClF_3,XeF_2, XeF_4. IF_7, Geometry of ions - carbonate, nitrate, sulphate, perchlorate, chlorate.

MOT- LCAO, explanation for formation of bonding and antibonding molecular orbitals. Conditions using LCAO approach. Energy Level diagram for molecular orbitals, mixing of orbitals, filling up of electrons in molecular orbitals, molecular orbital configuration, bond order and magnetic properties of species like He_2, B_2, C_2, N_2, O_2,F_2 and ions. molecular orbital configuration and bond order of CO, NO, HF.

UNIT III:

Structure and Bonding in organic molecules: **8 Hours**

(Self Study : Introduction to Organic Chemistry, Aim and scope of organic chemistry, Importance of organic compounds, Catenation, Classification of organic compounds, representations and conventions of writing formula. IUPAC Nomenclature of aliphatic organic Compounds - simple & bifunctional)

Inductive, mesomeric, electromeric and Hyperconjugative effect-explanation and examples. Notations-curved arrows, drawing electron movements, half-headed (in tautomerism) and double-headed (in resonance) arrows. Types of bond breaking-homolytic and heterolytic, Types of reagents-electrophiles and nucleophiles, Types of reactions-addition, substitution, elimination and rearrangement. Reactive intermediates-carbocations, carbanion, free radicals, formation and their order of stability. Rearrangement of carbocations 1,2 hydride and 1,2-methyl shift by taking dehydration of 2-methylbutane-1-ol and 3,3 dimethyl-2-butanol as examples. Preparation of carbenes,nitrens and benzyne. Concept of singlet and triplet carbene. Addition reactions of singlet and triplet carbenes.

Dienes **4 Hours**

Nomenclature, Classification-isolated, conjugated and cumulated, Structure-hybridisation, geometry and shape of propadiene and 1,3- butadiene, Methods of preparation of 1,3-butadiene – dehydration and dehydrohalogenation. Reactions of 1,3- butadiene-Polymerisation, 1,2- and 1,4- addition of bromine and hydrogen bromide, Diels-Alder reaction .

UNIT IV:

Errors In Quantitative Analysis **3 Hours**

Classification - types of errors, Determinate and indeterminate errors, Absolute error and relative error, Minimization – methods suggested for minimizing errors (any 2 methods), Accuracy, Precision -mean deviation, relative mean deviation, Standard deviation, Significant figures – examples.

General Purification Techniques **9 Hours**

Introduction, Techniques (sublimation, distillation and crystallisation – principle with examples) and applications

Chromatographic Techniques and Applications :

Introduction to chromatography, Classification- Types of chromatography, partition and adsorption, R_f value.

Paper chromatography-Principles, procedure, and applications. Ascending, descending, circular and 2D chromatography. TLC- Principles, procedure, applications. Superiority of TLC over paper chromatography. Column chromatography- Principles, procedure, and applications. Types- Thin layer, ion exchange ,HPLC and gas chromatography

G502.1P: Chemistry Practical I

3 Hours/Week

I. Organic Chemistry Practicals (8 Weeks x 3Hours)

Identification of an organic compound through functional group analysis, determination of melting point / boiling point and preparation of suitable derivatives.

II. Separation of organic compounds from natural sources (2 Weeks x 3Hours)

Isolation of mucic acid from milk

Isolation of citric acid from lemon

III. Preparation of organic compounds (2 Weeks x 3Hours)

a) Preparation of benzoic acid from benzaldehyde / toluene
b) Preparation of Acetanilide from aniline.
c) Preparation of p - bromoacetanilide from acetanilide.
d) preparation of m-dinitrobenzene from nitrobenzene
e) nitration of acetanilide
f) Use of Flash evaporator for the recovery of solvent
(Calculation of theoretical yield using density/mass concept)

ELECTIVE FOR SEMESTER I

ESSENTIALS OF PRACTICAL CHEMISTRY (30 HOURS)

UNIT-I

Apparatus Handling and Lab Safety (2 Hours)

Use of balance, glasswares, burette, pipette, dessicator, filtration apparatus.

Safe use of chemicals, Laboratory precautions.

Qualitative Organic Analysis (6 Hours)

Determination of Melting Point and Boiling point, Detection of elements - N, S and halogen (Lassaigne's Test), detection of unsaturation, reactions of functional groups, preparation of derivatives, recrystallization.

Semi Micro Qualitative Inorganic Analysis (7 Hours)

Advantages of Semi micro analysis, Wet and dry tests, flame test, Centrifugation, Reactions of Anions, Classification of cations into groups, Reactions of cations. . Preparation of Nessler's Reagent, Tollen's Reagent, Lime water, Bromine water, H_2S.

UNIT-II

Quantitative Analysis

Basic Techniques (3Hours)

Calibration, Washing precipitates, Drying and igniting precipitates, Preparation of common reagents (Dilute acids, Dilute bases, indicator solutions), problems.

Reactions in solutions (8 Hours)

Solubility Product, Common ion effect, Fractional precipitation, Factors affecting solubility (Acid concentration, Temperature, Solvent), Ionic product of water, pH and pOH, Buffer solutions, Solubility and complexation, problems on pH, pOH, buffers, solubility.

Estimation of elements (4 Hours)

Principle and calculation involved in the estimation of Nitrogen byKjeldahl's method, Sulphur and Halogen by Carius method, Carbon and Hydrogen by Leibig's method.

References:

1. Vogel's text book of Quantitative Chemical Analysis, Fifth edition by G.H. Jeffery, J. Bassett, J. Mendham, R. C. Denny
2. Vogel's Qualitative inorganic analysis, Seventh edition by G. Svehla, B. Sivasankar
3. Comprehensive Practical organic chemistry: Preparation and quantitative analysis by v K Ahluwalia and RenuAggarwal
4. Practical Organic Chemistry, Fourth edition by F. G. Mann and B. C. Saunders.
5. Practical Chemistry for I, II, III year B.Sc students by Dr. O. P. Pandey, D. N. Bajpai, Dr. S. Giri
6. Advanced practical chemistry by Jagadamba Singh, R.K.P. Singh, Jaya Singh, L.D.S. Yadav, I.R. Siddiqui, Jaya Srivastava
7. Comprehensive Practical Organic Chemistry : Qualitative Analysis by V.K. Ahluwalia, SunitaDhingra

SECOND SEMESTER

G502.2: Chemistry Paper II

UNIT I: Solvents, Solid state, catalysis

Solvents : **4 Hours**

Classification of solvents- protonic - aprotic, acidic - basic - amphiprotic, ionising – non ionizing solvents, examples. Characteristic properties of a solvent-liquid range, dipole moment, dielectric constant, Heat of fusion and heat of vapourisation.

Reactions in water: hydration, hydrolysis, acid-base, reduction-oxidation, complex formation, precipitation (two examples in each case).

Reactions in non-aqueous solvent (Liquid ammonia) - ammoniation, ammonolysis, acid-base, reduction-oxidation, complex formation, precipitation, solutions of alkali metals in liquid ammonia.

