St Aloysius College (Autonomous)
Mangaluru

Re-accredited by NAAC "A" Grade

Course structure and syllabus of

B.Sc.

CHEMISTRY

Under NEP Regulations, 2021

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www.staloysius.edu.in

ESTD : 1880

ST ALOYSIUS COLLEGE (AUTONOMOUS)
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Re-accredited by NAAC with 'A' Grade with CGPA 3.62/4 (Cycle 4)
Recognised as Centre for Research Capacity Building under UGC-STRIDE Scheme
Recognised under DBT – BUILDER Scheme, Government of India
College with "STAR STATUS" Conferred by DBT, Government of India
Recognised by UGC as "College with Potential for Excellence"

Date:

NOTIFICATION

Sub: Syllabus of **B.Sc. CHEMISTRY** under NEP Regulations, 2021.
(As per Mangalore University guidelines)

Ref: 1. Decision of the Academic Council meeting held on 18-12-2021 vide Agenda No: 6.19 (2021-22)
2. Decision of the Academic Council meeting held on 09-07-2022 vide Agenda No: 14
3. Decision of the Academic Council meeting held on 25-02-2023 vide Agenda No: 12
4. Office Notification dated 21-02-2022
5. Office Notification dated 17-082022
6. Office Notification dated…….

Pursuant to the above, the Syllabus of **B.Sc. CHEMISTRY** under NEP Regulations, 2021 which was approved by the Academic Council at its meeting held on 18-12-2021, 09-07-2022 & 25-02-2023 is hereby notified for implementation with effect from the academic year **2021-22**.

PRINCIPAL **REGISTRAR**

To:

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

A meeting of the Board of Study in UG CHEMISTRY was held on 20.11.2021

Following members were present for the meeting.

1. Dr Ronald Nazareth (Chairman)
2. Prof Jagadish Prasad
3. Dr Vishwanatha P
4. Ms Helen Serrao
5. Dr Richard Gonsalves
6. Dr Nandini Shet
7. Dr Ashwini
8. Dr Rachael Natasha Mary
9. Ms Deepa Vasanth
10. Ms Sahana
11. Ms Divya Deepthi
12. Ms Crystal Menezes
13. Dr Laveena Dsouza
14. Ms Apeksha – Student representative

MEMBERS OF BOARD OF STUDIES

Chairman

Dr Ronald Nazareth, St Aloysius College (Autonomous), Mangaluru - 575 003.

University Nominee

Prof Jagadish Prasad D, Department of Chemistry, Mangalore University, Mangalagangothri.

Meritorious Alumnus

Dr Manoj Mathews, Department of PG studies and Research in Chemistry, St. Joseph's College (Autonomous), Devagiri, Kozhikode, Kerala – 673 008.

Representative from Industry/corporate sector/Allied area

Ms Meghana, Integrated Product Development, Dr Reddy's Laboratories Limited, Telangana State.

Subject Experts

Dr Vishwanatha P**,** Associate Professor and Head, Department of Chemistry, SDM College (Autonomous), Ujire – 574 240.

Mrs Helen Serrao, Department of Chemistry, St Agnes College (Autonomous), Mangaluru – 575 002.

Members of the Department

Dr Richard A Gonsalves, St Aloysius College (Autonomous), Mangaluru

Dr Nandini Shet, St Aloysius College (Autonomous), Mangaluru

Dr Ashwini, St Aloysius College (Autonomous), Mangaluru

Dr Rachael Natash Mary, St Aloysius College (Autonomous), Mangaluru

Ms Deepa Vasanth, St Aloysius College (Autonomous), Mangaluru

Ms Sahana, St Aloysius College (Autonomous), Mangaluru

Ms Divya Deepthi Monteiro St Aloysius College (Autonomous), Mangaluru

Dr Roshan F D'Souza, St Aloysius College (Autonomous), Mangaluru

Ms Crystal Vivita Menezes, St Aloysius College (Autonomous), Mangaluru

Dr Laveena DSouza, St. Aloysius College (Autonomous), Mangaluru

Student Representative

Ms Mahima Rodrigues, II B.Sc, St Aloysius College (Autonomous), Mangaluru

A meeting of the Board of Study in UG CHEMISTRY was held on 22.02.2023

Following members were present for the meeting.

Chairman

Dr Ronald Aquin Nazareth, St Aloysius College (Autonomous), Mangaluru-575003.

University Nominee

Dr Mahagundappa R Maddani, Assistant Professor, Department of Chemistry Mangalore University Mangalagangothri -574199

Meritorious Alumnus

Mr Manoj Mathew, Assistant Professor, Research & PG Dept of Chemistry, St Josephs College (Autonomous), Devagiri, Kozhikode, Kerala-673008

Representative from Industry/ Corporate sector/ Allied area

Mr Reon Sylvester , Aragen Life Sciences Pvt Ltd, Survey No. 125 & 126, IDA Mallapur Hyderabad 500 076, India.

Subject Experts

Dr Edwin D'Souza, Assistant Professor, St Philomena College, Puttur

Dr A Chitharanjan Hegde, Professor, Department of Chemistry, NITK, Surathkal.

Members of the Department

Dr Richard Gonsalves, St Aloysius College (Autonomous), Mangaluru

Dr Nandini Shet, St Aloysius College (Autonomous), Mangaluru

Dr Ashwini, St Aloysius College (Autonomous), Mangaluru

Dr Rachael Natasha Mary, St Aloysius College (Autonomous), Mangaluru

Ms Deepa Vasanth, St Aloysius College (Autonomous), Mangaluru

Ms Sahana, St Aloysius College (Autonomous), Mangaluru

Dr Ranjitha , St Aloysius College (Autonomous), Mangaluru

Ms Divya Deepthi Monteiro, St Aloysius College (Autonomous), Mangaluru

Dr Roshan Fedrick D'Souza, St Aloysius College (Autonomous), Mangaluru

Ms Vilisha Rodrigues, St Aloysius College (Autonomous), Mangaluru

Dr Laveena Precilla D'Souza, St Aloysius College (Autonomous), Mangaluru

Ms Meghana, St Aloysius College (Autonomous), Mangaluru

Student Representative

Mr Glen Philip Sequeira, II Bsc, St Aloysius College (Autonomous), Mangaluru

COURSE PATTERN

Course No & Paper / Practical	Teaching Hours per week	Duration of Exam (Hours)	Marks		
			I A	Exam	Total
FIRST SEMESTER					
G 502DC 1.1: Analytical and Organic Chemistry – I	4	2.5	40	60	100
G 502 DC2.1P: Analytical and Organic Chemistry – I	4	2.5	40	60	100
G 502 OE1.1: Chemistry in Daily Life	3	2.5	40	60	100
SECOND SEMESTER					
G 502 DC1.2: Inorganic and Physical Chemistry - I	4	2.5	40	60	100
G 502 DC 2.2P: Inorganic and Physical Chemistry - I	4	2.5	40	60	100
G 502 OE 1.2: Molecules of Life	3	2.5	40	60	100
THIRD SEMESTER					
G 502DC 1.3: Analytical and Organic Chemistry – II	4	2.5	40	60	100
G 502 DC2.3P: Analytical and Organic Chemistry – II	4	2.5	40	60	100
G 502 OE1.3: Structure, Bonding and concepts in organic chemistry	3	2.5	40	60	100
FOURTH SEMESTER					
G 502 DC1.4: Inorganic and Physical Chemistry - II	4	2.5	40	60	100
G 502 DC 2.4P: Inorganic and Physical Chemistry - II	4	2.5	40	60	100
G 502 OE 1.4: Electrochemistry, corrosion and Metallurgy	3	2.5	40	60	100

Syllabus for Discipline Specific Core

Total Credits for the Program: 176

Program Outcomes:

By the end of the program the students will be able to**,**

PO. 1: Develop enthusiasm for Chemistry and its application in various fields of life.

