University of Mumbai, Mumbai

R.P. Gogate College of Arts & Science
&
R.V. Jogalekar College of Commerce
(Autonomous)
Ratnagiri

Syllabus for

S.Y. B.Sc.

(Chemistry)

Semester III and IV

Under Choice Based Credit System (CBCS)

As Per framework of NEP 2020

With effect from the academic Year 2024-2025

New Skill Enhancement Courses w. e. f. 2025-2026

Revised Scheme of Examination
Faculty of Science
(Under-graduate Programme)
Choice Based Credit System (CBCS)
As Per framework of NEP 2020
Scheme of Examination

Bachelor of Science (B.Sc.) Programme

The performance of the learners shall be evaluated into two parts. The learner's performance shall be assessed by Internal Assessment with 40% marks and by conducting the Semester End Examinations with 60% marks. The allocation of marks for the Continuous Internal Evaluation and Semester End Examinations are as shown below-

A) Continuous Internal Evaluation: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Unit Test (MCQ / Descriptive – Based on Theory and/or Problems - Online/Offline – 1 unit test of 10 marks	10
02	Assignment / seminar / class test / worksheets	05
03	Active participation in routine class instructional deliveries and Overall conduct as a responsible learner.	05

B) Semester End Examination: 60% (30 Marks)

30 Marks per paper Semester End Theory Examination:
1. Duration - These examinations shall be of one hour duration.
2. Theory question paper pattern:
a. There shall be 03 questions each of 10 marks on each unit.
b. All questions shall be compulsory with internal choice within the questions.

Standard of Passing

The learner to pass a course shall have to obtain a minimum of 40% marks in aggregate for each course where the course consists of Continuous Internal Evaluation and Semester End Examination. The learner shall obtain minimum of 40% marks (i.e. 8 out of 20) in the Internal Assessment and 40% marks in Semester End Examination (i.e. 12 out of 30) separately, to pass the course and minimum of Letter Grade "P" in the project component, wherever applicable to pass a particular semester. A learner will be said to have passed the course if the learner passes the Continuous Internal Evaluation and Semester End Examination together.

Performance Grading:

Letter Grades and Grade Points

Semester GPA/ Program CGPA Semester/Program	**% of Marks**	**Alpha-Sign / Letter Grade Result**
9.00-10.00	90.0 -100	0 (Outstanding)
8.00 ≤ 9.00	80.0 ≤ 90.0	A+ (Excellent)
7.00 ≤ 8.00	70.0 ≤ 80.0	A (Very Good)
6.00 ≤ 7.00	60.0 ≤ 70.0	B+ (Good)
5.50 ≤ 6.00	55.0 ≤ 60.0	B (Above Average)
5.00 ≤ 5.50	50.0 ≤ 55.0	C (Average)
4.00 ≤ 5.00	40.0 ≤ 50.0	P (Pass)
Below 4.00	Below 40	F (Fail)
Ab (Absent)	-	Absent

B.Sc. Programme

Under Choice Based Credit System (CBCS)
Course Structure (Autonomous)
Second Year BSc

Semester III	Credits	No of Hours	Semester IV	Credits	No of Hours
Major					
Physical and Basics of Analytical Chemistry I 24_USCH301	**02**	**30**	Physical and Basics of Analytical Chemistry II 24_USCH401	**02**	**30**
Inorganic and Basics of Analytical Chemistry I 24_USCH302	**02**	**30**	Inorganic and Basics of Analytical Chemistry II 24_USCH402	**02**	**30**
Organic and Basics of Analytical Chemistry I 24_USCH303	**02**	**30**	Organic and Basics of Analytical Chemistry II 24_USCH403	**02**	**30**
Chemistry Practical III 24_USCH304	**02**	**60**	Chemistry Practical IV 24_USCH404	**02**	**60**
Minor					
Basic Analytical Chemistry – I 24_USCH305	**02**	**30**	Basic Analytical Chemistry – II 24_USCH405	**02**	**30**
Chemistry minor practical I 24_USCH306	**02**	**60**	Chemistry minor practical II 24_USCH406	**02**	**60**
Skill Enhancement Course					
Skills in Classical Method Analysis II 24_USCH307	**02**	**60**	Industrial Organic Chemistry 24_USCH407	**02**	**60**
OR					
Skill Course in Water Quality testing 25_USCHS308	**02**	**60**	Skill Course in Soil Analysis 25_USCHS408	**02**	**60**
Community Engagement & Service (CEP) Elective course					
			Community Engagement and services 24_USCHC408	**02**	**60**

Name of Programme	B.Sc.
Level	UG
No of Semesters	02
Year of Implementation	2024-25
Programme Specific Outcomes (PSO)	1. Acquire the fundamental knowledge of the main branches of chemistry viz. Physical, Inorganic, Organic and Analytical 2. Identify and separate components of organic or inorganic origin and will also be able to analyze them by making use of the instrumental methods viz. potentiometer, pH meter, colorimeter etc. 3. Inculcate the skills useful in chemistry laboratory. 4. Acquire and explore essential skills to succeed in various chemical industries. 5. Appreciate the central role of chemistry in our society and use this as a basis for ethical behavior in issues facing chemists including an understanding of safe handling of chemicals, environmental issues and key issues facing our society in terms of energy, health and medicine.
Relevance of PSO's to the local, regional, national, and global developmental needs (200 words)	The Bachelor of Science in Chemistry programme equips the candidate with knowledge, general competence, and analytical skills on an advanced level, needed in industry, consulting, education, and research and public and private administration. On completion of the programme, the learner will be able to: 1. Identify, formulate and analyze scientific problems and reach concrete solutions for societal benefits using various principles of chemical sciences. 2. Introduce the concepts useful for industries viz. Pharmaceutical, dyes, bulk chemical 3. Monitor and assess regional environmental issues and Industry process effectively.