Leveling effect- examples.

Solid State: **6 Hours**

Elementary account of unit cell and Bravais lattice. Laws of crystallography: Law of constancy of interfacial angles-definition and explanation taking hexagonal crystal system as an example. Law of rationality of indices. Miller indices, calculation of Miller indices for different planes in a cubic crystal system. Law of symmetry-definition. Types of elements of symmetry- a) axis of symmetry (b) plane of symmetry (c) centre of symmetry-definition and explanation taking cubic crystal system as an example. X-Ray diffraction by crystals. Derivation of Bragg's equation. Determination of crystal structure of NaCl by Bragg's method, calculation of Avogadro's number. Imperfections in crystal-Non-stoichiometric defects.

(Self-study: Stoichiometric defects- Frenkel and Schottky defects, their effect on density)

Catalysis: **2 Hours**

(Self Sudy: General characteristics of catalytic reactions, Homogeneous and heterogeneous catalysis)

Acid-base catalysis General and specific –(Qualitative treatment only) Enzyme catalysis-examples, Characteristics of enzyme catalysis, Mechanism of enzyme catalysis (Qualitative treatment only)

UNIT II:

Chemistry of s & p block elements **8 Hours**

Comparative study-Comparison between group I and group II elements with respect to Ionization potential, flame colouration, hydration of ions and reducing property.

Some special characteristics of p-block elements-reluctance of heavier p block elements to show maximum oxidation states and to involve p orbitals for pi bonding. Participation of d-orbitals in sigma bonding and in pi bonding. General characteristics of crown ethers. Complexation tendencies of s-block elements with crown ethers. Diagonal relationship-reasons for diagonal relationship, comparison of the properties of Li with Mg and Be with Al. Extraction of Li from silicate mineral. Extraction of Be from mineral beryl.

Pseudo halogens **2 Hours**

Preparation and properties of cyanides, thiocyanate and azide

Silicates **2 Hours**

Classification, structures-pyroxenes and amphiboles, silica gel, aluminosilicates and zeolites.

UNIT III:

Organic halogen compounds: **6 Hours**

(Self study : Aliphatic and aromatic halides : Nomenclature, classification)

Mechanism of nucleophilic substitution reactions (with energy profile diagrams) of alkyl halides: S_N2 reaction (Hydrolysis of methyl bromide), S_N1 reaction (Hydrolysis of tert-butyl bromide). Neighbouring group participation. Mechanisms of Nucleophilic aromatic substitution reaction: S_N1 (benzene diazonium salts), S_NAr (p- nitrochlorobenzene to p-nitrophenol). Relative reactivities of alkyl halides Vs allyl, vinyl and aryl halide. Mechanism of elimination reactions: E_1 and E_2 mechanisms, Orientation - Saytzeff and Hoffman's elimination.

Dihydric alcohols **3 Hours**

Dihydric alcohols –Nomenclature (Common and IUPAC), Ethylene glycol - Methods of formation - from ethylene and ethylene dibromide. Reactions of ethylene glycol with Na, with conc. HNO_3. oxidative cleavage with $Pb(OAc)_4$and HIO_4 -oxidation with $KMnO_4$, dehydration at 500^oC and with conc.H_2SO_4

Trihydric alcohols: Nomenclature (Common and IUPAC). Glycerol - Synthesis from propene. Chemical reactions of glycerol: reaction with Na, HI, oxalic acid (at 110°C and at 260°C), dehydrating agents ($KHSO_4$, Conc. H_2SO_4), oxidizing agents (HNO_3, $KMnO_4$)

Ethers and Epoxides. **3 Hours**

Metamerism in ethers, crown ethers, Preparation of ethers from alcohols and alkyl halides. Chemical reactions of ethers- formation of oxonium salt, auto-oxidation, Cleavage with sulphuric acid and HI. Ziesel's method for the estimation of ethoxy and methoxy groups. Synthesis of epoxides from alkenes and halohydrins. Mechanism of Acid and base-catalysed ring opening of epoxides. Examples for orientation during epoxide ring opening reactions. Reactions of Grignard and organolithium reagents with epoxides.

UNIT IV: Methods of Analysis **12 Hours**

Qualitative - Sample size and techniques. Macro, semi micro and micro sample size**,** Type of tests- wet, dry, spot. (terms, definition and examples)

Quantitative Analysis

Highlights of methods with examples

Volumetric Analysis- Principle, standard solution, Indicators - commonly used indicators. Selection of indicators. Types of titration - acid base, redox, complexometric and precipitation titrations - principle with example

Gravimetric Analysis– definition , Principle and types

Methods of expressing concentrations of solutions - ppm, normality, molarity, molality, mole fraction- Problems. Application of iodometry and iodimetry

G 502.2P: Chemistry Practical II

3Hours/Week

PART I. Volumetric Analysis (Any 10 of the following experiments)

(10 Weeks x 3Hours)

1) Estimation of a mixture of oxalic acid and sulphuric acid in a solution using standard potassium permanganate solution and. standard sodium hydroxide solution.
2) Estimation of sodium hydroxide using pure crystals of sodium carbonate and hydrochloric acid as link solution.

3) Estimation of hydrochloric acid using potassium biphthalate and sodium hydroxide as link solution.
4) Estimation of Mohr's salt using oxalic acid crystals and potassium permanganate as link solution.
5) Estimation of ferric chloride using pure ferrous ammonium sulphate crystals and potassium dichromate as link solution.
6) Estimation of ferrous and ferric in a mixture.
7) Estimation copper in copper sulphate by volumetry using redox titration
8) Estimation of calcium content in lime stone as calcium oxalate by permanganometry
9) Estimation of vitamin C
10) Estimation of glucose using iodimetry / Fehling's solution
11) Estimation of concentration of hydrogen peroxide using permanganate

PART II : Experiments of radiation chemistry **(2 Weeks x 3Hours)**

12) Study of the characteristics of a GM tube and determination of its operating voltage, plateau length / slope etc.
13) Verification of Inverse Square Law for gamma - rays
14) Study of nuclear counting statistics
15) Linear & Mass attenuation co-efficient using gamma source (for Aluminium, Lead & Copper)

ELECTIVE FOR SEMESTER II

FOOD AND INDUSTRIAL CHEMISTRY (30 HOURS)

UNIT-I

FOOD CHEMISTRY

Introduction **(2 Hours)**

Introduction to food chemistry, Basic components of food-water, carbohydrates, proteins, lipids, minerals and vitamins, pH of food

Lipids in Food **(3 Hours)**

Introduction, classification with examples, Lipid oxidation-general mechanism, Rancidity-Hydrolytic and oxidative

Vitamins **(3 Hours)**

Classification, Role of vitamins in enzyme function, Bioavailability of vitamins, structures of vitamin A and vitamin C