PO. 2: Have a broad and balanced knowledge and understanding of key concepts in Chemistry.

PO. 3: Develop a range of practical skills to understand and assess risks and work safely measures to be followed in the laboratory.

PO. 4: Develop the ability to apply standard methodology to the solution of problems in Chemistry.

PO. 5: Gain knowledge and skill towards employment or higher education in Chemistry or multi-disciplinary areas involving Chemistry.

PO. 6: Plan and carry out experiments independently and assess the significance of outcomes and to cater to the demands of chemical Industries of well-trained graduates.

PO. 7: Adapt and apply methodology to the solution of unfamiliar types of problems.

PO. 8: Critically aware of advances at the forefront of chemical sciences, prepare effectively for professional employment or research degrees in chemical sciences and to develop an independent and responsible work ethics.

Assessment:

Weightage for assessments (in percentage)

Type of Course	**Formative Assessment / IA**	**Summative Assessment**
Theory	**40**	**60**
Practical	**25**	**25**
Projects	**-**	**-**
Experiential Learning (Internships etc.)	**-**	**-**

Curriculum Structure for the Undergraduate Degree Program

BSc Chemistry (Discipline Specific Core)

Name of the Degree Program: B.Sc. **Discipline: Chemistry**

Program Articulation Matrix:

This matrix lists only the core courses. Core courses are essential to earn the degree in that discipline/subject. They include courses such as theory, laboratory, project, internships *etc*.

Semester	Title /Name Of the course	Program outcomes	Pre-requisite course(s)	Pedagogy	Assessment
1	**DSC-1: Analytical and Organic Chemistry-I**	The students will be able to understand, • The concepts of chemical analysis, accuracy, precision and statistical data treatment, errors, general purification and chromatographic techniques. • Chemical bonding and reactive intermediates involved in organic reactions. • The preparation and reactions of alkanes, alkenes, dienes. • The mechanism of nucleophilic, electrophilic reactions.	P.U.C. with Chemistry	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
	DSC lab-1: Analytical and Organic Practicals-I	The students will be able to, • Learn how to handle the glassware, prepare and dilute the solutions and perform	-	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams

		experiments with prepared reagents. • Prepare standard solutions, to determine the analyte through volumetric analysis and understand the chemistry involved in each method of analysis. • Deduce the conversion factor based on stoichiometry and in turn use this value for calculation. • Synthesize organic compounds.			
2	**DSC-2: Inorganic and Physical Chemistry-I**	The student will be able to, • Understand Bohr's theory and quantum mechanical approach to atomic structure, wave functions and the rules governing atomic structure, quantum numbers and their necessity in explaining the atomic structure. • Learn periodic properties of *s* and *p* block elements and comparative properties of their compounds. • Understand theories governing gaseous state of matter and physical properties of liquid state. • Learn laws of crystallography (unit cell, symmetry elements *etc*), Nernst distribution law and different types & applications of liquid	-	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams

		crystals.			
	DSC Lab -2: Inorganic and Physical Practicals-I	The student will be able to, • Learn techniques like precipitation, filtration, drying and ignition. • Perform gravimetric determination of metal ions. • Determine physical properties of liquids and solutions – viscosity, surface tension, partition coefficient *etc*.		Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
3	**DSC-3: Analytical and Organic Chemistry-II**	The student will be able to, • Learn analytical instrumentation techniques such as thermo-analytical methods, flame photometry and absorption spectroscopy. • Learn basic separation techniques such as column, ion-exchange and gas chromatography. • Understand mechanisms of named organic reactions and rearrangement reactions as well the use of organic reagents in synthesis.		Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams

	DSC Lab-3: Analytical and Organic Practicals-II	The student will be able to, • Perform quantitative determination of metals using colorimetric, titrimetric, spectrophotometric and nephelometric methods. • Learn basic separation techniques like column and thin layer chromatography. • Perform systematic qualitative analysis of organic compounds.		Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
4	**DSC-4: Inorganic and Physical Chemistry-II**	The student will, • Understand the theories on chemical bonding • Learn the chemistry of d- and f-block elements. • Learn basics of chemical kinetics, catalysis and thermodynamics.		Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
	DSC Lab-4: Inorganic and Physical Practicals-II	The student will be able to • Perform semimicro qualitative analysis of inorganic salt mixtures. • Determine the physical properties of matter such as viscosity, molecular weight, surface tension, degree of dissociation etc.		Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams

5	**DSC-5: Inorganic Chemistry**	The student will be able to • Understand the general characteristics of transition elements, • Bonding and applications of organometallic complexes, significance of metalloporphyrins • General characteristics of inorganic polymers		Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
	DSC Lab-5: Inorganic Chemistry Practicals	The student will be able to • Prepare the complexes of transition metal ions • Analyse the metals present in ores and complexes		Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
	DSC-6: Organic Chemistry	The student will be able to • Predict mechanism of electrophilic substitution reactions in heterocyclic compounds • Explain the structures of biomolecules • Summarize the functions of protein • Design multistep organic synthesis by retrosynthetic approach		Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
	DSC Lab -6: Organic Chemistry Practicals	The student will be able to • Prepare the organic compounds using single and multi-steps • Recrystallize and melting point determination • Isolate of organic compounds		Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams

6	**DSC -7: Physical Chemistry**	The student will be able to • Understand various colligative properties • Description of various types of nano materials • Classify basic symmetry groups • Explain photochemical and photophysical processes		Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
	DSC Lab-7: Physical Chemistry Practicals.	The student will be able to perform and analyse • Potentiometric titrations • Conductometric Titrations • Separation Techniques		Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
	DSC -8: Spectroscopy and Sustainable Chemistry	The student will be able to • Explain the basic concepts in infrared , Raman and NMR spectroscopy and apply this knowledge to elucidate the structure of simple organic molecules • Understand the principle, instrumentation of IR, NMR, UV Visible and mass Spectrometry • Understand Principles and applications of green chemistry in industrial processes		Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
	DSC Lab -8: Analytical and Industrial Chemistry Practicals	The student will be able to perform and analyse • Molecular mass determinations • Viscosity and surface tension determinations		Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams

		• Composition of NaCl in the mixture			

BSc Chemistry (Discipline Specific Core)

Semester 1

Course Title: **DSC-1: Analytical and Organic Chemistry-I**	
Total Contact Hours: 56	Course Credits: 4
Formative Assessment Marks: 40	Duration of ESA/Exam: 3 hrs
Summative Assessment Marks: 60	

Course Pre-requisite(s): ***PUC with Chemistry***

Course Outcomes (COs):

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

CO 1: The concepts of chemical analysis, accuracy, precision and statistical data treatment.