Syllabus for B.Sc. Chemistry from the year 2024-25

Nomenclature of the Course	Physical and Basics of Analytical Chemistry I
Class	S.Y.B.Sc.
Semester	III
Course Code	24_USCH 301
No. of Credits	02
Nature	Theory
Type	Major

Course Outcomes: On successful completion of this course learners will be able to

CO1 :	Discuss the basics of the thermodynamic properties, basic types of free energy, Gibb's-Helmholtz free energy, Thermodynamics of open system, concept of fugacity activity. Explain applications of electrochemistry in terms of migration of ions and explain concept of transference number.
CO2 :	Describe the concept of reaction mechanism, types of complex chemical reactions; discuss thermodynamics of ideal solutions; explain partial miscibility of liquids and immiscibility of liquids; Elaborate nernst distribution law & its applications.
CO3 :	Explain terms involved in titrimetric methods of analysis conditions suitable for types titrimetry; discuss types of titrimetry; Illustrate tools of titrimety; standard solutions; Explain concept of neutralization titrations; Describe the concept of gravimetric analysis.

Nomenclature: Physical & Basics of Analytical Chemistry I			
Unit No.	Unit Title	Sub titles (Learning Points)	No of Hours
Unit- I	**Chemical Thermodynamics-II and Electrochemistry**	1.1 Free Energy Functions: Helmholtz Free Energy, Gibb's Free Energy, Variation of Gibb's free energy with Pressure and Temperature. 1.2 Gibbs-Helmholtz equation, van't Hoff reaction isotherm and van't Hoff reaction isochore. (Numericals are expected). 1.3 Thermodynamics of Open System: Partial Molal Properties, Chemical Potential and its variation with Pressure and Temperature, Gibb's Duhem equation. 1.4 Concept of Fugacity and Activity 1.5 Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. 1.6 Kohlrausch law of independent migration of ions. 1.7 Applications of conductance measurements: determination of degree of ionization and ionization constant of weak electrolyte, solubility and solubility product of sparingly soluble salts, ionic product of water. (Numericals expected). 1.8 Transference number and its experimental determination using Moving boundary method. (Numericals expected). Factors affecting transference number.	10
Unit – II	**Chemical Kinetics –II and Solutions**	2.1 Introduction to reaction mechanism (concept of elementary steps, intermediates, and the overall reaction mechanism with an example of Thermal chain reactions: H_2. and Br_2. reaction. 2.2 Types of Complex Chemical reactions: Reversible or opposing, consecutive and parallel reactions (No derivations, only examples expected), 2.3 Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law–non-ideal solutions. Vapour pressure- composition and temperature - composition curves of ideal and non-ideal solutions. Distillation of solutions. Lever rule. Azeotropes. 2.4 Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids with respect to Phenol-Water , Triethanolamine – Water and Nicotine – Water systems 2.5 Immiscibility of liquids- Principle of steam	10

		distillation. 2.6 Nernst distribution law and its applications, solvent extraction.	

Unit- III	**Classical Methods of Analysis**	3.1 Titrimetric Methods 3.1.1 Terms involved in Titrimetric methods of analysis. Comparing volumetry and Titrimetry 3.1.2 The Conditions suitable for titrimetry 3.1.3 Types of titrimetry – Neutralisation (Acidimetry, alkalimetry), Redox, (Iodometry, Iodimetry,) Precipitation and Complexometric titrations and indicators used in these titrations 3.1.4 Tools of Titrimetry: Graduated glasswares and Callibration 3.2 Standard solutions (Primary and Secondary standards in Titrimetry) and Calculations in Titrimetry. 3.3 Neutralisation Titrations 3.3.1 Concept of pH and its importance in Neutralisation Titrations 3.3.2 End point and Equivalence point of Neutralisation titrations 3.3.3 Determination of End point by using i. Indicators causing colour change ii. Change in potential (by potentiometry) iii. Change in conductance (by conductometry) 3.3.4. Construction of titration curve (on the basis of change in pH) of a titration of i. Strong acid-weak base ii. Strong base-weak acid 3.4 Gravimetric analysis 3.4.1 General Introduction to Gravimetry. 3.4.2 Types of Gravimetric Methods – 3.4.3 Precipitation Gravimetry: i. Steps involved in precipitation gravimetry analysis ii. Conditions for precipitation iii. Completion of precipitation, iv. Role of Digestion, Filtration, Washing, Drying Ignition of precipitate. Applications of Gravimetric Analysis: Determination of sulfur in organic compounds; Estimation of Nickel in Cu-Ni alloy using dimethyl glyoxime; Determination of Aluminium by converting it to its oxide.	10