Food Additives **(7 Hours)**

Food additives: Classification with examples, functions of additives

Flavors: Classification with examples

Food pigments: Natural and artificial food colors, examples

Sweeteners: Classification and examples

Antioxidants-types, examples

UNIT-II

INDUSTRIAL CHEMISTRY

Polymers **(7 Hours)**

Introduction, examples for polymers with their monomers, Classification of polymers according to mechanical properties, General classification (thermosetting and thermoplastic; condensation and addition polymers), organic polymers, inorganic polymers, copolymers (definition with examples) Applications of polymers– plastics, adhesives, elastomers, fibres, surface coating

Cement **(2 Hours)**

Classification, Manufacture of Portland Cement, Setting of cement

Paints (2 Hours)

Composition of Paint, Classification of pigments, Manufacture of paint

Soaps and detergents (4 Hours)

General consideration in soap making, manufacture of soap – batch process, Classification of detergents, Principal groups of synthetic detergents, eco-friendly detergents containing enzymes

REFERENCES:

1. B.K SHARMA *Industrial chemistry* 15th Ed. 2006
2. P. C. Jain, M. Jain *Engineering chem*istry 14th Ed. 2002
3. H.K Chopra, P.S Panesar*Food chemistry* 2010
4. Billmeyer,F.W. *Textbook of polymer science,* 3rd Ed. Wiley Interscience, 1971.
5. M.S. Bhatnagar. *Text book of Polymers(Basic concepts),* Volume 1,1st Ed. 2004 .
6. M.S. Bhatnagar. *Text book of Polymers(Processing and applications),* Volume 2,1st Ed. 2004.
7. D.G. Hundiwale, V.D. Athawale, U.R. Kapadi and V.V. Gite*Experiments in polymer science,* 2009.

THIRD SEMESTER

G502.3: Chemistry Paper III

UNIT I:

Chemical Kinetics **5 Hours**

(Self Study: Rate of a reaction-definition, rate equations of simple chemical reactions-two examples. Effect of concentration on the rate of a chemical reaction. Order of a reaction-Zero order, I order, II order, pseudo order- definition two examples for each. Half life-Definition and general mathematical expression)

Rate constants for II order and n^{th} order reactions. Derivation with equal and unequal concentrations for second order reaction. Determination of the order of a reaction-differential, integration, half life period and isolation methods. Problems on determination of order of the reaction and half-life.

Simple collision theory based on hard sphere model (mention the mathematical expression). Transition state theory (equilibrium hypothesis). Derivation of the relationship between rate constant and equilibrium constant.

Chemical Equilibrium: **4 Hours**

(Self-Study: Equilibrium constants Kp and Kc, Relation between them, Concept of free energy)

Relation between Equilibrium constant and free energy. Thermodynamic derivation of law of mass action (in terms of partial pressures)- Van't Hoff's Reaction isotherm and reaction isochore - Clapeyron equation and Clausius -Clapeyron equation (to be derived) and their applications.

Nuclear and Radiation Chemistry: **3 Hours**

Nuclear Reactions. Difference between nuclear and chemical reactions. Natural radioactivity, Characteristics of alpha, beta and gamma rays. Group Displacement Law, Derivation of decay constant, Half-life period, Artificial transmutation of elements, Artificial radioactivity, Nuclear fission, Nuclear fusion, Carbon-14 dating, (problems).

UNIT II d and f block elements

d block elements **6 Hours**

(Self study : Definition, transition elements four series of d block elements, general electronic configuration)

Position in the periodic table. General characteristic properties- metallic character, ionisation energy, oxidation state, reducing property, colour, magnetic property, catalytic property and complexability.

Aqueous chemistry of Fe in different oxidation states (potassium ferrocyanide and potassium ferricyanide-preparation and properties) .Comparative study of 4d and 5d elements with 3d elements.

f block elements **6 Hours**

Lanthanides - Occurrence, properties of lanthanides-electronic state, oxidation state, ionic radii-lanthanide contraction, causes and consequences. Complex formation, Colour and magnetic properties. Separation of lanthanides by ion exchange method.

Actinides- General features- Electronic configuration, oxidation state, ionic radii, colour of ions, and formation of complex. Chemistry of separation of Np and Pu from U. Similarities and dissimilarities between actinides and lanthanides.

UNIT III: Mechanisms of organic Reactions **12 Hours**

Self study: (Aromaticity-The criterion for aromaticity including Huckel rule Structure and Stability of Benzene and Molecular Orbital Description of Benzene)

Mechanism of aromatic ring substitution: **4 Hours**

Effect of substituent groups and determination of orientation. Mechanisms of Nitration, Sulphonation, Halogenation, Friedel-Crafts reaction, Kolbe's reaction, Reimer-Tiemann reaction.

Polynuclear aromatic hydrocarbons: **4 Hours**

Examples, naphthalene- Nomenclature of naphthalene derivatives, structure of naphthalene, method of preparation from 4-phenyl-1-butene and Haworth synthesis. Electrophilic substitution reactions of naphthalene - nitration, sulphonation and Friedel Crafts reaction. Reduction and oxidation, Structure of anthracene and phenanthrene

Molecular rearrangement: **4 Hours**

Types, Mechanisms of Pinacol- Pinacolone, Beckmann, Hofmann, Benzylic, Claisen, Cope and Fries Rearrangement.

UNIT IV: Flame Photometry, Plasma Emission Spectroscopy, AAS, Thermal Analysis, TGA, DTA and DTG **12 Hours**

Flame Photometry- General Principles and Instrumentation of flame photometry, (2 Types of burners, slit, monochromators, reader).Applications-qualitative and quantitative.

Plasma Emission Spectroscopy- Principle, instrumentation and application.

AAS -_Principle, instrumentation and application

Thermo analytical methods- Principle and 2 specified applications of TGA, DTA and DTG

G502.3P: Chemistry Practical III

3Hours/Week

PART I : Semimicro Qualitative Analysis of Salt Mixtures- (8 Weeks x 3Hours)

Systematic qualitative analysis of mixtures of two simple inorganic salts (containing two cations and two anions)

Anions : CO_3^{2-}, HCO_3^{-}, SO_3^{2-}, $S_2O_3^{2-}$, S^{2-}, Cl^{-}, Br^{-}, I^{-}, NO_3^{-}, BO_3^{-3}, PO_4^{-3}, SO_4^{2-}

Cations : Pb^{2+}, Cu^{2+}, Bi^{3+}, Cd^{2+}, Co^{2+}, Ni^{2+}, Al^{3+}, Fe^{3+}, $Mn^{2+,}$ Zn^{2+}, Ca^{2+}, $Ba^{2+,}$ Sr^{2+}, Mg^{2+}, Na^{+}, K^{+}, NH_4^{+}

PART II: Chromatographic separation of inorganic ions by thin layer and paper chromatography.

Ag^{+}, Hg^{+} Pb^{2+} / Hg^{2+} , Cu^{2+} , Pb^{2+} , Bi^{3+} , Cd^{2+} / Fe^{3+} , Cr^{3+} **(2 Weeks x 3Hours)**

Part III(Any two) **(2 Weeks x 3Hours)**

1. Estimation of Efficiency of the G.M. detector for a) Gamma source b) Beta source
2. To Study Beta Particle Range and Maximum Energy
3. Measurement of short half-life using G.M. counter

Third Semester

G502.3E: Environmental Chemistry

UNIT I

Air Pollution **15 Hrs**

Major regions of atmosphere; Chemical and photochemical reactions in atmosphere; Air pollutants and their sources: oxides of carbon, nitrogen and sulphur.