CO 2: The errors in chemical analysis and methods of minimizing.

CO 3: The preparation of standard solutions and dilution of stock solution.

CO 4: The concept of volumetric and gravimetric analysis and deducing the conversion factor for determination.

CO 5: General purification techniques and different types of chromatographic methods.

CO 6: Handling of toxic chemicals, concentrated acids and organic solvents and practice safety procedures.

CO 7: The concepts of organic reactions and techniques of writing the movement of electrons, bond breaking, bond forming and reactive intermediates involved.

CO 8: The concepts of aromaticity, resonance and hyperconjugation.

CO 9: Understand the preparation of alkanes, alkenes, dienes and their reactions.

CO 10: Understand the mechanism of nucleophilic, electrophilic reactions.

BSc Semester 1 – Chemistry (Discipline Specific Core)

Title of the Course: G 502DC 1.1: Analytical and Organic Chemistry – I

Number of Theory Credits	Number of lecture hours / semester	Number of Practical Credits	Number of practical hours / semester
4	56	2	56

Unit – 1 **14 Hrs**

Language of analytical chemistry: Definitions of analysis, determination, measurement, techniques and methods. Classification of analytical techniques. Qualitative analysis; Sample size and techniques - macro, semi-micro and micro. Type of tests - wet, dry and spot tests (terms, definition and examples) Quantitative analysis - Volumetry, Gravimetry and Instrumental analytical methods.

Errors in quantitative analysis, types of errors - determinate and indeterminate, methods of minimizing errors. Accuracy - absolute error, relative error. Precision – mean deviation, relative mean deviation, standard deviation, t-test, F-test and Q-test. Significant figures. Rules for computation of results; Problems.

Basic laboratory practices - calibration of glassware (pipette, burette and volumetric flask), Sampling (solids and liquids), weighing, drying, dissolving, Acid treatment, Rules of work in analytical laboratory, General rule for performing quantitative determinations (volumetric and gravimetric), Safety in Chemical laboratory, Rules of fire prevention and accidents, First aid.

General purification techniques - sublimation, distillation – types; crystallization – Principle with examples; applications.

Chromatography - Introduction; classification - types of chromatography, partition and adsorption, Rf value. Chromatographic methods for the separation, concentration and identification of organic compounds - Thin layer, paper and column chromatography principles. Solvent extraction - basic principles and applications.

Nernst distribution law - definition and its derivation; Partition coefficient; Distribution constant, factors affecting distribution constant, validity of Distribution Law, Modification of distribution law when molecules undergo (a) association (b) dissociation.

Unit – 2 **14 Hrs**

Titrimetric analysis: Basic principle of titrimetric analysis. Classification, Preparation and dilution of reagents/solutions. Normality, Molarity and Mole fraction. Use of $N_1V_1 = N_2V_2$

formula, Preparation of ppm level solutions from source materials (salts). Standard solutions – primary and secondary standards

Acid-base titrimetry: Titration curves for strong acid vs strong base, weak acid vs strong base and weak base vs strong acid titrations; Indicators.

Complexometric titrimetry: Indicators for EDTA titrations - theory of metal ion indicators, titration methods employing EDTA - direct, back, displacement and indirect determinations; Application-determination of hardness of water.

Redox titrimetry: Balancing redox equations ($KMnO_4$ vs oxalic acid; $K_2Cr_2O_7$ *vs* Mohr's salt), calculation of the equilibrium constant of redox reactions, titration curves; Redox indicators; calculation of standard potentials using Nernst equation. Applications.

Precipitation titrimetry: Titration curves, titrants and standards, indicators for precipitation titrations involving silver nitrate - Volhard's and Mohr's methods and their differences.

Gravimetric Analysis: Requisites of precipitation, mechanism of precipitation, Factors influencing precipitation, co-precipitation, post-precipitation; Advantages of organic reagents over inorganic reagents, reagents used in gravimetry (8-hydroxyquinoline and dimethylglyoxime).

Unit – 3 **14 Hrs**

Classification and nomenclature of organic compounds, Hybridization (sp^3, sp^2 and sp); Shapes of organic molecules, Influence of hybridization on bond properties.

Nature of bonding in Organic molecules

Formation of Covalent bond, Types of chemical bonding, localized and delocalized, conjugation and cross conjugation, concept of resonance, electronic displacements: Inductive effect, Electromeric effect, Resonance effect and Hyperconjugation - explanation with examples. Concept of aromaticity, Huckel rule, anti-aromaticity explanation with examples. Strengths of Organic acid and bases - comparative study with emphasis on factors effecting pK values. Relative strength of aliphatic and aromatic carboxylic acids - acetic acid and chloroacetic acid, acetic acid and propionic acid, acetic acid and benzoic acid, aliphatic and aromatic amines. Steric effect.

Mechanisms of Organic Reactions

Notations used to represent electron movements and directions of reactions – Types of arrows (curved, fish-hook, double headed), formal charges. Types of bonds breaking - homolytic and heterolytic. Types of reagents - Electrophiles, nucleophiles, nucleophilicity and basicity. Types of organic reactions - substitution, addition, elimination, rearrangement reactions; explanation with examples.

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-methylbutan-1-ol and 3,3-dimethyl-2-butanol as examples). Preparation of carbenes, concept of singlet and triplet carbene. Addition reactions of singlet and triplet carbenes. Concept of nitrenes and benzyne.

Carbon-carbon pi bonds

Formation of alkenes by elimination reaction. Mechanism of E1, E2 reactions. Saytzeff and Hofmann eliminations. Addition of HBr to propene, Free radical addition of HBr to propene. Addition of halogens to alkenes - carbocation and halonium ion mechanism. Stereospecificity of halogen addition. Ozonolysis (ethene and propene); Addition of hydrogen halides to alkenes, mechanism. Hydrogenation, hydration, hydroxylation and epoxidation of alkenes, explanation with examples.

Unit – 4 **14 Hrs**

Dienes

Nomenclature, classification - isolated, conjugated and cumulated; Structure - hybridization; methods of preparation of 1,3-butadiene – dehydration and dehydrohalogenation. Addition reactions of 1,3-butadiene - polymerization; Mechanism of 1,2- and 1,4- addition of bromine and hydrogen bromide, effect of temperature, free radical addition to 1,3-butadiene; Diels-Alder reaction and its importance; 1,3-Dipolar cycloaddition and pericyclic reactions – explanation with examples.

Nucleophilic substitution at saturated carbon.

Mechanism of S_N1 and S_N2 reactions with suitable examples (hydrolysis of *t*-butyl bromide and methyl bromide, respectively). Energy profile diagrams, Stereochemistry and factors effecting S_N1 and S_N2 reactions. Neighbouring group participation.

Aromatic Electrophilic substitution reactions.

Mechanisms, σ and π complexes, Halogenation, Nitration, Sulphonation, Friedel Crafts alkylation and acylation with their mechanism. Activating and deactivating groups. Orientation influence, *ortho-para* ratio.

Aromatic nucleophilic substitution reaction:

S_NAr and Benzyne mechanism with suitable examples. Relative reactivities of alkyl halides *vs* allyl, vinyl and aryl halide.

Text Books

1. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D.Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, Pearson Education Pvt.Ltd.(2007).

