

Date:

From

Chairperson, BOS in Chemistry
Poornaprajna College (Autonomous),
Udupi

To,

The Principal,
Poornaprajna College (Autonomous),
Udupi

Respected Sir,

Sub: Submission of Syllabus copy of Chemistry UG courses (SEP 2024)

With reference to the above subject, I am herewith submitting the syllabus copy of Chemistry for I and II semester UG courses. The syllabus is prepared, discussed and approved by the Board of Studies of Chemistry. The syllabus is prepared according to the norms of State Education Policy-2024. The proposed copy of syllabus is enclosed herewith for your kind perusal and needful action.

Thanking you

Yours Faithfully

Chairperson, BOS

Board Members and Special Invitees:

- | | | |
|---|---|--|
| 1 | Dr. Mahesh Bhat
Head, Department of Chemistry
Poornaprajna College (Autonomous), Udupi | Chairperson |
| 2 | Dr. M. R. Maddani
Assistant Professor
DoS in Chemistry
Mangalore University, Konaje | Member
(University
Representative) |
| 3 | Dr. Preethi Kumari P
Associate Professor,
Department of Chemistry MIT, MAHE,
Manipal -576 105 | External Member |
| 4 | Dr. Ashwini
Associate Professor - Stage I
Department of Chemistry,
St Aloysius (Deemed to be University),
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| 5 | Dr. Nagabhushana
Senior Manager R&D
Manipal Technologies Limited, Manipal | Member
(Industrial
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| 6 | Mr. Puneet Tendulkar
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| 6 | Dr Rangaswamy J
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Department of Chemistry
Poornaprajna College (Autonomous), Udupi | Member |
| 7 | Mrs. Suparna
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Department of Chemistry
Poornaprajna College (Autonomous), Udupi | Member |

POORNAPRAJNA COLLEGE (AUTONOMOUS), UDUPI

NAAC Re-Accredited “A+” (3.27 CGPA)

(Promoted and Managed by Udupi Shree Adamaru Matha Education Council, Bengaluru)



SYLLABUS FOR UNDER GRADUATE PROGRAM (UG) OF CHEMISTRY CURRICULUM FRAMEWORK

Course pattern and scheme of examination for UG Courses

**FRAMED ACCORDING TO THE
STATE EDUCATION POLICY (SEP 2024)**

Program Name

B.Sc.

CHEMISTRY

I & II SEMESTERS

TO IMPLEMENT FROM THE ACADEMIC YEAR 2025-26

Board of studies in Chemistry

POORNAPRAJNA COLLEGE (AUTONOMOUS),

UDUPI - 576101

SYLLABUS FOR CHEMISTRY
UNDERGRADUATE COURSES
SEMESTER SCHEME 2025-26 ONWARDS

PREAMBLE

Program Name: B.Sc.

Course Title: Chemistry

Including all the six semesters in B.Sc. offer hardcore, softcore and open elective course papers with credits to each course amounting to 146 for the entire VI semesters.

Program outcome:

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

1. Understand the applications of chemistry in various fields.
2. Get the broad and balanced knowledge of chemistry.
3. Develop practical skills which can be applied in actual practice.
4. Get the knowledge and skill towards employment and higher education.

Course Pattern

Core	Paper	Title of the Paper & Code	Instruction Hours	Duration of Exam (Hrs)	Max. Marks			Credits
					Exam	IA	Total	
I Semester								
Subject	Theory	Chemistry Paper I BSCHCS101	4	3	80	20	100	3
	Practical	Chemistry Practical I - Volumetric Analysis BSCHPS101	4	4	40	10	50	2
Total number of credits for chemistry in I semester: 05								
II Semester								
Subject	Theory	Chemistry Paper II BSCHCS201	4	3	80	20	100	3
	Practical	Chemistry Practical II - Qualitative Organic Analysis and Chromatography BSCHPS201	4	4	40	10	50	2
Total number of credits for chemistry in II semester: 05								

Objectives of The Syllabus:

- To acquire knowledge and skills in the field of chemistry
- To generate manpower trained in chemistry to meet the need of industry and academia and to pursue higher studies
- To appreciate, understand and use the scientific method in the solving of problems
- To develop the ability to disseminate chemical information effectively
- To acquire good laboratory skills and practice safety measures while handling chemicals
- To understand safe disposal of chemical waste contributing to environmental sustainability
- To apply chemical knowledge to real world situations
- To develop their personality with the necessary skills
- To get good placement

Program Outcome:

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

1. Understand the applications of chemistry in various fields.
2. Get the broad and balanced knowledge of chemistry.
3. Develop practical skills which can be applied in actual practice.
4. Get the knowledge necessary for employment and higher education.