Effects of air pollution on living organisms and vegetation. Greenhouse effect and Global warming; depletion of ozone layer: ozone layer, effects of oxides of nitrogen, oxides of fluorocarbons.

Particulates and their sources; toxic effects of particulates, smog and its types; control of air pollution.

UNIT II

Water Pollution **10 Hrs**

Nature of water pollutants, surfactants, techniques for measuring water pollution, impacts of water pollution on hydrological and ecosystems; Water purification methods (reverse osmosis, electro dialysis, ion exchange), Effluent treatment plants (primary, secondary and tertiary treatment). Water quality parameters for wastewater, industrial water and domestic water; Industrial wastewater - contamination and treatment.

Non-specific tests: COD, DO, BOD, TOC, chlorine demand, taste and odour, colour and turbidity. Specific tests: nutrients, nitrogenous, phosphorous, toxic compounds, nuisance matter. The water act (India), reasons for water analysis.

Soil Pollution and Waste Management **5 Hrs**

Causes and impact of soil pollution. Pesticides and its environmental effects. Methods of pest control. Disposal techniques. Waste management approach. Industrial waste management, incineration of waste. Causes and remedies of Radiation and noise pollution.

Reference Books:

1. *Environmental Chemistry*, K. De, New Age International Pvt., Ltd, New Delhi (2006).
2. *Environmental Pollution Analysis*, S. M. Khopkar, Wiley Eastern Ltd, New Delhi (2015).
3. *Environmental Chemistry*, S.E. Manahan, CRC Press (2005).
4. *Environmental Chemistry*, H. Kaur, Pragathi Edition (2010).
5. *Principles of Inorganic Chemistry*, B. R. Puri, L. R. Sharma, K. C. Kalia, Vallabh Publications, Delhi (2017).
6. *Environmental Chemistry Pollution and Remedial Perspective*, V. Salker, Narosa publishing house (2017).

FOURTH SEMESTER

G502.4: Chemistry Paper IV

UNIT I: Thermodynamics **12 Hours**

Self study-(system, surroundings, types of system, process, types of process, enthalphy,internal energy,I^{st} law of thermodynamics)

Variation of heat of reaction with temperature. Derivation of Kirchoff's equation.

Second law of thermodynamics (definition), efficiency (definition), Carnot's theorem, carnot's cycle. Expression for efficiency of carnot's engine. Thermodynamic scale of temperature(definition), Concept of entropy, entropy as a state function,statement of zeroth and third law of thermodynamics (definition)

Entropy change in reversible process, irreversible process, for a ideal gas under different conditions (derivations) $\Delta S = C_v \ln T_2/T_1 + R \ln V_2/V_1$ and $\Delta S = C_P \ln T_2/T_1 + R \ln P_1/P_2$. Derivation of ΔS during phase change and on mixing of ideal gases.

Gibbs free energy, Helmholtz free energy: significance, variation of G with T and P.

Criteria for feasibility of a process on the basis of G and A.Problems based on above topics

UNIT II: Coordination Chemistry **12 Hours**

Coordination Chemistry **12 Hours**

(Self study: Brief elementary account of complex salt, complexation, types of complexes, coordination sphere. Ligands , types of ligands, werners coordination theory)

EAN, stability of complexes and factors affecting stability of complexes. Nomenclature and isomerism in coordination compounds.

Crystal field theory of coordination compounds- orientation of d orbitals and crystal field splitting of energy levels, crystal field stabilization energy, crystal field splitting in octahedral, tetragonal and square planar complexes.

Factors affecting magnitude of crystal field splitting- Spectrochemical series. Geometry of complexes with coordination number 2-6. Jahn Teller Distortion. Adjusted crystal field theory (Ligand field theory)

UNIT III Mechanism of Organic reactions. **12 Hours**

Nucleophilic addition and elimination reactions.

Mechanisms of Aldol, Perkins, Knovenagel, Benzoin, Claisen, Wittig, Canizzaro, Reformatsky Reactions. Mechanisms of reduction with $NaBH_4$, $LiAlH_4$, Wolf Kishner reduction, MPV Reduction, Haloform, Michael addition.

UNIT IV: Photochemistry **12 Hours**

Differences between thermal and photochemical reactions. Laws of photochemistry: Grothus - Draper law, Stark - Einstein law, primary and secondary reactions, ,Quantum yield- reasons for low and high quantum yield, Examples for high quantum yield with explanation (decomposition of HI, combination H_2 and Cl_2 reaction), Examples for low quantum yield with explanation (combination of H_2 and Br_2). Photosensitized reactions with examples. Photo-physical processes- Jablonski diagram depicting various processes occurring in the excited state-fluorescence and phosphorescence- definition, explanation of fluorescence. Types of fluorescence-sensitized and resonance fluorescence (explanation with examples). Definition, explanation of phosphorescence with examples. Chemiluminescence. Photochemical reactions : Norrish Type I and II

G502.4P: Chemistry Practical IV

3Hours/Week

Physical Chemistry: (Minimum 12 experiments) **(12 Weeks x 3Hours)**

1) The percentage of NaCl present in water - phenol system.
2) Determination of composition of a binary liquid mixture (Alcohol & toluene) by Refractometry
3) The molecular weight of a non - volatile solute by Walker - Lumsden method.
4) The density and surface tension of a liquid.
5) Determination of density and viscosity of a liquid
6) The percentage composition of a given mixture of glycerol and water by viscometry.
7) The rate constant of decomposition of hydrogen peroxide
8) Rate constant for acid hydrolysis of an ester.
9) Catalytic strengths of HCl and H_2SO_4 by studying the kinetics of hydrolysis of an ester.
10) Distribution of benzoic acid between benzene and water.
11) Effect of acid strength on the acid hydrolysis of an ester.
12) Preparation of arsenious sulphide sol and comparison of the precipitating powers of mono-, bi- and trivalent anions.
13) Determination of degree of hydrolysis of sodium acetate and ammonium chloride
14) Estimation of sugar by refractometric method
15) Determination of hydrolysis constant of aniline hydrochloride

Fourth Semester
G502.4E: Chemistry in Everyday Life
UNIT I

Cosmetics and Toiletries Industry 10 Hrs

Raw materials: Surfactants – structure, types (anionic, cationic, nonionic and zwitterionic) hydrophilic lipophilic balance (HLB); Thickeners, foam stabilizers, natural oils, emulsifiers, humectants (definition, types and examples), plasticizers.

Hair-care products – Structure of hair keratin, major components of shampoo, hair dyes (mechanism and composition), Health & Environmental concerns.

Skin care products – skin structure, sunscreens, fairness creams, moisturizers, Health & environmental concerns.

Nail polish – formulation, manufacture and safety concerns.