2. Fundamentals of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch, 8th edition, Saunders College Publishing, New York (2005).
3. Analytical Chemistry, G.D. Christian, 6th edition, Wiley-India (2007).
4. Practical Volumetric Analysis, Peter A C McPherson, Royal Society of Chemistry, Cambridge, UK (2015).
5. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. Finar, I. L. Organic Chemistry (Volume I), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
7. McMurry, J. E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
8. Organic Reaction mechanism by V. K. AhIuwalia and K. Parashar (Narosa Publishers).
9. Organic Chemistry by S. M. Mukherji, S. P. Singh and R. K. Kapoor. (Narosa Publishers)
10. A Guide book to mechanism in Organic Chemistry by Peter sykes. Pearson.
11. Advanced Organic Chemistry by J. Singh, L. D. S. Yadav (Pragati Prakashan).
12. A Textbook of Organic Chemistry by A. Bahl and B. S. Bahl, 22nd Edition, 2019 (S. Chand Publications).

Pedagogy

Formative Assessment	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test	40
Sem End Exam	60
Total	100

Content of Practical Course 1: G 502 DC2.1P

PART – A Analytical Chemistry

1. Calibration of glassware, pipette, burette and volumetric flask.
2. Preparation of standard decinormal solution of sodium carbonate and standardization of hydrochloric acid and estimation of sodium hydroxide in solution.

3. Preparation of standard decinormal solution of potassium biphthalate and standardization of sodium hydroxide solution and estimation of hydrochloric acid in solution.
4. Determination of oxalic acid and sodium oxalate / sulfuric acid in a given mixture using standard $KMnO_4$/NaOH solution.
5. Preparation of standard decinormal solution oxalic acid and standardization of potassium permanganate solution and estimation of Mohr's salt in solution.
6. Preparation of standard decinormal solution of ferrous ammonium sulphate (Mohr's salt) and standardization of potassium dichromate solution and estimation of ferric chloride in solution.
7. Estimation of ferrous and ferric in a mixture.
8. Determination of sodium carbonate and sodium bicarbonate in a mixture.
9. Determination of alkali content in antacid tablet using HCl.
10. Determination of alkali present in soaps/detergents.
11. Standardization of EDTA solution and determination of hardness of water.
12. Standardization of silver nitrate and determination of chloride in a water sample (demonstration).
13. Determination of chlorine in bleaching powder using iodometric method.

PART - B Organic Chemistry

1. Selection of suitable solvents for Purification/Crystallization of organic compounds.
2. Preparation of acetanilide from aniline using Zn/acetic acid (Green method).
3. Synthesis of p-nitro acetanilide from acetanilide using nitrating mixture.
4. Bromination of acetanilide (i) Conventional method and/or (ii) with ceric ammonium nitrate and potassium bromide (Green method).
5. Hydrolysis of methyl *m*-nitrobenzoate to *m*-nitrobenzoic acid (Conventional method)
6. Synthesis of diazoaminobenzene from aniline (conventional method).
7. Preparation of dibenzalacetone (Green method).
8. Diels Alder reaction between furan and maleic acid (Green method).

BSc Semester 1

Title of the Course: G 502 OE1.1: CHEMISTRY IN DAILY LIFE

Number of Theory Credits	Number of lecture hours / semester	Number of practical credits	Number of practical hours/ semester
3	42	-	42

Unit – 1 **14 Hrs**

Dairy Products: Composition of milk and milk products. Analysis of fat content, minerals in milk and butter. Estimation of added water in milk. Beverages: Analysis of caffeine in coffee and tea, detection of chicory in coffee, chloral hydrate in toddy, determination of methyl alcohol in alcoholic beverages.

Food additives, adulterants, and contaminants- Food preservatives like benzoates, propionates, sorbates, disulphites. Artificial sweeteners: Aspartame, saccharin, dulcin, sucralose, and sodium cyclamate. Flavors: Vanillin, alkyl esters (fruit flavors), and monosodium glutamate.

Artificial food colorants: Coal tar dyes and non-permitted colors and metallic salts. Analysis of pesticide residues in food.

Unit – 2 **14 Hrs**

Vitamins: Classification and Nomenclature. Sources, deficiency diseases, and structures of Vitamin A1, Vitamin B1, Vitamin C, Vitamin D, Vitamin E & Vitamin K1.

Oils and fats: Composition of edible oils, detection of purity, rancidity of fats and oil. Tests for adulterants like argemone oil and mineral oils. Halphen test.

Soaps & Detergents: Definition, classification, manufacturing of soaps and detergents, composition and uses.

Unit – 3 **14 Hrs**

Chemical and Renewable Energy Sources: principles and applications of primary & secondary batteries and fuel cells. Basics of solar energy, future energy storer.

Polymers: Basic concept of polymers, 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, elastomers, fibres medical fields. Problems of plastic waste management. Strategies for the development of environment-friendly polymers.

Text Books

1. B. K. Sharma: Introduction to Industrial Chemistry, Goel Publishing, Meerut (1998).
2. Medicinal Chemistry- Ashtoush Kar.

3. Analysis of Foods – H.E. Cox: 13.
4. Chemical Analysis of Foods – H.E. Cox and Pearson.
5. Foods: Facts and Principles. N. Shakuntala Many and S. Swamy, 4thed. New Age International (1998)
6. Physical Chemistry – P l Atkins and J. de Paula – 7thEd. 2002, Oxford University Press.
7. Handbook on Fertilizer Technology by Swaminathan and Goswamy, 6th ed. 2001, FAI.
8. Organic Chemistry by I. L. Finar, Vol. 1 & 2. 9. Polymer Science and Technology, J. R. Fired (Prentice Hall).

Pedagogy

Formative Assessment	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test	40
Sem End Exam	60
Total	100

BSc Semester 2 – Chemistry (Discipline Specific Core)

Title of the Course: G502 DC1.2: INORGANIC AND PHYSICAL CHEMISTRY - I

Number of Theory Credits	Number of lecture hours/semester	Number of Practical Credits	Number of practical hours/ semester
4	56	2	56

Unit – 1 **14 Hrs**

Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ^2. Quantum numbers and their significance.

Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of *s*, *p*, *d* and *f* orbitals. Contour boundary and probability diagrams.

Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations- Electronic configurations of the elements (Z=1-30), effective nuclear charge, shielding/screening effect, Slater's rules. Variation of effective nuclear charge in Periodic Table.

Unit - 2 **14 Hrs**

***s* and *p* block elements**

Variation of the following properties with reference to *s* and *p*-block elements: atomic radii (van der Waals); ionic and crystal radii; covalent radii; ionization enthalpy - successive ionization enthalpies and factors affecting ionization energy - applications of ionization enthalpy; electron gain enthalpy – trends; electronegativity - Pauling's, Mulliken's, Allred Rachow's and Mulliken-Jaffé's electronegativity scales - variation of electronegativity with bond order, partial charge, hybridization.

Chemistry of *s*-Block Elements

Hydrogen - isotopes; hydrides – types (ionic, covalent, interstitial, polymeric, complex), preparation and properties; structure of NaH and BeH_2; applications of complex hydrides ($LiAlH_4$, $NaBH_4$). Comparison of standard reduction potentials and reducing properties of alkali metals and alkaline earth metals. Complexation tendencies of alkali metals with crown ether, cryptates. Diagonal relationship - reasons for diagonal relationship, comparison of the properties of Li with Mg and Be with Al.