BASIS FOR INTERNAL ASSESSMENT, PATTERN OF THEORY QUESTION PAPERS AND PRACTICAL EXAMINATION

1. Basis of Internal Assessment in Theory and Practicals. The internal assessment marks in theory papers shall be based on two tests. The tests shall be at least 1 hour duration each and to be conducted after 6 and 12 weeks after the start of a semester. The average of the two tests shall be taken as the internal assessment marks in theory papers.

The practical internal assessment marks shall be based on one test and continuous evaluation during the practical classes. The practical test shall be conducted after 10 weeks after the start of a semester. The average of the test and continuous evaluation shall be taken as the internal assessment marks in practicals.

2. Theory Question Papers Pattern:

Theory Question Papers shall carry 80 marks. The Question Paper shall consist of Parts A and B, as detailed below.

Part A: Part A Shall contain 12 short answer type questions (Q.No 1'a' to '1') drawn from all the 4 units (3 questions per unit) carrying 2 marks each. 10 questions are to be answered (10x2=20 marks.)

Part B: Part B shall contain eight questions (Q. Nos 2 to 9) carrying 15 marks each drawn from all the four units (2 questions per units). There shall be four divisions per question. The students are required to answer 4 questions, choosing one full question from each unit. (4x15=60 marks.)

	Unit -I		Unit-II		Unit -III		Unit-IV	
Q. Nos (Max Maks 15)	2	3	4	5	6	7	8	9
Marks Splitting	4+4+4+3	3+3+5+4	4+4+4+3	3+3+5+4	4+4+4+3	3+3+5+4	4+4+4+3	3+3+5+4

I Semester

Chemistry Paper-I [BSCHCS101]

[4 HOURS PER WEEK (14X4=56)]

Learning Objectives:

This course helps to understand the following basic aspects of chemistry

1. Principles of chemical kinetics and theories of reaction rate.
2. Chemical and physical characteristics of solvents.
3. Different aspects of adsorption process.
4. Nature of chemical bonds in molecules.
5. Fundamentals of reaction mechanism
6. Basic methods of qualitative and quantitative analysis.

Course Outcome:

On completion of this course, the student will be able to appreciate the following aspects.

1. Principles of chemical kinetics and different theories of reaction rate.
2. Adsorption isotherms and adsorption by liquids.
3. Physical and chemical properties of solvents.
4. Nature of bonding in organic molecules and criteria for aromaticity, resonance, hyper conjugation etc.
5. The concepts of Organic reactions and techniques of writing the reaction mechanism
6. Basics of analytical methods and chromatographic techniques.
7. Analytical skills involved in volumetric analysis.

UNIT-I

Chemical Kinetics :

5 Hours

Concentration dependence of rates, differential rate laws of simple chemical reactions, Zero, First, Second, nth and pseudo first order reaction. Derivation of rate constants for second order and nth order reactions with equal initial concentrations. Determination of order of a reaction- Differential, Integration, Half life period and Isolation methods. Transition state theory- Derivation of relationship between rate constant and equilibrium constant. Thermodynamic aspects of activation.

Surface Chemistry:

4 Hours

Adsorption of gases on solids: Freundlich and Langmuir adsorption isotherms. Multilayer adsorption-BET equation. Determination of surface area and area of cross section of a molecule. Adsorption from solution - Gibb's Adsorption isotherm.

Solvents:

5 Hours

Physical properties of a solvent - density, dipole moment, specific conductance, dielectric constant. Types of solvents - classification into protic - aprotic, acidic - basic - amphiprotic, ionizing - non ionizing (examples) solvents, Characteristics- liquid range, auto ionization and solvating properties. Reactions in aqueous and non-aqueous solvents (explanation with examples). Water-hydration, hydrolysis, acid-base, reduction-oxidation, complex formation and precipitation. Ammonia- ammoniation, ammonolysis, acid-base, reduction-oxidation, complex formation, precipitation, alkali metals in ammonia. Levelling effect of solvents - examples.