Perfumes – Perfumes and odours in nature, synthetic perfumes, ingredients, chemoreception.

Polymers in Everyday Life 5 Hrs

Natural and synthetic polymers – Properties, classification and structures, polymers and the environment, recycling of polymers.

Natural polymers – cellulose, starch, polysaccharides, proteins, polyisoprene.

Synthetic polymers – Rubber, Adhesive, paints, silicones and plastics.

UNIT II

Drugs and Medicines 15 Hrs

General principles of drug action; classification on the basis of origin and therapeutic use; different routes of drug administration; mechanism of drug action.

Drug-receptor interactions – Covalent, ionic, hydrogen bonded, Vander Waals and hydrophobic/hydrophilic interactions.

Chemistry of Prodrugs – Concept; applications; some important prodrug concepts (to improve chemical stability, increased water solubility, decrease toxicity).

General anaesthetics – Introduction and classification, Examples (nitrous oxide, chloroform).

Local Anaesthetics – Definition, properties of ideal local anaesthetics; Examples (Benzocaine, lidocaine).

Sedatives and hypnotics – Classification (Barbiturates and non-barbiturates); Chemistry of Barbiturates – Examples, structure-activity relationship, mechanism of action and uses of Barbiturates.

Non-steroidal Anti-inflammatory Drugs (NSAIDs) – Definition, general structure and Classification – Salicylates (Aspirin, Salol) and Propionic acid (Ibuprofen).

UNIT III

Reference Books:

1. *Chemistry and technology of the cosmetics and toiletries industry*, D. F. Williams, W. H. Schmitt (1992), Kluwer Academic Publishers.
2. *The chemistry of fragrances: From Perfumer to Consumer*, Charles Sell, 2nd Ed. (2015), Royal Society of Chemistry.
3. *Medicinal Chemistry*, Ashutosh Kar, 7th Ed. (2018), New Age Publishers.
4. *Principles of organic medicinal chemistry*, R. R. Nadendla (2005), New Age Intl Publishers.
5. *Essentials of pharmaceutical chemistry*, Donald Cairns, 4th Revised Ed. (2012), Pharmaceutical Press.

FIFTH SEMESTER

G502.5a : Chemistry Paper V

UNIT I:

Dilute solutions and Colligative properties **5 Hours**

Ideal and non-ideal solutions- Raoult's law, thermodynamic properties of (ΔG, ΔH and ΔS) of ideal solutions. Colligative properties (definition) and an elementary account of the 4 colligative properties.

Thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point. Experimental determination of molecular weight by Walker-Lumsden method and Beckmann's method. Van't Hoff factor, abnormal molar mass, degree of dissociation and association of solutes. Problems

Binary Mixtures: **5 Hours**

Ideal liquid mixtures- Raoult's law, vapour pressure vs composition (mole fraction) curves. Azeotropes –HCl-H_2O and ethanol-water system. Partially miscible liquids: Phenol-water, triethylamine-water and Nicotine-water systems. Lower and upper consolute temperature. Effect of impurity on consolute temperature. Immiscible liquids- steam distillation, Nernst distribution law- definition and applications , association and dissociation of a solute , solvent extraction, Parke's process of desilverisation.(principle)

Nanochemistry **3 Hours**

Introduction, nanostructures, types with examples, quantum structures, synthesis and properties of carbon nano structures. Inorganic nanotubes and nanowires. Nano composites and nano fibres. Applications of nanotechnology in catalysis, biology, nano filters, nano switches.

UNIT II:

Oxidation and reduction **5 Hours**

Redox reactions, redox couple, redox potentials, standard reduction potential, electrochemical series, use of redox potential data. Latimer diagram (chlorine in acidic and basic medium), applications. Frost diagram of manganese and nitrogen, Conversion of Latimer to_Frost diagram. Applications of Frost diagram. Redox stability in water on the basis of Pourbaix diagram .

Applications of metal complexes and complexation **3 Hours**

Applications of complexes and complex formation in metallurgy of gold, silver, nickel, aluminium. Volumetric analysis in the determination of hardness of water, masking and demasking agents. qualitative analysis (detection of Fe^{2+}, Fe^{3+}, Cu^{2+},Cd^{2+}) and gravimetric analysis(of Ni and Mg)

Electronic spectroscopy **5 Hours**

Introduction to spectroscopy. Electromagnetic radiation-Wave theory of electromagnetic radiation, quantum theory of electromagnetic radiation. Electromagnetic spectrum.

Absorption laws (Beer-Lambert law with limitations),Derivation of Beer-Lambert's law, molar absorptivity, Concept of potential energy curves for bonding and antibonding molecular orbitals , qualitative description of selection rules (Forbidden and allowed transitions).Theory of electronic spectra, formation of bands, Frank Condon principle. Presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation with examples. Concept and effect of addition of chromophore and auxochrome. Absorption and intensity shifts-Bathochromic, hypsochromic, hyperchromic and hypochromic shifts. Woodward-Fieser rules for calculating absorption maximum in dienes.

UNIT III:

Heterocyclic Compounds **10 Hours**

Introduction: Types and nomenclature, Methods of synthesis of pyrrole (Paal-Knorr, from acetylene), furan (Paal-Knorr, Fiest Benary), thiophene(Paal-Knorr, from Furan), and pyridine (Hantzsch , from acetylene).Chemical reactions with particular emphasis on the mechanism of electrophilic substitution (nitration, sulphonation, halogenations, Friedel-Craft's reaction). Mechanism of nucleophilic substitution reactions in pyridine derivatives (reaction with sodamide). Comparison of basicity of pyridine, piperidine and pyrrole. Introduction to condensed five and six- numbered heterocycles. Preparation and reactions of indole, quinoline and isoquinoline with special reference to Fisher indole synthesis, Skraup synthesis and Bischler-Napieralski synthesis. Mechanism of electrophilic substitution, reactions of indole, quinoline and isoquinoline (nitration, sulphonation, halogenation, Friedel-Crafts reaction).

Bioinorganic chemistry **3 Hours**

Essential and trace elements in biological processes. Metalloporphyrins with reference to haemoglobin and myoglobin – skeletal structures and functions. Biological role of alkali and alkaline earth metals - Ca^{2+}, Mg^{2+},Na^{+}, K^{+}.. Mechanism of Na^{+}/K^{+} pump. Explanation for co-operative effect and Bohr Effect.