Chemistry of *p*-Block Elements

Comparative study of *p*-Block elements and their compounds. Boranes – Diborane (Preparation, properties, structure and bonding), B_4H_{10}, B_5H_9 - structure; Styx number, Wade's rule – closo-, nido- and arachno-boranes. Silicates - types, basic units, structure and applications of zeolites. Noble gases - structure and bonding in Clathrates, XeF_2, XeF_4, XeF_6 and XeO_3.

Unit – 3 **14 Hrs**

Gaseous State

Elementary aspects of kinetic theory of gases, Ideal and real gases. Boyle temperature (derivation not required), Molecular velocity, collision frequency, collision diameter, Collision cross section, collision number and mean free path and coefficient of viscosity, calculation of σ and η, variation of viscosity with temperature and pressure.

Maxwell's Boltzmann distribution law of molecular velocities (Most probable, average and root mean square velocities). Relation between RMS, average and most probable velocity and average kinetic energies. (Mathematical derivation not required), law of equipartition of energy.

Behaviour of real gases: Deviation from ideal gas behaviour. Compressibility factor (Z) and its variation with pressure for different gases. Causes of deviation from ideal behaviour, vander Waals equation of state (no derivation) and application in explaining real gas behaviour. Critical phenomena - Andrews isotherms of CO_2, critical constants and their calculation from van der Waals equation, Continuity of states, Law of corresponding states. Numerical problems.

Liquid State

Surface Tension: Definition and its determination using stalagmometer, effect of temperature and solute on surface tension.

Viscosity: Definition, Coefficient of viscosity. Determination of viscosity of a liquid using Oswald viscometer. Effect of temperature, size, weight, shape of molecules and intermolecular forces.

Refraction: Specific and molar refraction - definition and advantages. Determination of refractive index by Abbes Refractometer. Additive and constitutive properties.

Parachor: Definition, Atomic and structure parachor; Elucidation of structure of benzene and benzoquinone. Viscosity and molecular structure. Molar refraction and chemical constitution**.**

Unit – 4 **14 Hrs**

Liquid Crystals

Explanation, classification with examples - Smetic, nematic, cholesteric, disc shaped and polymeric. Structures of nematic and cholesteric phases - molecular arrangements in nematic and cholesteric liquid crystals. Applications of liquid crystals in LCD's and thermal sensing.

Solids

Forms of solids: Unit cell and space lattice, anisotropy of crystals, size and shape of crystals, Laws of Crystallography: Law of constancy of interfacial angles, Law of rational indices, Law of symmetry; Symmetry elements – Types: (a) axis of symmetry (b) plane of symmetry (c) centre of symmetry - definition and explanation taking cubic crystal system as an example. Crystal systems, Bravais lattice types and identification of lattice planes. Miller indices and its calculation, X–Ray diffraction by crystals: Bragg's law and derivation of Bragg's equation, Single crystal and powder diffraction methods. Cesium Chloride, Zinc blende structures. Defects in crystals, glasses and liquid crystals. Numerical problems.

Text Books

1. Concise Inorganic Chemistry: J D Lee, 4th Edn, Wiley, (2021)
2. Fundamentals Concepts of Inorganic Chemistry, Vol 1 and 2, 2nd Edition, Asim K Das, CBS Publishers and Distributors, (2013)
3. Basic Inorganic Chemistry, F A Cotton, G Wilkinson and P. L. Gaus, 3rd Edition. Wiley. India
4. Inorganic Chemistry, 2nd Edn. Catherine E. Housecroft and A.G. Sharpe, Pearson Prentice Hall (2005)
5. Atkins Physical Chemistry.8th Edition. Peter Atkins & Julio De Paula Oxford University Press.
6. Physical Chemistry by Samuel Glasstone, ELBS (1982).
7. A Text book of Physical Chemistry, A S Negi & S C Anand, New Age International Publishers (2007).
8. Principles of Physical Chemistry, Puri, Sharma & Pathania, Vishal Publishing Co.
9. A Text Book of Physical Chemistry P.L.Soni , O.P. Dharmarhaand and U.N.Dash, Sultan Chand and Sons.
10. Advanced Physical Chemistry, Gurdeep Raj, Goel Publishing House (2018).

Pedagogy

Formative Assessment	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test	40
Sem End Exam	60
Total	100

Content of Practical Course 2: G 502 DC 2.2P

PART-A Inorganic Chemistry

Gravimetry

1. Determination of Ba^{2+} as $BaSO_4$
2. Determination of Cu^{2+} as CuSCN
3. Determination of Fe^{2+} as Fe_2O_3
4. Determination of Ni^{2+} as $Ni(DMG)_2$ complex.
5. Determination of Chloride/Silver as AgCl.
6. Determination of Magnesium as oxinate.

PART-B Physical Chemistry

1. Determination of density using specific gravity bottle and viscosity of liquids using Ostwald's viscometer (Ethyl acetate, Toluene, Chloroform, Chlorobenzene or any other non-hazardous liquids)
2. Study of the variation of viscosity of sucrose solution / Glycerol-water mixture with the concentration of solute / mixture.
3. Determination of the density using specific gravity bottle and surface tension of liquids using Stalagmometer (Ethyl acetate, Toluene, Chlorobenzene, any other non-hazardous liquids
4. Study of variation of surface tension of detergent solution with concentration.
5. Determination of the composition of liquid mixture by refractometry (Toluene & Alcohol, Water & Sucrose).
6. Determination of partition/distribution coefficient - i) Acetic acid in water and cyclohexane. ii) Acetic acid in Water and Butanol. iii) Benzoic acid in water and toluene.

BSc Semester 2

Title of the Course: G 502 OE 1.2: Molecules of Life

Number of Theory Credits	Number of lecture hours/semester	Number of Practical Credits	Number of practical hours/ semester
3	42	-	42

Unit – 1 **14 Hrs**

Carbohydrates

Classification of carbohydrates, reducing and non-reducing sugars; General properties of glucose and fructose, their open chain structures. Epimers, mutarotation and anomers.

Linkage between monosaccharides, structure of disaccharides (sucrose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation.

Amino Acids, Peptides and Proteins

Classification of amino acids, Zwitterion structure and Isoelectric point, acid-base properties of amino acids. Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins. Determination of primary structure of peptides, ion -exchange chromatography.

Unit - 2 **14 Hrs**

Enzymes and correlation with drug action

Mechanism of enzyme action, factors affecting enzyme action, Co-enzymes and cofactors and their role in biological reactions, Specificity of enzyme action (including stereospecificity).

Enzyme inhibitors and their importance, phenomenon of inhibition (Competitive and Non-competitive inhibition including allosteric inhibition).

Drug action

General principles of drug action, receptor theory. Structure–activity relationships of drug molecules, binding role of –OH group, -NH_2 group, double bond and aromatic ring.

Lipids

Introduction to lipids, classification. Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).

Unit - 3 **14 Hrs**

Nucleic Acids

Components of nucleic acids: Adenine, guanine, thymine and cytosine (Structure only), other components of nucleic acids, Nucleosides and nucleotides (nomenclature), Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA (types of RNA), Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation.