UNIT II

Chemical Bonding

14 Hours

Covalent bond-Valence bond theory-Concept of hybridization, Valence Shell Electron Pair Repulsion (VSEPR) theory, Comparative study of structure and bonding between F_2O and H_2O , H_2S and H_2O , NH_3 and NF_3 , ClF_3 and $XeOF_2$. Basic principle of Molecular orbital theory. Molecular orbital diagrams of homo and hetero nuclear species- N_2 , O_2 , CO , NO and CN^- . Ionic bond- Lattice energy, Born-Landé equation, Solvation and Solubility of ionic solids. Polarising power and Polarizability of ions. Fajan's rules to explain bond character, covalent character of ionic compounds, relative covalent character. Comparative trend in properties: a) Melting point-e.g: $NaBr$, $MgBr_2$, $AlBr_3$; LiF , $LiCl$, $LiBr$, LiI ; $CaCl_2$, $HgCl_2$ b) Solubility-e.g AgF , $AgCl$, $AgBr$, AgI c) Thermal stability-e.g $BeCO_3$, $MgCO_3$, $CaCO_3$, $SrCO_3$, $BaCO_3$. Metallic Bond-Application of Band theory.

UNIT III

Nature of Bonding In Organic Molecules:

3 Hours

Localised and Delocalised bonds. Conjugation and Cross conjugation. Resonance. Aromaticity-Huckel rule, explanation with examples. Antiaromaticity. Hyper conjugation- relative stabilities of primary, secondary and tertiary carbonations. Electron displacements in covalent bond. Inductive effect and Field effect – Explanation with examples. Concepts of organic acids and bases. Relative strengths of aliphatic and aromatic carboxylic acids-Acetic acid with Chloroacetic acid, Propionic acid and Benzoic acid. Anomalous basic strength of tertiary alkyl amines. Steric

effect- Relative stabilities of trans and cis-2-butene, relative reactivities of alkyl halides in S_N2 reaction, steric hindrance in esterification of acids.

Mechanism of Organic Reactions

7 Hours

Breaking and making of covalent bonds. Notations used to represent electron movements and directions of reactions- arrows, curved arrows, half-headed and double-headed arrows. Types of bond breaking- homolytic and heterolytic. Substrate and reagent. Types of reagents-Electrophiles and Nucleophiles- explanation with examples. Types of organic reactions - Substitution, Addition, Elimination and Rearrangement reactions, explanation with examples. Reactive intermediates- Carbo cations, Carbanions, free radicals, carbenes, arynes and nitrenes- explanation with examples. Mechanism of Friedel–Craft’s reaction, Cannizzaro reaction, Hofmann rearrangement, Addition of HCN and NaHSO₃ to carbonyl compounds. (benzaldehyde and acetophenone).

Electrophilic Addition to Carbon-Carbon Multiple Bonds

4 Hours

Addition of halogens to alkenes-carbocation and halonium ion mechanisms. Stereo specificity of halogen addition. Limitations of open carbocation mechanism. Ozonolysis - Mechanism of ozonolysis of propene. Addition of hydrogen halides to alkenes mechanism, regioselectivity and relative rates of addition. Markownikoff’s and AntiMarkownikoff’s addition of HBr to propene. Hydrogenation, hydration, hydroxylation and epoxidation of alkenes- Explanation with examples. Electrophilic addition to conjugated dienes- mechanism of addition of HBr to 1,3-butadiene, effect of temperature. Free radical addition to 1,3-butadiene. Diels-Alder reaction and its importance, 1,3- Dipolar cycloaddition and Pericyclic reaction-explanation with example.

UNIT IV

Chromatography

3 Hours

Chromatographic methods for the separation, concentration and identification of organic compounds-Thin layer, paper and column chromatography. R_f value and its significance. Principle and applications of Gas chromatography.

Methods of Analysis

7 Hours

Qualitative analysis - Sample size and techniques- macro, semi micro and micro. Type of tests-wet, dry and spot tests. Quantitative analysis - Volumetry, Gravimetry and Instrumental analytical methods. Principles of gravimetric analysis-methods of precipitation, optimum conditions for precipitation, co- precipitation and post precipitation. Solvent extraction-basic principles and applications. Errors in quantitative analysis, types of errors- determinate and indeterminate, methods of minimising 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. (Numerical problems to be solved wherever necessary).

Periodic Properties

4 Hours

Methods of determination of atomic properties -Atomic size by Lande's method, Ionization energy by Discharge tube method, Electron affinity from Born-Haber cycle and Electronegativity from Pauling and Mulliken scales. Predicting and explaining the chemical behaviour of elements on the basis of periodic properties (metallic/non metallic, ionic/covalent, reducing/oxidizing). Effective nuclear charge-shielding effect. Slater's rule and its applications.