G 502.5b: Chemistry Paper VI

UNIT I:

Quantum mechanics: **7 Hours**

Comparison of classical mechanics with quantum mechanics. Black-body and black body radiation. Planck's radiation law (definition and expression). Photoelectric effect. Dual nature c matter and radiation (definition with eg). Heisenberg's uncertainty principle (definition with eg) Compton effect. Postulates of quantum mechanics. Setting up Schrodinger wave equation. Application of Schrodinger wave equation to a particle in 1 dimensional box (no derivation). Eigen functions and Eigen values**.** Concept of operators +, - and x operators, linear operators (Laplacian and Hamiltonian)

Rotational Spectroscopy **6 Hours**

Rigid rotator (definition), to derive $I=\mu r^{2.}$ Derivation of the expression for rotational energy**.** Rotational energy level diagram, selection rules**.** To prove that various lines in rotational spectra are equally spaced**.** Intensity of rotational spectral lines (explanation by taking population of energy level and degeneracy only elementary account). Isotopic effect-explanation by taking ^{12}CO and ^{13}CO only (elementary account)**.** Non rigid rotor (qualitative description). Application of rotational spectra(to calculate r_o and I from frequency separation).Problems

UNIT II:

Magnetic Properties of Transition Metal Complexes **5 Hours**

Types of magnetic behaviour – Dia, para, ferro and antiferromagnetic substances. Curie law. Curie –Weiss law. Variation of magnetic susceptibility with temperature- Curie and Neel temperatures, calculation of magnetic moment using spin only formula. Correlation of μ_s and μ_{eff}, values, Orbital contribution to magnetic moments, Application of magnetic moment data –determination of geometry of the complex. Guoy method of determining magnetic susceptibility

Electronic spectra of transition metal complexes **5 Hours**

Types of electronic transitions. Term symbols for d^1- d^{10} system. Spectroscopic ground states d^1 and d^9. Selection rules for d-d transitions. Orgel-energy level diagram for d^1 and d^9 states. Discussion of the electronic spectrum of $[Ti(H_2O)_6]^{3+}$ complex ion.

Inorganic polymers **3 Hours**

Inorganic Polymers: General characteristics of inorganic polymers.

Silicones – linear and cross linked. Preparation, applications.

Phosphazenes- examples. Preparation and applications.

Boron nitride -Structural features & production of boron nitride, applications.

UNIT III:

Carbohydrates **6 Hours**

Classification and nomenclature. Monosaccharides: Mechanism of osazone formation. Inter conversion of glucose and fructose, chain lengthening and chain shortening of aldoses. Configuration of Monosaccharides- Glucose and fructose. Conversion of glucose into mannose. Formation of glycosides, ethers and esters. Determination of ring size of glucose. Elucidation of Cyclic structure of D(+)glucose. Mutarotation and its mechanism

Amino Acids and Proteins **4 Hours**

Classification and structure (glycine, Cysteine, proline, tyrosine, and aspartic acid). Acid-base behaviour. Isoelectric point and electrophoresis. Preparation (Gabriel Phthalimide and from malonic ester) and reactions of amino acids (action of heat, esterification), Structure and nomenclature of peptides and proteins.Classification of proteins. Peptide structure determination, end group analysis, selective hydrolysis of peptides. Levels of protein structure. Protein denaturation / renaturation.

Mass spectroscopy. **3 Hours**

Principles, Aston Mass spectrograph. Fragmentation pattern (of ethanol, isobutene and 2-pentene). McLafferty rearrangement. Applications- Separation of isotopes.

G502.5P: Chemistry Practical V

4 Hours/Week

1) **Inorganic Gravimetric Exercises :** **(6 Weeks X 4 Hours)**

Determination of Percentage purity of the compound involving the estimation of:

a. Barium as barium sulphate.
b. Iron as ferric oxide.
c. Copper as cuprous thiocyanate
d. Nickel as nickel dimethyl glyoximate
e. Chloride/Silver as AgCl.

f. Magnesium as oxinate

2) Separation of compounds(Any two) (2 Weeks X 4 Hours)

a. Separation and estimation of Mg (II) and Fe (III) Ion by solvent extraction method.

b. Separation of methylene blue and fluorescein by column chromatography, thin layer chromatography

c. Preparation of 2,4, dinitrophenyl hydrazones of acetone, Benzaldehyde and vaniline and separation by TLC

3) Effluent analysis: (1 Week X 4 Hours)

a. Analysis of effluent water (Determination of COD, DO, pH and conductivity)

4) Preparation of Inorganic complexes: (Any two) (2 Weeks X 4 Hours)

a. Preparation of tetramminecopper(II) sulphate

b. Preparation of sodium trioxalatoferrate(III).

c. Preparation of hexaminecobalt(III) chloride

5) Instrumental Analysis: (Any one) (1 Week X 4 Hours)

a. Determination of pH of buffer solution using a pH meter and evaluation of pKa of acids

b. Determination of solubility of sparingly soluble compound by conductometry

c. Potentiometric determination of solubility of silver halide and the standard electrode potential using quinhydrone electrode

SIXTH SEMESTER

G502.6a: Chemistry Paper VII

UNIT I:

Infra-red spectroscopy **5 Hours**

Types of molecules showing vibrational spectra (i.e, IR active and IR inactive). Vibrational energy levels of a SHO (simple harmonic oscillatior), Zero point energy, Selection rules. Frank Condon principle, Vibrational spectrum for SHO, Vibrational energy levels of an anharmonic oscillator. Applications of IR- calculation of moment of inertia, bond length, force constant, and dissociation energy. Vibrational frequencies of functional groups.

Raman spectroscopy: **4 Hours**

Explanation for Raman frequency, Raman Effect, Raman spectrum, Rayleigh's line, stokes line and antistokes line. Type of molecules giving Raman spectra, mutual exclusion principle.

Application of IR and Raman spectroscopy in the structural elucidation of organic molecules,

Advantages of Raman spectroscopy over IR spectroscopy.

Phase Diagrams and Applications of Phase Rule **4 Hours**

Gibbs phase rule and explanation of the terms- phase, component and degrees of freedom. Derivations of Gibbs phase rule**.** Application of phase rule to one component systems- water system and sulphur system. Application of phase rule to two component systems- Pb-Ag system, Freezing mixture - ice - salt.

UNIT II:

Thermodynamic and Kinetic Aspects of Metal Complexes **5 Hours**

Thermodynamic and kinetic stability of metal complexes, stepwise and overall stability constants. Methods of determination of stability constants (any 1 method). Substitution reactions of square planar complexes. - trans effect (S_N1 andS_N2)

Organometallic Chemistry **4 Hours**

Definition, Nomenclature and classification of organometallic compounds. Structure, Preparation, properties, bonding and applications of alkyls and aryls of Li, Al, Hg, Grignard reagents.

Metal carbonyls **4 Hours**

Mononuclear carbonyls, 18 electron rule, nature of bonding in metal carbonyls. Preparation and structure of Nickel tetracarbonyl,$Co_2(CO)_8$.Infrared absorption spectra of mononuclear metal carbonyls.

UNIT III:

Stereochemistry of Organic Compounds: 8 Hours

Optical isomerism, plane of symmetry, molecular chirality, stereogenic centre, chiral and achiral molecules, enantiomers, properties of enantiomers, optical activity in Example - Lactic acid and Tartaric acid. Diastereomers, threo and erythro diastereomers, meso compounds, resolution of enantiomers (mechanical, Biochemical and chemical), inversion, and racemization. Relative and absolute configuration, sequence rules, D & L, R & S systems of nomenclature. Geometric isomerism (cis-trans). Determination of configuration of geometric isomers (dipole moment, melting point and ring formation). E & Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds. Conformational isomerism — conformational analysis of ethane and 1,2-dichloroethane. Conformations of cyclohexane (Newman projection). Difference between configuration and conformation.