References:
Physical and Analytical Chemistry

1. Concise Graduate Chemistry – I, II, III and IV, University Textbook of Chemistry, University of Mumbai.
2. Atkins, P.W.and Paula, J. de Atkin's Physical Chemistry 10th Ed. Oxford University Press (2014).
3. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
4. Keith J. Laidler and John H. Meiser, Physical Chemistry, 2nd Ed. (2004)
5. Puri B.R., Sharma L.R.and Pathania M.S. Principles of Physical Chemistry, Vishal Publishing Company, 2008
6. Ball, D.W. Physical Chemistry Thomson Press, India (2007).
7. Mortimer, R.G. Physical Chemistry3rdEd.Elsevier: NOIDA, UP (2009).
8. Engel, T. and Reid, P. *Physical Chemistry 3rd Ed.*, Prentice-Hall (2012).
9. Mc Quarrie, D.A. and Simon, J.D. *Molecular Thermodynamics* Viva Books Pvt. Ltd.: New Delhi (2004).
10. Fundamental of Analytical Chemistry by Douglas A. Skoog, West, F. James Holler, S. R.Crouch.
11. Modern Analytical Chemistry by David Harvey, McGraw-Hill Higher Education.
12. Skoog et al. "Fundamentals of Analytical chemistry" Cengage Learning, Eight Edition
13. Day and Underwood, "Quantitative analysis" prentice hall 1991,
14. S. M. Khopkar, "Basic Concepts of Analytical Chemistry", IInd Edition New Age International Publisher.
15. Gary D. Christan," Analytical Chemistry", VIth Edition, Wiley Students Edition,
16. Modern Analytical Chemistry, David Harvey

Teaching Plan:

Unit No.	Unit Title	Teaching Methods	No of Hours
I	Chemical Thermodynamics-II and Electrochemistry	Lecture, PPT,	10
II	Chemical Kinetics –II and Solutions	Lecture, PPT,	10
III	Classical Methods of Analysis	Lecture, PPT, Demo	10

Evaluation Pattern:

A. Continuous Internal Evaluation (40%) : 20 Marks

Sr. No.	Particulars	Marks
01	Unit Test (MCQ / Descriptive – Based on Theory and/or Problems - Online/Offline – 1 unit test of 0 marks	10
02	Assignment / seminar / class test / worksheets	05
03	Active participation in routine class instructional deliveries and Overall conduct as a responsible learner.	05

B. Semester End Evaluation (Paper Pattern) (60%): 30 Marks

Guidelines for paper pattern for Semester End Evaluation:

30 Marks per paper Semester End Theory Examination:
1. Duration - These examinations shall be of one hour duration.
2. Theory question paper pattern:
a. There shall be 03 questions each of 10 marks on each unit.
b. All questions shall be compulsory with internal choice within the questions.

Question Number	Unit	Marks
1	I	10
2	II	10
3	III	10

CIE	SEE	Total Marks
20	30	50

Syllabus for B.Sc. Chemistry from the year 2024-25

Nomenclature of the Course	Inorganic & Basics of Analytical Chemistry I
Class	S.Y.B.Sc. (Chemistry)
Semester	III
Course Code	24_USCH302
No of Credits	02
Nature	Theory
Type	Major

Nomenclature: Inorganic & Basics of Analytical Chemistry I
Course Out comes: On successful completion of this course learners will be able to:

CO1	Understand and apply the principles of ionic and covalent bonding, including the use of radius ratio rules, lattice energy, hybridization, and molecular orbital theory, to predict and explain the structure, stability, and properties of chemical species.
CO2	Gain a comprehensive understanding of the chemistry related to boron, silicon, germanium, and nitrogen compounds.
CO3	Effectively select and utilize appropriate spectral instrumental techniques for various analytical challenges and aligning with their applicability in different areas.

Curriculum:

Unit	Title	Learning Points	No of Hours
I	**Chemical Bonding**	**1.1 Non-Directional Bonding** 1.1.1 Ionic Bond: Conditions for the Formation of Ionic Bond. 1.1.2 Radius Ratio Rules 1.1.3 Lattice Energy, Borne-Lande Equation 1.1.4 Kapustinski Equation 1.1.5 Born-Haber Cycle and its Application **1.2 Directional Bonding: Orbital Approach** 1.2.1 Covalent Bonding – The Valence Bond Theory- Introduction and basic tenets. 1.2.2 Resonance and the concept of Formal Charge; Rules for Resonance or Canonical structures.	**10**

		1.2.3 Bonding in Polyatomic Species: The role of Hybridization and types of hybrid orbitals-*sp, sp^2, sp^3, sp^3d, $sp^2d^2$and sp^2d sp^3d^2*. 1.2.4 Equivalent and Non-Equivalent hybrid orbitals 1.2.5 Contribution of a given atomic orbital to the hybrid orbitals (with reference to sp^3 hybridisation as in CH_4, NH_3 and H_2O and series like NH_3, PH_3, AsH_3, BiH_3) **1.3 Molecular Orbital Theory** 1.3.1 Comparing Atomic Orbitals and Molecular Orbitals. 1.3.2 Linear combination of atomic orbitals to give molecular orbitals LCAO-MO approach for diatomic homonuclear molecules). 1.3.3 Molecular orbital Theory and Bond Order and magnetic property: with reference to O_2,O_2^+ O_2^-,O_2^{2-} (Problems and numerical problems expected wherever possible)	
II	**Selected topics on *'p'* block elements**	**2.1 Chemistry of Boron compounds** 2.1.1 Electron deficient compounds – BH_3, BF_3, BCl_3 with respect to Lewis acidity and applications. 2.1.2 Preparation of simple boranes like diborane and tetraborane. 2.1.3 Structure and bonding in diborane and tetraborane (2e-3c bonds) 2.1.4 Synthesis of Borax. **2.2 Chemistry of Silicon and Germanium** 2.2.1 Silicon compounds: Occurrence , Structure and inertness of SiO_2 2.2.2 Preparation of structure of $SiCl_4$ 2.2.3 Occurrence and extraction of Germanium 2.2.4 Preparation of extra pure Silicon and Germanium **2.3 Chemistry of Nitrogen family** 2.3.1 Trends in chemical reactivity - Formation of hydrides, halides, oxides with special reference to oxides of nitrogen. 2.3.2 Oxides of nitrogen with respect to preparation and structure of NO, NO_2, N_2O and N_2O_4. 2.3.3 Synthesis of ammonia by Bosch – Haber process.	**10**
III	**Instrumental Methods-I**	**Basic concepts in Instrumental Methods** **3.1.** Relation between the analyte, stimulus and measurement of change in the observable property. **3.2.** Block diagram of an analytical instrument. **3.3.** Types of analytical instrumental methods based on i. Optical interactions (e.g. Spectrometry: UV-visible, Polarimetry) ii. Electrochemical interactions (e.g. Potentiometry, Conductometry,) iii. Thermal interactions (e.g. Thermogravimetry) **3.4. Spectrometry** 3.4.1. Interaction of electromagnetic radiation with matter: absorption and emission spectroscopy 3.4.2. Basic Terms: radiant power, absorbance, transmittance, monochromatic light, polychromatic light, wavelength of maximum absorbance, absorptivity and molar absorptivity 3.4.3. Statement of Beer's Law and Lambert's Law, Combined mathematical expression of Beer -Lambert's Law, Validity of Beer-Lambert's Law, Deviations from Beer-Lambert's law ((Real deviations, Instrumental deviations and chemical deviations) (Numerical problems based on Beer-Lambert's Law) 3.4.4. Instrumentation for absorption spectroscopy: Colorimeters and Spectrophotometers	**10**