CHEMISTRY PRACTICALS – I Volumetric Analysis -BSCHPS101

[4 HOURS PER WEEK (14X4=56)]

Objectives: To understand the concepts and develop the skill of volumetric analysis.

Course Outcome: After the completion of the course, the student will develop the skill of analysis by volumetric methods.

Volumetric Analysis

1. Microscale experiment-Two burette titration and beral pipette titration.
2. Preparation of standard sodium carbonate solution, standardization of hydrochloric acid and estimation of sodium hydroxide in solution.
3. Preparation of standard solution of potassium biphthalate, standardization of sodium hydroxide solution and estimation of hydrochloric acid in solution.
4. Preparation of a standard solution of oxalic acid, standardization of potassium permanganate solution and estimation of Mohr's salt in solution.
5. Preparation of standard ferrous ammonium sulphate solution, standardization of Potassium dichromate solution and estimation of ferric chloride in solution.
6. Preparation of standard potassium dichromate solution, standardization of sodium thiosulphate solution and estimation of copper sulphate in solution.
7. Estimation of a mixture of oxalic acid and sulphuric acid in a solution using standard Potassium permanganate solution and standard sodium hydroxide solution.
8. Estimation of calcium content in lime stone as calcium oxalate by permanganometry.
9. Estimation of hardness of water by EDTA method.
10. Estimation of manganese in pyrolusite by volumetric method.
11. Determination of acetic acid in commercial vinegar using NaOH.
12. Determination of alkali content in antacid tablet using HCl.
13. Estimation of glucose using iodine and sodium thiosulphate.
14. Estimation of Vitamin C.

Reference Books

1. A Text Book of Inorganic Chemistry-P.L.Soni.1998, Sultan Chand and Sons.
2. A Text Book of inorganic Chemistry-Puri and Sharma 2000, Shobanlal Nagin Chand.
3. A Text Book of inorganic Chemistry- s Educational Publishers.
4. A Text Book of inorganic Chemistry-Sathya Prakash, 2001.
5. A Text Book of Quantitative analysis- A.I_Vogel, ELBS.
6. Physical Chemistry by Samuel Glasstone, 1982 ELBS.
7. A Text Book of Physical Chemistry by P.L.Soni , O.P. Dharmarha and U.N.Dash, Sultan Chand and Sons.
8. Physical Chemistry-Madan and Tuli,2001, S.Chand. NEW DELHI.
9. A Text Book of Advanced Physical Chemistry-Gurudeep Raj 2001, Goel, Meerut
10. Organic Reaction mechanism by V.K.Ahluwalia and R.K.Parashar(Narosa Publishers).
11. Organic Chemistry by S.M.Mukherji, S.P.singh and R.K.Kapoor.(Narosa Publishers)
12. A Guide book to mechanism in Organic Chemistry by Peter sykes. Pearson.
13. Instrumental methods of Chemical analysis. Willard, Merritt, Dean and Skettle, CBS Publishers.
14. Instrumental methods of Chemical analysis -Gurudeep R.Chatval and Sham Anand, 1998, Himalaya Publishing House.

II SEMESTER
Chemistry Paper-II [BSCHCS201]
[4 HOURS PER WEEK (14X4=56)]

Learning objectives:

This course helps to understand the following aspects of chemistry

1. The structure and properties of solids, Liquid Crystals and Gases.
2. General characteristics and properties of s and p block elements.
3. The reaction intermediates of organic reactions and predicting the reaction mechanism.
4. Basic concepts of electrophilic and nucleophilic reactions.
5. Characteristics of chemical compounds of industrial importance.

Course Outcomes:

On completion of this course, the student will be able to appreciate the following aspects.

1. Molecular structure of solids and their properties.
2. Different types of liquid crystals and their applications.
3. Thermodynamic properties of gases.
4. Applications of chemicals in daily life.
5. General characteristics and properties of s and p block elements.
6. Organic reaction pathways and writing the reaction mechanism.
7. Basic concepts of electrophilic and nucleophilic substitution reaction

UNIT I

Solid State

7 Hours

Laws of crystallography: Law of constancy of interfacial angle-explanation taking hexagonal crystal system as an example. Law of symmetry. Elements of symmetry- axis of symmetry, plane of symmetry and centre of symmetry- explanation taking cubic crystal system as an example. Law of rationality of indices. Miller indices- calculation of Miller indices for different planes in a cubic crystal system. Bravais lattices. X-ray diffraction by crystals. Derivation of Bragg's equation. Determination of crystal structure of NaCl and determination of Avogadro number. Caesium Chloride, Zinc blende structures (numerical problems to be discussed).