Organic Synthesis *via* Enolates 5 Hours

Acidity of alpha-hydrogens. alkylation of diethyl malonate and ethyl acetoacetate. Synthesis of ethyl acetoacetate, Claisen condensation with mechanism. Keto-enol tautomerism of ethyl acetoacetate.

Uses of malonic ester(to Synthesize alkyl acetic acid, dicarboxylic acids, β-keto acids, α,β-unsaturated acids) and acetoacetic ester (for synthesis of carboxylic acids, diketones and dicarboxylic acids, α-β unsaturated acids and methyl ketones).

G502.6b: Chemistry Paper VIII

UNIT I: Electrochemistry 13 Hours

Activity, activity coefficient, Debye Huckel theory. Relaxation effect, electrophoretic effect, Debye Huckel Onsagar equation. Transport number: determination by moving boundary method. Application of conductance measurements in the determinations of α , K_a and K_s. Conductometric titrations- weak acid-strong base, strong acid-weak base, weak acid-weak base, strong acid-strong base and mixture of acids against strong base. Types of electrodes – glass, calomel, quinhydrone electrode. Determination of pH using quinhydrone electrode**.** Potentiometric titrations - Redox and acid base. Concentration cells and types (expression for emf to be assumed)**.** Liquid junction potential, Solubility product by means of concentration cells**.** Problems

UNIT II:

Environmental Chemistry: **4 Hours**

Air pollution -air pollutants (gaseous and Particulate matter), their sources, effects – green house effect, acid rain, photochemical smog. Water pollution -types of water pollutants, Biochemical Oxygen demand (BOD) Chemical Oxygen demand (COD) – definition, significance and detemination. Water treatment. Soil Pollution -Pollutants-Agricultural wastes, animal manures, pesticides, radioactive wastes, industrial pollutants.

Industrial Chemistry **6 Hours**

Fuels: Characteristics of fuels. Brief account of gaseous fuels - natural gas, water gas, producer gas. Liquid petroleum gas, biogas (production, composition and applications). Octane number, cetane number.

Explosives: Classifications of explosives. Compositions, preparation of TNT, RDX.

Glass: types of glass. Raw materials, manufacture of glass, their composition of different types of glass and uses, annealing of glass.

Rocket propellants- examples, types,

Green Chemistry: **3 Hours**

Introduction, the need of green chemistry, principles of green chemistry, Designing a green synthesis – Green reactions, Concept of atom economy for simple organic reactions. Calculation of atom economy for organic reactions, Applications.

UNIT III:

NMR spectroscopy and applications: **7 Hours**

Proton magnetic resonance ('H NMR) Spectroscopy, nuclear shielding and deshielding, calculation of chemical shift (TMS as Internal standard) and molecular structure, spin-spin splitting and coupling constants, areas of signals, interpretation of PMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1,1,2- tribromoethane and ethyl acetate. Factors affecting chemical shift (inductive, anisotropic, hydrogen bonding).

Dyes and colouring agents : **3 Hours**

Molecular orbital theory of Colour and constitution. Classification of dyes. Synthesis of Methyl orange, Congo red, Malachite green, crystal violet, Phenolphthalein, Fluorescein,

Alizarin and Indigo. Action of Methyl orange and Phenolphthalein as indicators.

Chemistry of Natural products **3 Hours**

Alkaloids: Definition, occurrence, extraction of alkaloids from plants, Structural elucidation of nicotine.

Terpenoids: Classification, isoprene rule, structure of menthol and camphor.

G502.6P: Chemistry Practical VI

4 Hours/Week

Part A: Compulsory for all students.

Part B : For students not opting the project work

PART A (4 experiments to be carried out) (Compulsory for all students)

(4 Weeks x 4 Hours)

1) To determine the strength of the given acid mixture (acetic acid + hydrochloric acid) conductometrically using standard alkali solution.
2) To determine the concentration of sodium ions by flame photometry.
3) Potentiometric titration of ferrous ammonium sulphate using potassium dichromate as titrant and calculation of the redox potential of Fe^{2+}/ Fe^{3+} system on the hydrogen scale
4) To determine the concentration of cupric ions present in a solution using a colorimeter.
5) To determine the strength of the given acid mixture (Trichloroacetic acid and acetic acid or monochloroacetic acid and acetic acid)
6) Estimation of vitamin c in the tablets by conductometry

Part B : For the students without project work (Any 8 experiments)

(8 Weeks) X 4 Hours)

1) To determine the concentration of potassium ions by flame photometry
2) To determine the dissociation constant of a weak acid by potentiometric method
3) Analysis of alloys
4) Analysis of ores
5) To determine equivalent conductance of sodium chloride by conductometric method
6) To determine the ionisation constant of a weak acid conductometrically.
7) To study the rate of inversion of cane sugar
8) Determination of nitrogen in organic compounds by Kjeldahl's method.
9) Estimation of hardness of water by EDTA method
10) Estimation of manganese in- pyrolusite by volumetric (EDTA) method
11) Determination of adulteration in food stuffs.
12) Determination of Chloride or sulphate by nephelometric method
13) Spectrophotometric estimation of Iron.
14) Estimation of sodium, potassium, calcium and lithium by flame photometry

PROJECT WORK **(8 Weeks X 4 Hours)**

In addition to experiments of Part A of G502.6P, student will take experimental

project work related to the elective chosen by the student. The work will be supervised and certified by a teacher in the department. The experimental work will be undertaken in the departmental laboratory and a project report should be submitted at the end of the semester for evaluation.

REFERENCE BOOKS

ANALYTICAL CHEMISTRY

1) Analytical Chemistry, John H.Chenady, Vol.II 1986, Saunders College, New York
2) Basic concepts of Analytical Chemistry, S.M. Khopkar Vol. II, 1993, New Age International Publishers
3) Fundamentals of Analytical Chemistry, Skoog West, Holler, Vol.VI 1993, Saunders College, New York
4) Instrumental Methods of Chemical analysis, Gurudeep R. Ghatval and Sham Anand 1998, Himalaya Publishing House (1998)
5) Instrumental Methods of Chemical Analysis, Willard, Merritt, Dean, Skettle
6) Instrumental methods of Chemical analysis -2001 B K.Sharma, 1999, Goel Publishing House
7) Management of Water Resources in agriculture V. S. Shreeramulu, 1998
8) Principals of Instrumental Analysis, Skoog, Holler, Niemann, Vol.V 1993, Harcout
9) Environmental Chemistry, A.K. De, Vol.IV, 2000, New Age International Publishers
10) Environmental Pollution Analysis, S.M. Khopkar, 2001, New Age International Publishers
11) Environmental Pollution Control Engineering C.S. Rao 2001
12) Environmental Studies, A.K.De, Vol.IV 2001, New Age International Publishers
13) Water Pollution, Causes, Effects & Control, P.K. Goel, 1997

INORGANIC CHEMISTRY

1) A Text Book of Qualitative Analysis, A. I. Vogel
2) A Text Book of Quantitative Inorganic Analysis, A. I. Vogel, E.L. B. S. & Longman.
3) A Textbook of Inorganic Chemistry, P.L Soni, 1998, Sultan Chand and Sons.