		3.4.5. Block Diagrams for single beam colorimeter, and spectrophotometer (principles, construction and working-details of components expected i.e. , source, sample holder , filters/monochromators, detectors such as photomultiplier tube) 3.4.6. Applications of UV-Visible Spectrophotometry (a) Qualitative analysis such as identification of functional groups in organic compounds, chromophores and auxochrome, c*is* and *trans* isomers (b) Quantitative analysis by calibration curve method and 3.4.7. Photometric Titrations: principle, instrumentation, types of photometric titration curves with examples.	

References:

Inorganic and Analytical Chemistry

1. Quantitative Analysis – R. A. Day, A. L. Underwood, sixth edition Prentice Hall of India (1999)
2. Puri, Sharma and Kalia, Milestone publishers, Principles of Inorganic Chemistry.
3. Bruce H. Mahan, University Chemistry, Narosa publishing house pg. 611 to 683.
4. R. Gopalan, Universities Press India Pvt. Ltd. Inorganic Chemistry for Undergraduates.
5. J. D. Lee, 4th Edn. Concise Inorganic Chemistry, ELBS, The group III elements Pg.359-648.
6. D. F. Shriver and P. W. Atkins, Inorganic Chemistry, 3rd edition, Oxford University Press (1999) page 325-446.
7. Ramesh Kapoor and R.S. Chopra, Inorganic Chemistry, R. Chand publishers, New Delhi.
8. James E. Huheey, Inorganic Chemistry: Principles of Structure and Reactivity,
9. Cotton and Wilkinson, Advanced Inorganic Chemistry, 3rd. Edition.
10. Instrumental Methods of Chemical Analysis by Gurdeep R. Chatwal, Sham K. Anand pp 2.107-2.148.
11. Principles of Instrumental Analysis by Skoog, Holler, Nieman, 5th Edition pp 143-172.
12. Instrumental Methods of Analysis by Willard, Merritt, Dean, Settle 7th Edition pp 118-181.

Teaching Plan:

Unit No.	Unit Title	Teaching Methods	No of Hours
I	Chemical Bonding	Lecture, PPT,	10
II	Selected topics on '*p*' block elements	Lecture, PPT,	10
III	Instrumental Methods-I	Lecture, PPT, Demo	10

Evaluation Pattern:

A) Continuous Internal Evaluation (40%) : 20 Marks

Sr. No.	Particulars	Marks
01	Unit Test (MCQ / Descriptive – Based on Theory and/or Problems - Online/Offline – 1 unit test of 10 marks	10
02	Assignment / seminar / class test / worksheets	05
03	Active participation in routine class instructional deliveries and Overall conduct as a responsible learner.	05

B) Semester End Evaluation (Paper Pattern) (60%): 30 Marks

Guidelines for paper pattern for Semester End Evaluation:

30 Marks per paper Semester End Theory Examination:
1. Duration - These examinations shall be of one hour duration.
2. Theory question paper pattern:
a. There shall be 03 questions each of 10 marks on each unit.
b. All questions shall be compulsory with internal choice within the questions.

Question Number	Unit	Marks
1	I	10
2	II	10
3	III	10

CIE	SEE	Total Marks
20	30	50

Syllabus for B.Sc. Chemistry from the year 2024-25

Nomenclature of the Course	Organic & Basics of Analytical Chemistry I
Class	S.Y.B.Sc. (Chemistry)
Semester	III
Course Code	24_USCH303
No of Credits	02
Nature	Theory
Type	Major

Nomenclature: Organic & Basics of Analytical Chemistry I
Course Out comes: On successful completion of this course learners will be able to:

CO1 :	Understand the reactivity, mechanisms, and properties of halogenated hydrocarbons, alcohols, and phenols, with a focus on nucleophilic substitution, acidity, and key synthetic transformations
CO2 :	Understand the nomenclature, structure, reactivity, and reaction mechanisms of carbonyl compounds, focusing on nucleophilic addition, condensation reactions, and key synthetic transformations
CO3 :	Understand and apply key principles of analytical chemistry, including sampling techniques for solids, liquids, and gases, along with classical and modern analytical methods for accurate chemical analysis

Curriculum:

Unit	Title	Learning Points	No of Hours
I	**Reactions and reactivity of halogenated hydrocarbons, alcohols, Phenols**	**1.1. Reactions and reactivity of halogenated hydrocarbons** 1.1.1. **Alkyl halides:** Nucleophilic substitution reactions: SN^1, SN^2 and SN^i mechanisms with stereochemical aspects and factors affecting nucleophilic substitution reactions-nature of substrate, solvent, nucleophilic reagent and leaving group. 1.1.2. **Aryl halides:** Reactivity of aryl halides towards nucleophilic substitution reactions. Nucleophilic aromatic substitution (SN^{Ar}) addition-elimination mechanism and benzyne mechanism. **1.2 Alcohols and phenols** 1.2.1. **Alcohols:** Nomenclature, Preparation: Hydration of alkenes, hydrolysis of alkyl halides, reduction of aldehydes and ketones, using Grignard reagent. Properties: Hydrogen bonding, types and effect of hydrogen bonding on different properties. Acidity of alcohols, Reactions of alcohols 1.2.2. **Phenols:** Preparation, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols.	10
II	**Carbonyl Compounds**	2.1 Nomenclature of aliphatic, alicyclic and aromatic carbonyl compounds. Structure, reactivity of aldehydes and ketones and methods of preparation; Oxidation of primary and secondary alcohols using PCC, action of Grignard reagent on esters, Rosenmund reduction, Gattermann – Koch formylation and Friedel Craft acylation of arenes 2.2 General mechanism of nucleophilic addition, and acid catalyzed nucleophilic addition reactions. 2.3 Reactions of aldehydes and ketones with $NaHSO_3$ HCN, RMgX, 2, 4-Dinitrophenyl hydrazine, $LiAlH_4$, $NaBH_4$ 2.4 Mechanisms of following reactions: Benzoin condensation, Knoevenagel condensation, 2.5 Keto-enol tautomerism: Mechanism of acid and base catalysed enolization	10
III	**Introduction to Analytical Chemistry and Sampling Techniques**	**3.1 Role of Analytical Chemistry** 3.1.1 Language of analytical chemistry: important terms and their significance in Analytical Chemistry. Purpose of Chemical Analysis; 3.1.2 Analysis Based on i) the nature of information required:(Proximate, Partial, Trace, Complete Analysis) and ii) On the size of the sample used (Macro, semi-micro and microanalysis) 3.1.3 Classical and Non-Classical Methods of Analysis; their types and Importance. **3.2 Significance of Sampling in Analytical Chemistry** 3.2.1 Terms involved in Sampling, Purpose of Sampling, Difficulties encountered in sampling 3.2.3 Types of Sampling: Random Sampling, Systematic Sampling,	10

		3.2.4 Sampling of solids: Sample size – bulk ratio, size to weight ratio, size reduction methods, sampling of compact solids, equipment's and methods of sampling of compact solids, sampling of particulate solids, 3.2.5 Sampling of liquids: Homogeneous and heterogeneous, Static and flowing liquids. 3.2.6 Sampling of gases: Ambient and stack sampling: Apparatus and methods for sampling of gases.	

References:

Organic & Basics of Analytical Chemistry I

1. Morrison, R. T. and Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).2012
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
4. Mc Murry, J. E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013. 5. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.
5. Graham Solomons, T.W. Organic Chemistry, John Wiley and Sons, Inc.
6. Comprehensive Organic Chemistry- The synthesis and reactions of Organic Compounds, Derek Barton, W. David Ollis.
7. Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd.
8. Eliel, E. L. and Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994.
9. Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005.
10. Instrumental Methods of Chemical Analysis by Gurdeep R. Chatwal, Sham K. Anand pp 2.107-2.148.
11. Principles of Instrumental Analysis by Skoog, Holler, Nieman, 5th Edition pp 143-172.
12. Instrumental Methods of Analysis by Willard, Merritt, Dean, Settle 7th Edition pp 118- 181.

Teaching Plan:

Unit No.	Unit Title	Teaching Methods	No of Hours
I	Reactions and reactivity of halogenated hydrocarbons, alcohols, Phenols	Lecture, PPT,	10
II	Carbonyl Compounds	Lecture, PPT,	10
III	Introduction to Analytical Chemistry and Sampling Techniques	Lecture, PPT, Demo	10

Evaluation Pattern:

A) Continuous Internal Evaluation (40%) : 20 Marks

Sr. No.	Particulars	Marks
01	Unit Test (MCQ / Descriptive – Based on Theory and/or Problems - Online/Offline – 1 unit test of 10 marks	10
02	Assignment / seminar / class test / worksheets	05
03	Active participation in routine class instructional deliveries and Overall conduct as a responsible learner.	05

B) Semester End Evaluation (Paper Pattern) (60%): 30 Marks

Guidelines for paper pattern for Semester End Evaluation:

30 Marks per paper Semester End Theory Examination:
1. Duration - These examinations shall be of one hour duration.
2. Theory question paper pattern:
a. There shall be 03 questions each of 10 marks on each unit.
b. All questions shall be compulsory with internal choice within the questions.

Question Number	Unit	Marks
1	I	10
2	II	10
3	III	10

CIE	SEE	Total Marks
20	30	50

Nomenclature of the Course	Chemistry Practical III
Class	S.Y.B.Sc. (Chemistry)
Semester	III
Course Code	24_USCH 304
No of Credits	02
Nature	Practical
Type	Major

Syllabus for B.Sc. Chemistry from the year 2024-25

Practical I

Course Outcomes:

After successful completion of this course learners are able to

CO1	Verify Ostwald Dilution Law.
CO2	Determine order of reaction as well as energy of activation.
CO3	Identify cations from its binary mixture.
CO4	Estimate hardness of water.
CO5	Prepare Glucosazone derivative from dextrose.
CO6	Operate spectral instruments like colorimeter and discuss its construction and working
CO7	Estimate different metal ions by complexometric method.
CO8	Draw various analytical tools with respect to principles, construction and its uses.