Liquid Crystals

2 Hours

Explanation, classification with examples - smectic, nematic, cholesteric, disc shaped and polymeric. Structures of nematic and cholesteric phases- molecular arrangements in nematic and cholesteric liquid crystals. Application of liquid crystals in LCDs and thermal sensing.

Gaseous State

5 Hours

Maxwell's distribution of molecular velocities- explanation with graph. Most probable, average and RMS velocities and the relation between them. Qualitative discussion of the collision number, mean free path and collision diameter. Critical phenomena: P-V isotherms of real gases – Andrews's isotherms of carbon dioxide. Continuity of states principles. Isotherms of van der Waal's equation. Relationship between critical constants and Van der Waals constants-derivation of the expressions for a, b, T_c , P_c and V_c , Law of corresponding states- statement, reduced equation of state- derivation of the equation.

UNIT II

s-Block Elements:

6 Hours

Hydrogen-position of hydrogen in the periodic table. Hydrides-types, preparation, properties and applications. Structure of NaH and BeH_2 . Complex hydrides- $LiAlH_4$, $NaBH_4$. Preparation and applications. Comparative study of Li and Be with other members of the same group. Comparative study of lattice energy, enthalpy of formation, enthalpy of hydration and solubilities of alkali metal and alkaline earth metal halides, hydroxides and sulphates. Comparison of standard reduction potentials and reducing properties of alkali metals and alkaline earth metals. Complexation tendencies of alkali metals with crown ether, Cryptates.

p-Block Elements:

8 Hours

Comparative study of p-Block elements and their compounds-comparison between Boron and other members of the group.

Boranes: Diborane- Preparation, properties, structure and bonding, chemical evidences for the presence of bridge hydrogen. B_4H_{10} , B_5H_9 , Preparation and structure, Styx number, Wade's rule-Closo, Nido and Arachno boranes. Silicates-types, basic units, structure and applications. Hydrazine and hydroxylamine-structure and reducing property. Hypophosphorous acid, phosphorous acid, phosphoric acid, orthophosphoric acid, meta phosphoric acid and pyro phosphoric acid- structure. Halogens in positive oxidation state. Inter halogen compounds- ICl , BrF_3 , IF_5 and IF_7 - preparation, properties, structure and uses. Noble gases- Structure and bonding in: Clathrates, XeF_2 , XeF_4 , XeF_6 and XeO_3 .

UNIT III

Reactions Involving Intermediates:

6 Hours

- Generation, stability and mechanism of reactions
- i) Carbocations - Dienone- phenol rearrangement
 - ii) Carbanions- Perkin reaction, Aldol condensation and Claisen condensation
 - iii) Free radicals- Sandmeyer's reaction
 - iv) Nitrenes - Hofmann rearrangement, Curtius rearrangement
 - v) Carbenes-Reimer-Tieman reaction
 - vi) Arynes-Benzyne mechanism for the conversion of Bromobenzene to aniline.

Methods of determination of reaction mechanism-Product analysis, intermediates, isotope effects, kinetic and stereo- chemical studies.

Nucleophilic Substitution at Saturated Carbon **2 Hours**

Mechanism of S_N1 and S_N2 reactions with suitable examples and energy profile diagrams. Stereochemistry and factors affecting S_N1 and S_N2 reactions.

Elimination Reactions **2 Hours**

Mechanism of E_1 and E_2 - explanation with suitable examples, evidences, orientation and stereochemistry. Hoffmann and Saytzeff rules.

Aromatic Electrophilic and Nucleophilic Substitutions **4 Hours**

Aromatic electrophilic substitution-General mechanism with energy profile diagram. Role of σ and π - complexes. Activating and de-activating substituents, Orienting influence, orthopara ratio. Nucleophilic aromatic substitution reactions- Addition-elimination and Elimination-addition mechanism.

UNIT IV

Industrial Chemistry **14 Hours**

Fuels: Composition, production and applications of natural gas, water gas, producer gas, LPG and bio gas.

Propellants: Characteristics and applications.

Glass: Raw materials, manufacture-tank furnace, steps in manufacture and annealing of glass. Types of glasses: composition and uses of - hard, soft, Pyrex, jena, flint, safety, optical, fibre, coloured and Crooke's glasses.