Concept of Energy in Biosystems

Calorific value of food. Standard caloric content of carbohydrates, proteins and fats. Oxidation of foodstuff (organic molecules) as a source of energy for cells. Introduction to Metabolism (catabolism, anabolism), ATP: the universal currency of cellular energy, ATP hydrolysis and free energy change. Conversion of food into energy. Outline of catabolic pathways of Carbohydrate - Glycolysis, Fermentation, Krebs Cycle. Overview of catabolic pathways of Fats and Proteins. Interrelationships in the metabolic pathways of Proteins, Fats and Carbohydrates.

Text Books

1. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. *Organic Chemistry* (*Volume 2)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Biochemistry 7th Ed.*
5. W. H. Freeman. Berg, J.M., Tymoczko, J.L. & Stryer, L. *Biochemistry*, 2002.

Pedagogy

Formative Assessment	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test	40
Sem End Exam	60
Total	100

BSc Semester III – Chemistry (Discipline Specific Core)

Title of the Course: G 502DC 1.3: Analytical and Organic Chemistry – II

Number of Theory Credits	Number of lecture hours / semester	Number of Practical Credits	Number of practical hours / semester
4	56	2	56

Unit-I

Quantitative analysis-Instrumental methods

Electromagnetic spectrum, absorption of electromagnetic radiation, Definition and units of frequency, wavelength, wave number, Beer's law, Beer-Lambert law derivation, deviations from Beer's law, limitations, construction of calibration graph (Plot of absorbance versus concentration), Evaluation Procedures- standard addition, Internal standard addition, validation parameters-detection limits, sensitivity, dynamic/linearity range, Instrumentation, single beam and double beam spectrophotometers, quantitative applications of colorimetry (determination of Fe, Mo, Cu, Ti and PO_4^{3-}) and numerical problems on application of Beer's law.

08 hrs

Flame Photometry: Principle, Flames used (fuel-oxidant mixtures), Instrumentation, types of burners- Total consumption burner and Laminar flow burner. Qualitative applications; Limitations of Flame Photometry.

02 hrs

Nephelometry and Turbidimetry: Introduction, principle, instrumentations of nephelometry and turbidimetry; effects of concentration, particle size and wavelength on scattering; choice between nephelometry, applications of nephelometry and turbidimetry (determination of $S0_4^{2-}$ and PO_4^{3-})

04 hrs

Unit-II

Separation methods

Fundamentals of chromatography: General description, definition, terms and parameters used in chromatography, classification of chromatographic methods, criteria for selection of stationary and mobile phase and nature of adsorbents. Principles of paper, thin layer, column chromatography. Column efficiency, factors affecting the column efficiency, van Deemter's equation and its modern version.

3 hrs

Paper chromatography: Theory and applications Thin layer chromatography (TLC): Mechanism, Rf value, efficiency of TLC plates, methodology–selection of stationary and mobile phases, development, spray reagents, identification and detection, qualitative applications.

4 hrs

Solvent Extraction: Types- batch, continuous, efficiency, selectivity, distribution coefficient, Nernst distribution law, derivation, factors affecting the partition, relationship between % extraction and volume fraction, Numerical problems on solvent extraction. Solvent extraction of iron and copper.

4 hrs

Ion exchange chromatography: resins, types with examples- cation exchange and anion exchange resins, mechanism of cation and anion exchange process and applications of ion-exchange chromatography (softening of hard water, separation of lanthanides, industrial applications).

3 Hrs

Unit-III

Polynuclear aromatic hydrocarbons – 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 reactions. Reduction and oxidation, structure of anthracene and phenanthrene.

4 hrs

Reaction Intermediates: Generation, Stability and Reactions of,

i) Carbocations: Dienone-phenol; and Pinacol-Pinacolone Baeyer-Villiger rearrangement, Beckmann rearrangement.

ii) Carbanions: Perkin Reaction, Aldol condensation, Claisen-Schmith condensation, Knoevenagel condensation.

iii) Free Radicals: Sandmeyer Reaction, Birch reduction, Antimarkownikoff's addition,Wurtz Reaction

IV) Carbenes – Singlet and Triplet states, their relative stability Reimer Tiemann reaction, Arndt-Eistert Synthesis

iv) Nitrenes: Singlet and Triplet states, their relative stability and Curtius reaction

v) Arynes: Formation, detection etc, nucleophilic substitution of p-chloro toluene with sodamide

7 hrs

Methods for Identifying Reaction Mechanism:

Product analysis, Isolation and Identification of Intermediates, Stereochemical

Evidences, Effect of Catalyst, cross over Experiments, Isotopic studies, Kinetic Studies.

3 hrs

Unit-IV

Stereochemistry of Organic Compounds:

Fischer projection, Newmann and Sawhorse projection formulae and their interconversions.

Geometric isomerism (*cis-trans* and *syn-anti* isomerism). Determination of configuration of geometric isomers (dipole moment, melting point and ring formation). E & Z system of nomenclature with C.I.P rules, geometric isomerism in oximes and alicyclic compounds.

Optical isomerism, plane of symmetry, Optical activity, Specific rotation, molecular chirality/asymmetry, stereo genic center, chiral and achiral molecules, enantiomers, properties of enantiomers, molecules with two or more chiral centers, optical activity in Example -Lactic acid and Tartaric acid. Diastereomers, threo and erythro diastereomers, meso structures, resolution of enantiomers (mechanical, Biochemical and chemical), inversion, and racemization, racemic mixture and resolution. Relative and absolute configuration, sequence rules, D/L, R/S systems of nomenclature.

Conformational isomerism — conformational analysis of ethane and 1,2-dichloroethane. Conformations of cyclohexane (Newman projection). Difference between configuration and conformation.

14 hrs

Pedagogy

Formative Assessment

Assessment Occasion/ type	Weightage in Marks
Internal Test	40
Sem End Exam	60
Total	100

PRACTICALS SEM III

PART-A (Analytical Chemistry)

1) Colorimetric determination of copper using ammonia solution

2) Colorimetric determination of iron using thiocyanate solution

3) Colorimetric determination of nickel using DMG solution

4) Colorimetric determination of titanium using hydrogen peroxide

5) Colorimetric determination of nitrite in a water sample (diazo coupling Reaction/Griess reagent

6) Colorimetric determination of phosphate as ammonium phosphomolybdate

7) Determination of Rf values of two or three component systems by TLC.

8) Separation of different metal ions by paper chromatography/ Solvent extraction of iron using oxine solution (demonstration)

PART-B (Organic Chemistry)

Qualitative analysis Systematic qualitative analysis of mono and bifunctional organic compounds. Such as

Mono-functional Organic Compounds - Phenol, oxalic acid, urea, benzoic acid, aniline, benzaldehyde, acetophenone, benzophenone, chlorobenzene, bromobenzene, nitrobenzene, benzamide – (At least 5 mono functional organic compounds to be analyzed in a semester)

Bi-functional Organic Compounds - Salicylic acid, p-Nitrobenzoic acid, Antranilicacid, p-Choro benzoic acid, o-Cresol-Cresol, Resorcinol-Nitrophenol, p-nitrophenol, o-Nitro aniline, p-Nitroaniline-Toluidine-Chloroaniline, p-Bromoaniline, Ethyl Salicylate, Salicylaldehyde, Acetophenone-Dichlorobenzene-Nitrotoluene, Benzamide etc. (At least 6-8 3-4 compounds)

References

1) Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, Pearson Education Pvt. Ltd. (2007)
2) Vogels Text Book of Qualitative Chemical Analysis, ELBS.