4) A Textbook of Inorganic Chemistry, A.K. De, Vol VIII 2001, New Age International
5) A Textbook of Inorganic Chemistry, Gurudeep Raj, 2000
6) A Textbook of Inorganic Chemistry, Puri & Sharma, 2000, Shobanlal Nagin Chand
7) Advanced Inorganic Chemistry, Volume I & II, Satyaprakash, G. D. Tuli, S. K. Basu, R. D. Madan. S. Chand & Company Ltd, Delhi, 19th Edition 2005.
8) Advanced Inorganic Chemistry, F. Albert Cotton, Geoffrey Wilkinson, Carlos A. Murillo, Manfred Bochmann, John Wiley & Sons, Inc, 6th Edition.
9) Basic Concepts of Analytical Chemistry, S. M. Khopkar, New Age International (P) Ltd, 2nd Edition, 2004.
10) Comprehensive Inorganic Chemistry, O.P. Agarwal, 2001
11) Concise Inorganic Chemistry, J. D. Lee, Blackwell Science Ltd, 5 th Edition, 1996.
12) Elements of Nuclear Chemistry, R. Gopalan, 2000, Vikas Publishing House
13) Engineering Chemistry, Jayaprakash- Venugo pal, 2001
14) Engineering Chemistry, B.K. Sharma, 2001
15) Engineering Chemistry, Jain & Jain, 15th Edition, Dhanpat Rai Publishing Company.
16) Handbook of Industrial Chemistry, Riegel's, Vol IX 1995, B.S. Publishers
17) Industrial Chemistry, B.K. Sharma, 2001
18) Industrial Chemistry, B.N. Chakrabarthy, 1998, Oxford &IBH Publishers
19) Inorganic Chemistry- Principles of Structure and Reactivity, James E. Huheey, Ellen A. Keiter, Richard L. Keiter, Pearson Education, Indian Branch, Delhi, 4th Edition.
20) Inorganic Chemistry, D. F. Shriver, P.W. Atkins, Oxford University Press, Indian Edition 2004.
21) Inorganic Chemistry, Kapoor & Chopra, 2001
22) Inorganic Polymers, G.R. Chatwal, 1993, Himalaya Publishing house
23) Instrumental Methods of Chemical Analysis -2001, B.K. Sharma, 1999, Goel Publishing House
24) Instrumental Methods of Chemical Analysis, Gurudeep R. Chatwal, Sham K. Anand, Himalaya Publishing House, 5th Edition, 2002.
25) Management of Water Resources in Agriculture, V.S. Shrelramulu, 1998
26) Principles of Inorganic Chemistry, B. R. Puri, L. R. Sharma, K. C. Kalia, Milestone Publishers & Distributors, Delhi, 2006.
27) Selected Topics in Inorganic Chemistry, Madan, Malik Tuli, 2000, S. Chand and Company Ltd.

28) Text Book of Inorganic Chemistry, P. L. Soni, Mohan Katyal, Sultan Chand & Sons, New Delhi,
29) Theoretical Principles of Inorganic Chemistry, G. S. Manku, Tata McGraw-Hill Publishing Company Ltd-New Delhi, 21st Reprint, 2004.
30) Theoretical Principles of Inorganic Chemistry, Manku, 2001, Tata McGraw Hills

ORGANIC CHEMISTRY

1) Organic Chemistry, 3rd Edition, Paula Yurkanis Bruice, Pearson Education.
2) Organic Chemistry, Volume 1, 6th Edition, I.L Finar, Pearson Education.
3) Organic Chemistry, Volume 2, Stereochemistry and the Chemistry Natural Products, 5th Edition, I.L Finar, Pearson Education.
4) Problems and Their Solution in Organic Chemistry, I.L Finar, Pearson Education.
5) Vogel's Text book of Practical Organic Chemistry, 5th Edition, Brian S. Furniss, Antony J. Hannaford, Peter W. G. Smith, Austin R.Tatchell, Pearson Education.
6) Mechanism and Theory in Organic Chemistry, Thomas H. Lowry, Kathleen Schueller Richardson, Pearson Education.
7) Organic Chemistry, 6th Edition, Robert Thornton Morrison, Robert Neilson Boyd, Pearson Education.
8) A Guide book to Mechanisms in Organic Chemistry, 6th Edition, Peter Sykes, Pearson Education.
9) Organic Chemistry, 5th Edition, Leroy G. Wade Jr.
10) Organic Chemistry, 5th Edition, Francis A. Carey, Tata McGraw- Hill Publishing Company Ltd, New Delhi.
11) Text Book of Organic Chemistry, 28th Revised Edition, P. L. Soni, H. M. Chawla, Sultan Chand & Sons Educational Publishers, New Delhi.
12) Organic Chemistry 8thEdition, T. W. Graham Solomons, Craig B. Fryhle, John Wiley & Sons, Inc.
13) Organic Chemistry, 6th Revised Edition, Megh K. Jain and Subhash C. Sharma, Shoban Lal &Co. Educational Publishers.
14) A Text book of Chemistry, 4th Edition, Raj K. Bansal, New Age International (P) Ltd

Publishers.

15) Advanced Organic Chemistry, 2005, Arun Bahl & B. S. Bahl, S. Chand & Company Lyd. Ram Nagar, New Delhi.

PHYSICAL CHEMISTRY

16) Textbook of Physical Chemistry, 22nd Edition,2001, P.L.Soni, O.P.Dharmarha and U.N.Dash, Sultan Chand & Sons.

17) Atkin's Physical Chemistry,1st Indian Edition 2003,Peter Atkins & Julio de Paula, Oxford Publication.

18) Physical Chemistry, 3rd Edition, 1986, M. Kundan & S. K. Jain, S. Chand & Company.

19) Text Book of Physical Chemistry, 8th Edition, 1988, Sharma & Sharma, Vani Educational Books.

20) Text Book of Advanced Physical Chemistry, 2001, Guru deep Raj, Goel, Meerut.

21) Principles of Physical Chemistry, 41st Edition, 2004, Puri, Sharma & Pathania, Vishal Publishing Co.

22) Text Book of Physical Chemistry, 22nd Revised Edition, 2001, Sultan Chand & Sons Educational Publishers.

23) Colloidal Chemistry, 2nd Edition, 1992, D. K. Sharma, Goel Prakashan, Meerut.

24) Essential Physical Chemistry, 2002, B. S. Bahl, G.D. Tuli & Arun Bahl, S.Chand & Company Ltd.

25) Environmental Chemistry with Green Chemistry, Dr. Asim K. Das, Books and Allied (P) LTD.

26) An Introduction to Nanoscience and Technology- CNR Rao, Jawaharlal Nehru Centre for advanced Scientific Research.

****