Curriculum:

Group	Title	Learning points	No. of Hours
A	**Physical and Basics of Analytical Chemistry**	1. To verify Ostwald's dilution law for weak acid conductometrically. 2. Determination of energy of activation of acid catalyzed hydrolysis of methyl acetate. 3. To investigate the reaction between $K_2S_2O_8$ and KI with equal initial concentrations of the reactants. 4. Colorimetric Determination of Copper Ions in given Solution by using calibration curve method and calculation of % error. 5. Estimation of iron by 1, 10 phenanthroline using colorimeter. (The learner is expected to learn the relation between concentration and Absorbance, to draw a calibration curve, use the slope of the calibration curve and	**30**

		compare it with the calculated slope. They are also expected to state the error estimate of their results). 6. Gravimetric estimation of sulphate as $BaSO_4$ and calculation of % error. (The learner is expected to write a balanced chemical reaction, need for digestion of the precipitate and to estimate the % error.) 7. Gravimetric estimation of barium ions using K_2CrO_4 as precipitant calculation of % error. (The learner is expected to learn the skills of using the counterpoise technique used in this gravimetric estimation; Using counterpoise method Whatmann No. 42 for filtration. In such a case no incineration or use of silica crucible is required. They are also expected to state the error estimate of their results) **8. Tools of Analytical Chemistry-I:** a) Analytical glass wares like burettes, pipettes, Standard flasks, Separating funnels. b) Weighing tools such as two pan balance and monopan balance, digital balances: c) Incineration devices: Burners, Electrical Incinerators, Muffle Furnace, d) Drying Devices: Hot Air Oven, Microwave Oven, Desiccators, Vacuum desiccators e) Monochromators, Filters, Sample holders, Prisms, Diffraction Gratings, Photoemissive cells, Photomultiplier tubes (The learner should draw diagrams and write-ups providing uses, care and maintenance of the items mentioned in (a) principle, construction and uses of items (b) to (e) in his journal.	
B	**Inorganic and Organic Chemistry**	1. Estimation of total hardness 2. Estimation of Aspirin 3. Gravimetric estimation of Nickel (II) as Ni-DMG and calculation of % error. (The learner is expected to know the role of the various reagents/chemicals used in the estimation, various steps involved. They should write the complete and balanced chemical reaction for the formation of the	**30**

		$[Ni(DMG)_2]$ complex. **4-7. Preparation of :** i. Cyclohexanone-oxime from cyclohexanone. ii. Glucosazone from dextrose or fructose iii. Tribromoaniline from aniline. iv. m-Dinitrobenzene from nitrobenzene v. Phthalic anhydride from phthalic acid by sublimation vi. Acetanilide from aniline vii. p-Bromoacetanilide from acetanilide viii. Iodoform from acetone (Any four preparations)	

References:

1. Khosla B. D., Garg V. C. and Gulati A., Senior Practical Physical Chemistry, R. Chand and Co., New Delhi (2011).
2. Garland C. W., Nibler J. W. and Shoemaker D.P., Experiments in Physical Chemistry, 8th Ed., McGraw-Hill, New York (2003).
3. *Practical Inorganic Chemistry* by G. Marr and B. W. Rockett van Nostrand Reinhold Company (1972)
4. Ahluwalia, V.K. and Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).
5. Vogel, A. I., Tatchell, A. R., Furnis, B. S., Hannaford, A. J. and Smith, P. W. G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996
6. D. A. Skoog, D. M. West, F. J. Holler, and S. R. Crouch, Analytical Chemistry: An Introduction, 7th Edn. Chapter 15, pp. 345-381.
7. A. I. Vogel. "Textbook of Quantitative Inorganic Analysis," Longman, London (1961).
8. Shaikh G., Ravishankar L., and Ladage Savita; Experiments in Chemistry: Through Pre-Lab and Post-Lab Activities, Himalaya Publishing House (2024)

Evaluation Pattern: Practical Total Marks: 50

A) Continuous Internal Evaluation: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Performance during practical session Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of journal	15
02	Overall performance (attendance, punctuality, interaction during Practical session throughout semester	05
Total		**20**

B) Semester End Examination: 60% (30 Marks)

Sr. No.	Group	Title	Method	Marks
1.	A	Physical and Analytical experiments	Experiment performance as per the practical slip	25
2.	B	Inorganic and Organic experiments	Experiment performance as per the practical slip	
Viva Voce and journal				05
Total				**30**

Students has to perform any one experiment either from group A or B.