Cement: Raw materials, manufacture of cement, mechanism of setting of cement. RCC composition and uses.

Ceramics: Raw materials used in modern ceramics, stages in ceramic making, glazing, applications of porcelain.

Paints: Constituents of paints and their functions with examples. Manufacture of white lead and lithopone.

Refractories: Characteristics, classification with examples and applications.

Abrasives: Natural abrasives, synthetic abrasives, characteristics and applications. Silicon carbide and boron nitride- structure and production.

Cane sugar: Outline of production and composition, molasses, its composition.

Paper: Production of wood pulp and preparation of paper.

Chemical fertilizers: Primary nutrients, different types of fertilizers, importance, production of urea, CAN and superphosphate of lime.

Chemistry Practical-II
Qualitative Organic Analysis and Chromatography- BSCHPS201
[4 hrs/week (14 x 4 = 56 hours)]

Objectives:

To understand the concepts and develop the skill of qualitative analysis.

Course Outcome:

After the completion of the course, the student will develop the skill of chromatographic technique and qualitative organic analysis.

I. Systematic qualitative analysis of mono and bifunctional organic compounds.

Determination of melting point/boiling point. Preparation of suitable solid derivative. Following compounds may be given - Resorcinol, oxalic acid, urea, thiourea, thiophenol, benzoic acid, salicylic acid, phenol, p-cresol, aniline, p-nitroaniline, p-toluidine, benzaldehyde, ethyl methyl ketone, acetophenone, benzophenone, chlorobenzene, bromobenzene, nitrobenzene and benzamide. 8 weeks

II. Thin Layer Chromatography: Any two of the following. 2 weeks

Determination of R_f values and identification of organic compounds,

- a) Separation of green leaf pigments (Spinach leaves may be used),
- b) Preparation and separation of 2,4-dinitrophenylhydrazones of acetone, 2-butanone, hexan-2- and 3-one using toluene and light petroleum (40:60)
- c) Separation of a mixture of dyes using cyclohexane and ethyl acetate (8.5: 1.5)

III. Paper Chromatography: Ascending and Circular. Any two of the following: 2 weeks

Determination of R_f values and identification of organic compounds,

- a) Separation of a mixture of phenylalanine and glycine, Alanine and aspartic acid, Leucine and glutamic acid. Spray reagent-ninhydrin.
- b) Separation of a mixture of D, L-alanine, glycine, and L-Leucine using n- butanol, acetic acid-water (4:1:5). Spray reagent-ninhydrin,
- c) Separation of monosaccharides-mixture of D-galactose and D- fructose using nbutanol: acetone: water (4:5:1), Spray reagent - aniline hydrogen phthalate.

IV. Column Chromatography: 2 weeks

- a) Separation of fluorescein and methylene blue.
- b) Separation of leaf pigments from spinach leaves.

Reference Books

1. A Text Book of Inorganic Chemistry-P.L.Soni.2013, Sultan Chand and Sons.
2. A Text Book of inorganic Chemistry-B.R.Puri and L.R. Sharma 2000,Shobanlal Nagin Chand.
3. A text book of Inorganic chemistry-Gurdeep Raj, Krishna Prakashan , 2020.
4. A text book of Inorganic Chemistry-Sathya Prakash, 2001, S.Chand.
5. A Text Book of Quantitative Chemical Analysis- A.I.Vogel, 1989, Longman Group.
6. Physical Chemistry by Samuel Glasstone, 1982, ELBS.
7. A Text Book of Physical Chemistry by P.L.Soni , O.P. Dharmarha and U.N.Dash, 2023, Sultan Chand and Sons.
8. Physical Chemistry-Madan R.L.and Tuli G.D.,2010, S.Chand, New Delhi.
9. A Text Book of Advanced Physical Chemistry-Gurdeep Raj 2009, Goel, Meerut
10. Organic reaction mechanism by V.K.Ahluwalia and R.K.Parashar 2011,Narosa, New Delhi.
11. Organic Chemistry by S.M.Mukherji, S.P.Singh and R.K.Kapoor, 2012, New Age International.
12. A Guide Book to Mechanism in Organic Chemistry by Peter Skypes, 2003, Pearson.
13. Instrumental Methods of Chemical Analysis. Willard, Merritt, Dean and Skettle, 2004, 9, CBS Publishers.
14. Instrumental Methods of Chemical Analysis -Gurdeep R.Chatwal and Sham K. Anand, 2011, Himalaya Publishing House.