BSc Semester 3

Title of the Course: OE – 3: Structure, Bonding and concepts in Organic Chemistry

Number of Theory Credits	Number of lecture hours/semester	Number of Practical Credits	Number of practical hours/ semesters
3	42	-	42

Unit – 1 **14 Hrs**

Atomic Structure

General Introduction: Importance and scope of Chemistry. Dalton's atomic theory: concepts of elements, atoms and molecules. Discovery of electron, proton and neutron; atomic number, isotopes and isobars. Rutherford's model and its limitations. Bohr's model and its limitations, concept of shells and subshells, dual nature of matter and light, De Broglie's relationship, Heisenberg uncertainty principle, concept of orbitals, quantum numbers, shapes of s, p and d orbitals, rules for filling electrons in orbitals - Aufbau principle, Pauli exclusion principle and Hund's rule, electronic configuration of atoms, stability of half-filled and completely filled orbitals.

Unit - 2 **14 Hrs**

Bonding and Concepts in Organic Chemistry - I

General introduction, methods of qualitative and quantitative analysis. Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties. Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. Homolytic and Heterolytic fission with suitable examples.

Unit - 3 **14 Hrs**

Bonding and Concepts in Organic Chemistry – II

Electrophiles and Nucleophiles; Nucleophilicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes. Introduction to types of organic reactions andtheir mechanism: Addition, Elimination and Substitution reactions.

Aromaticity: Aromaticity and Huckel's rule, Aromaticity in benzenoid and non-benzenoid compounds, annulenes. antiaromaticity, homoaromaticity, non-aromatic compounds.

Text Books

1. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (PearsonEducation).
2. Finar, I. L. Organic Chemistry (Volume I), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. McMurry, J. E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.

4. Organic Reaction mechanism by V. K. AhIuwalia and K. Parashar (Narosa Publishers).
5. Organic Chemistry by S. M. Mukherji, S. P. Singh and R. K. Kapoor. (Narosa Publishers)
6. Advanced Organic Chemistry by J. Singh, L. D. S. Yadav (Pragati Prakashan).
7. A Textbook of Organic Chemistry by A. Bahl and B. S. Bahl, 22nd Edition, 2019 (S. ChandPublications).

Pedagogy

Formative Assessment	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test	40
Sem End Exam	60
Total	100

BSc Semester IV– Chemistry (Discipline Specific Core)

Title of the Course: G502 DC1.4: INORGANIC AND PHYSICAL CHEMISTRY - II

Number of Theory Credits	Number of lecture hours/semester	Number of Practical Credits	Number of practical hours/ semester
4	56	2	56

Unit - I

Structure and Bonding -I

The ionic bond :Structures of ionic solids

Radius ratio rules, Calculation of some limiting radius ratio values, Coordination number 3 (planar triangle), Coordination number 4 (tetrahedral and square planar), Coordination number 6 (octahedral), Close packing. **3hrs**

Classification of ionic structures:

Ionic compounds of the type AX (ZnS, NaCl, CsCI)

Ionic compounds of the type AX_2 (Calcium fluoride (fluorite) and Rutile structure Layer structures CdI_2 , Cadmium iodide structure

Limitations of radius ratio concept 2 hrs Lattice energy and Born-Haber cycle, Derivation of Born-Lande equation and its drawbacks, Kapustinskii equation, solvation energy and solubility of ionic solids,polarizing power and polarizability, Fajan's rules with applications.

Numerical problems **5 hrs**

Covalent bond: Valence bond theory, The Lewis theory,The octet rule, Exceptions to the octet rule, Sidgwick- Powell theory. Valence shell electron pair repulsion (VSEPR) theory, Effect of lone pairs, electronegativity, isoelectronic principle, Examples using VSEPR theory: BF_3 and BF_4^-, $NH_3$and NH_4^+, H_2O, PCl_5, CIF_3, SF_4, $I_3^-$and I_3^+, SF_6, and IF_7.

Limitations of VSEPR. **4 hrs**

Unit - II

Structure and Bonding -II

Concept of resonance, resonance energy, hybridisation, types of hybridization, sp, sp^2, sp^3 dsp^2 dsp^3, d^2sp^3, sp^3d^2 with one example each, and energetics of hybridization. Bent's rule, Limitations of Valence Bond Theory.

3 hrs

Molecular Orbital theory:

LCAO concept: s-s, s-p, p-p, p-d and d-dcombinations of orbitals, bonding, nonbonding and antibonding molecular orbitals, non-bonding combinations of orbitals,Rules for linear combination of atomic orbitals

Examples of molecular orbital treatment for homonuclear diatomic molecules H_2 molecule, H_2^+ He_2 molecule, He_2^+ molecule ion, Li_2 molecule, Be_2 molecule B_2 molecule, C_2 molecule, N_2 molecule,N_2^+,O_2 molecule, O_2^- and O_2^{2-} .

M.O. energy diagrams of heteronuclear diatomic molecules with examples (NO, NO^+ CO and HCl). Calculation of bond order, relationship between bond order, bond energy and bond length, magnetic properties based on MOT. **7 hrs**

Metallic Bonding:

General properties of metals : Conductivity, Lustre, Malleability and cohesive force Crystal structures of metals and Bond lengths

Theories of bonding in metals:

Free electron theory,Valence bond theory, Molecular orbital or band theory of solids Prediction of conducting properties of conductors. insulators and semiconductors, extrinsic and intrinsic semiconductors using M.O. theory. **4 hrs**

UNIT III

First Law of Thermodynamics

Thermodynamic Processes, Reversible and Irreversible Processes, Nature of Heat and Work,Internal Energy, First Law of Thermodynamics, Enthalpy of a System,Work done in isothermal and adiabatic expansion of an ideal gas, Numerical problems, Joule -Thomson Expansion, Relation between Joule-Thomson coefficient and other thermodynamic parameters.

Second law of Thermodynamics

Concept of entropy, thermodynamic scale of temperature, Statements of the Second Law of Thermodynamics, molecular and statistical interpretation of entropy, Calculation of entropy change for reversible and irreversible processes, Free Energy Functions: Gibbs and Helmholtz energy, Variation of S, G, A with T, V and P, Numerical problems, Free energy change and spontaneity, Gibbs-Helmholtz equation.

Third Lawof Thermodynamics

Statement of third law, concept of residual entropy, calculation of absolute entropy ofmolecules.
10 Hrs

Surface Chemistry Adsorption

Types of adsorption isotherms. Freundlich adsorption isotherm (only equation), its limitations. Langmuir adsorption isotherm (derivation to be done) and BET equation(derivation not included).

Catalysis

Types of Catalysis and theories with examples (intermediate compound theory and adsorption theory), Theory of acid base catalysis, Michaelis-Menten mechanism. Heterogeneous catalysis: surface reactions, unimolecular, bimolecular surface reactions. Autocatalysis with examples. Applications: Design process to removal of toxic compounds from industrial wastewater and treatment of portable water requirements.