CIE	SEE	Total
20	**30**	**50**

Syllabus for B.Sc. Chemistry from the year 2024-25	
Nomenclature of the Course	Physical & Basics of Analytical Chemistry II
Class	S.Y.B.Sc.
Course Code	24_USCH 401
No. of Credits	2
Nature	Theory
Type	Major

Course Outcomes:

Course Out comes: On successful completion of this course learners will be able to:

CO1 :	Define important terms in electrochemisty; explain concepts in electrochemistry; discuss thermodynamic properties ΔG, ΔS, ΔH from EMF Data; Calculate equilibrium constant and pH measurement using hydrogen & quinhydrone electrode from EMF data; Discuss applications of electrochemistry. Explain concept of phase equilibria; Derive clausius - clapeyron equation; Draw diagrams of phase one-component system & two Component system.
CO2 :	Illustrate laws of crystallography and types of crystal; Discuss characteristics of simple cubic, FCC, BCC & interplanar distance in cubic lattice; Explain use of x-rays in study of crystal structure; Derive Bragg's equation, Determine Avagadro's number; Explain terms involved in catalysis; write mechanisms & kinetics of acid-base catalysed reactions, enzyme catalysed reactions.
CO3 :	Know the analytical separation techniques and its importance in analysis; Explain principle involved in electrophoresis, instrumentation & working & application in separation of biomolecules; discuss terms & laws involved in solvent extraction, types of solvent extraction; Introduce terms in chromatography and their types (paper chromatography, TLC)

Curriculum:

Unit No.	Unit Title	Sub titles (Learning Points)	No. of Hours
I	**Electrochemistry – II and Phase Equilibria**	1.1 Electrochemical cells, Nernst equation and its importance in generating electricity through chemical reactions. Types of electrochemical cells - Reversible and irreversible cells (Definition, example, characteristics) 1.2 Concentration cells with transfer and without transfer. Liquid junction potential and salt bridge. 1.3 Thermodynamics of a reversible cell, calculation of thermodynamic properties: ΔG, ΔH and ΔS from EMF data. 1.4 Calculation of equilibrium constant and pH measurement using Hydrogen electrode and quinhydrone electrode, from EMF data. 1.5 Application of electrochemistry in the field of – 'Hydrogen Clean energy' and the role of Batteries in clean energy storage. (Numerical to be solved wherever necessary) 1.6 Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation 1.7 Derivation of Clausius – Clapeyron equation and	**10**

		its importance in phase equilibria. (numericals expected) 1.8 Phase diagrams of one-component systems (water and sulphur). 1.9 Two component systems involving eutectics, congruent and incongruent melting points (lead-silver system).	
II	**Solid State, Catalysis**	2.1 Recapitulation of laws of crystallography and types of crystals 2.2 Characteristics of simple cubic, face centered cubic and body centered cubic systems, interplanar distance in cubic lattice (only expression for ratio of interplanar distances are expected) 2.3 Use of X-rays in the study of crystal structure, Bragg's equation (derivation expected), X- rays diffraction method of studying crystal lattice structure, structure of NaCl and KCl. Determination of Avogadro's number (Numericals expected) 2.4 Types of catalysis, catalytic activity, specificity and selectivity, inhibitors, catalyst poisoning and deactivation 2.4.1 Mechanisms and kinetics of acid-base catalyzed reactions, effect of pH. 2.4.2 Mechanisms and kinetics of enzyme catalyzed reactions (Michaelis – Menten equation) 2.4.3 Effect of particle size and efficiency of nanoparticles as catalyst	**10**
Unit-III	**Separation techniques in Analytical Chemistry**	3.1 An Introduction to Analytical Separations and its importance in analysis. 3.2 Estimation of an analyte without effecting separation. 3.3 Types of separation methods 3.3.1 Based on Solubilities (Precipitation,Filtration Crystallisation) 3.3.2 Based on Gravity- Centrifugation 3.3.3 Based on volatility-Distillation ; 3.3.4 Based on Electrical effects-Electrophoresis 3.3.5 Based on retention capacity of a Stationary Phase – Chromatography; 3.3.6 Based on distribution in two immiscible phases-Solvent Extraction; 3.3.7 Based on capacity to exchange with a resin-Ion Exchange; 3.4 Electrophoresis : Principles, Basic Instrumentation, Working and Application in separation of biomolecules like enzymes and DNA. 3.5 Solvent extraction 3.5.1 Introduction, Nernst distribution Law, Distribution Ratio, Partition Coefficient. 3.5.2 Conditions of extraction: Equilibration time, Solvent volumes, temperature, pH. 3.5.3 Single step and multistep extraction, Percentage	**10**

		extraction for single step and multistep extraction. Separation factor. 3.5.4 Batch and continuous extraction 3.6 Chromatography : 3.6.1 Introduction to Chromatography 3.6.2 Classification of chromatographic methods based on stationary and mobile phase 3.6.3 Paper Chromatography: Principle, techniques and applications of Paper Chromatography in separation of cations. 3.6.4 Thin layer Chromatography Principle, technique and Applications in determining the purity of a given solute; Following progress of a given reaction.	

References:

Physical Chemistry & Analytical Chemistry

1. Concise Graduate Chemistry – I, II, III and IV, University Text Book of Chemistry, University of Mumbai.
2. Atkins, P. W. and Paula J. de Atkin's Physical Chemistry 10th Ed., Oxford University Press (2014).
3. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
4. Keith J. Laidler and John H. Meiser, Physical Chemistry, 2nd Ed. (2004)
5. Puri B.R., Sharma L.R.and Pathania M.S. Principles of Physical Chemistry, Vishal Publishing Company, 2008
6. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
7. Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).
8. Engel, T. and Reid, P. *Physical Chemistry 3rd Ed.*, Prentice-Hall (2012).
9. Mc Quarrie, D. A and Simon, J.D. *Molecular Thermodynamics* Viva Books Pvt. Ltd.: New Delhi (2004).
10. Levine I. N. *Physical Chemistry* 6thEd.,TataMcGraw Hill(2010)
11. Khosla B. D., Garg V.C. and Gulati A., Senior Practical Physical Chemistry, R. Chand and Co., New Delhi (2011).
12. Garland C. W., Nibler J.W. and Shoemaker D.P., Experiments in Physical Chemistry, 8th Ed., McGraw-Hill, New York (2003).
13. Halpern A. M. and McBane G. C., Experimental Physical Chemistry, 3rd Ed., W.H. Freeman and Co., New York (2003).
14. Athawale V. D. and Mathur P., Experimental Physical Chemistry, New Age International, New Delhi (2001)
15. D. A. Skoog, D. M. West, F. J. Holler, and S. R. Crouch, Analytical Chemistry: AnIntroduction, 7th ed., Chapter 15, pp. 345-381.
16. A.I. Vogel. "Textbook of Quantitative Inorganic Analysis," Longman, London (1961).
17. R.V. Dilts. "Analytical Chemistry. Methods of Separation," van Nostrand, N.Y. (1974).
18. Some Experiments for B. Tech in Chemistry and Chemical Technology compiled by Prof. J.B.Baruah, Mrs. Abhilasha Mohan Baruah and Mr. Parikshit Gogoi.