4Hrs

UNIT IV

Chemical Kinetics

Differential and integrated form of rate expressions up to second order reactions, Derivation of expression of rate constant of second order reaction (a=b and a ≠ b), Problems on rate constant (a=b), Methods of determination of order of a reaction, temperature dependence of reaction rates; Arrhenius equation, activation energy, Numerical problems on Arrhenius equation in calculating energy of activation and rate constants. Collision theory of reaction
rates, Lindemann's mechanism, qualitative treatment of the theory of absolute reaction rates. Experimental determination of kinetics of (i) inversion of cane sugar by polarimetric method (ii) spectrophotometric method for the reaction between potassium persulphate and potassium iodide.
7 Hrs

Electrochemistry – I

Arrhenius theory of electrolytic dissociation. Merits and Demerits, Conductance, Specific conductance, equivalent and molar conductivity and their variation with dilution. Molar conductivity at infinite dilution. Numerical problems.

Kohlrausch's law of independent migration of ions and its applications, Debye-Hückel- Onsager equation. Ionic mobilities and their determinations, transference numbers and their relation to ionic mobility's, determination of transference numbers using Hittorf and Moving Boundary methods.

Applications of conductance measurement: (i) degree of dissociation of weak electrolytes (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts (iv) conductometric titrations (acid base titrations only) and (v) Hydrolysis constants of salts. Numerical problems.

7 Hrs

Reference Books

Peter Atkins & Julio De Paula, Physical Chemistry, 9th Ed., Oxford University Press(2010)

G W Castellan, Physical Chemistry, 4th Ed., Narosa (2004)

R G Mortimer, Physical Chemistry 3rd Ed., Elsevier: Noida, UP (2009)

B R Puri, L R Sharma and M S Pathania, Principal of Physical Chemistry, Vishal Publishing Co.

B S Bahl, G D Tuli and Arun Bahl, Essentials of Physical chemistry, S Chand & Company Ltd.

A S Negi and S C Anand, A textbook of Physical Chemistry, New Age International Publishers.

B N Bajpai, Advanced Physical chemistry, S Chand and Company ltd.

R L Madan, Chemistry for Degree Students, Semester I, II, III and IV, S Chand and Company Ltd.

P L Soni, O P Dharmarha and U N Dash, Textbook of Physical Chemistry, Sultan Chand and Sons.

Pedagogy

Formative Assessment	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test	40
Sem End Exam	60
Total	100

PRACTICALS SEM IV

Part A- Inorganic Chemistry Practicals

Qualitative semi-micro analysis of mixtures containing 2 anions and 2 cations. Emphasis should be given to the understanding of different reactions.

The following cations and anions are suggested.

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

Anions: CO_3^{2-}, CH_3COO^-, Cl^-, Br^-, I^-, NO_3^-, BO_3^{3-}, SO_4^{2-}, $C_2O_4^{2-}$ and PO_4^{3-}

Spot tests and flame tests to be carried out wherever possible.

Part B- Physical Chemistry Practicals

1. Determination of the enthalpy of neutralization of a strong acid with strong base.
2. Verification of Freundlich and Langmuir isotherms for adsorption of acetic acid onactivated charcoal.
3. The study of kinetics of potassium persulphate and potassium iodide volumetrically.
4. Determination of velocity constant for acid catalyzed hydrolysis of methyl acetate.
5. Determination of velocity constant for the saponification of ethyl acetate ($a = b$) volumetrically.
6. Determination of equivalent conductivity of strong electrolyte and verification of DHO equation.
7. Determination of dissociation constant of weak acid by conductivity method.
8. Conductometric titration of strong acid and strong base.
9. Conductometric titration of weak acid and strong base.
10. Determination of the hydrolysis constant of aniline hydrochloride conductometrically.
11. Determination of solubility product of sparingly soluble salt conductometrically.

References

1. Vogel's Qualitative analysis, Revised by G. Svehla, Pearson education,2002
2. J B Yadav, Advanced Physical Chemistry, Krishna Prakashan Media (P) Ltd,Meerut.
3. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R.Chand & Co.: New Delhi (2011).
4. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry8th Ed.; McGraw-Hill: New York (2003).
5. Halpern, A. M. &McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H.Freeman & Co.: New York (2003).

BSc Semester 3

Title of the Course: OE – 4: Electrochemistry, Corrosion and Metallurgy

Number of Theory Credits	Number of lecture hours/semester	Number of Practical Credits	Number of practical hours/ semesters
3	42	-	42

UNIT I

Electrochemistry

Conductance, specific and molar conductance Types of Electrolytes, Conductivity in electrolytic solution, Electrolysis, Kohlrausch's law and its application, Equivalent Conductance of Weak electrolyte at Infinite dilution.

Oxidation -reduction reactions, electrode potential, EMFof an electrochemical cell, cell reaction, Daniel cell, dry Cells - electrolytic and Galvanic cell, Representation of a cell. Standard electrode potential, Nernst equation (No derivation) and its application to chemical cell, Electrochemical series and its importance. Types of Electrodes.

Basic Principles of (i) Conductometric titrations- HCl Vs NaOH, CH_3COOH Vs NaOH

(ii) Potentiometric titrations: Acid-base titration HCl Vs NaOH,
Redox titration (FAS Vs $K_2Cr_2O_7$)
Determination of P^H using glass electrode. **12 hrs**

Batteries- Primary and Secondary batteries, Battery components and their role. Working of the following Batteries- Lead acid, Lithium Storage, Batteries, Fuel cells. **2 hrs**

UNIT II

Corrosion: Introduction, definition, Types of Corrosion, Corrosion rate, Factors affecting corrosion rate, Metallic factor-purity, electrode potential of metal, hydrogen over voltage, natureof corrosion product. Environmental Factors- Temperature, pH of the medium, humidity, presence of impurities, electrical conductivity of the medium, velocity of the medium, concentration of the medium.

Prevention of Corrosion: Material selection - Metals and alloys, metal purification, non- metallic, Alteration of environment - Changing media, inhibitors, Design-wall thickness, design rules, Coating-Metallic and other inorganic coatings, organic coating.

Electroplating: Introduction, Electroplating of chromium (hard and decorative). Electro less plating: Introduction, distinction between electroplating and electroless plating processes. Electroless plating of copper. **14 hrs**

UNIT III

Metallurgy

Introduction: Ore, minerals, important ores of some common elements in India, General Principles of pyrometallurgy, roasting, Calcination, Gangue, Smelting, Flux, Gravity separation, Froth flotation process, leaching. Techniques employed for Purification of metal (Distillation process, Bessemerization, Electro-refining, Van Arkel and De Boer's Filament.

6 hrs

Extraction of metals: Extraction of Manganese (Pyrolusite), Titanium (Ilmanite) and Uranium.

4 hrs

Alloys: Introduction, Classification of alloys, commercially important alloys, gold karats, Production of Ferro alloys; Ferrochrome, Ferro Manganese, Uses of alloys. **4 hrs**

Reference Books

1. Barrow. G.M, Physical Chemistry, Tata McGraw-Hill, (2007)
2. An introduction to electrochemistry, Samuel Glasstone, East-West edition New Delhi, (1942)
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Pedagogy

Formative Assessment	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test	40
Sem End Exam	60
Total	100