Teaching Plan:

Unit No.	Unit Title	Teaching Methods	No. of Lectures.
I	Electrochemistry – II and Phase Equilibria	Lecture, PPT,	10
II	Solid State, Catalysis	Lecture, PPT,	10
III	Separation techniques in Analytical Chemistry	Lecture, PPT, Demo	10

Evaluation Pattern:

a. Continuous Internal Evaluation (40%) : 20 Marks

Sr. No.	Particulars	Marks
01	Unit Test (MCQ / Descriptive – Based on Theory and/or Problems - Online/Offline – 1 unit test of 10 marks	10
02	Assignment / seminar / class test / worksheets	05
03	Active participation in routine class instructional deliveries and Overall conduct as a responsible learner.	05

b. **Semester End Evaluation (Paper Pattern) (60%): 30 Marks**

Guidelines for paper pattern for Semester End Evaluation:

30 Marks per paper Semester End Theory Examination:

1. Duration - These examinations shall be of one hour duration.
2. Theory question paper pattern:

a. There shall be 03 questions each of 10 marks on each unit.

b. All questions shall be compulsory with internal choice within the questions.

Question Number	Unit	Marks
1	I	10
2	II	10
3	III	10

CIE	SEE	Total Marks
20	30	50

Nomenclature of the Course	Inorganic & Basics of Analytical Chemistry II
Class	S.Y.B.Sc. (Chemistry)
Semester	IV
Course Code	24_USCH402
No of Credits	02
Nature	Theory
Type	Major

Nomenclature: Inorganic & Basics of Analytical Chemistry II

Course Out comes: On successful completion of this course learners will be able to:

CO1	Understand and predict the chemical properties and reactivities of transition metals and their coordination compounds to use them in the various fields.
CO2	Analyze the acidity of cations and basicity of anions based on hydration, hydrolysis, and charge-to-radius ratios, and evaluate the properties, uses, and environmental implications of volatile oxides and oxo-acids
CO3	Select and utilize appropriate electrochemical methods for various analytical challenges, aligning with the learning objectives of similar courses in the fields.

Curriculum:

Unit	Title	Learning Points	No of Hours
I	**Comparative Chemistry of the transition metals and Coordination Chemistry**	1.1 Position in the periodic table; Natural occurrence principal ores and minerals; 1.2 Significance of special stability of d^0, d^5 and d^{10} leading to variable oxidation states; Unusual oxidation states and their stabilities in aqueous solutions (with special reference to vanadium, and chromium.) 1.3 Origin of colour for transition metals and their compounds: such as reflectivity, surface coatings, particle size, packing density for metals and nature of d-orbitals, number of electrons in the d-orbitals, geometry and ability for charge transfer). 1.4 Magnetic properties of transition metal compounds: Origin of magnetism, spin and orbital motion of electrons; equation for spin only and spin- orbital magnetism in terms of Bohr magnetons (No derivation of relevant equations expected); Reasons for quenching of orbital moments. 1.5 Chemistry of Titanium and vanadium: properties of Oxides and chlorides; use in titrimetric analysis 1.6 Introduction to Chemistry of Coordination Compounds i. Historical perspectives: Early ideas on coordination compounds ii. Basic terms and nomenclature. iii. Types of ligands iv. Isomerism : General Types with special reference to stereoisomerism of coordination compounds (CN = 6) v. Evidence for the formation of coordination compounds, 1.7 Theories of coordination compounds i. Werner's Theory of coordination compounds, ii. Effective atomic number rule. iii. Eighteen electron Rule 1.8 Nature of the Metal-Ligand Bond: i. Valence Bond Theory: Hybridisation of the central metal orbitals-sp^3, sd^3/d^3s sp^3d^2/d^2sp^3, sp^2d, ii. Inner and outer orbital complexes of .(suitable examples of Mn(II) Fe(II), Fe(III), Co(II)/Co(III), Ni(II), Cu(II) Zn(II) complexes with ligands like aqua, ammonia CN- and halides may be used) iii. Limitations of V.B.T **1**.9 Application of coordination compounds.	**10**

II	**Ions in aqueous medium and Uses and Environmental Chemistry of volatile Oxides and oxo-acids**	2.1. Acidity of Cations and Basicity of Anions i. Hydration of Cations; Hydrolysis of Cations predicting degree of hydrolysis of Cations-effect of Charge and Radious. ii. Latimer Equation. Relationship between pKa, acidity and z^2/r ratios of metal ions graphical Presentation iii. Classification of cations on the basis of acidity category – Non acidic, Moderately acidic, strongly acidic, very strongly acidic with pKa values range and examples iv. Hydration of Anions; Effect of Charge and Radius; Hydration of anions- concept, diagram classification on the basis of basicity 2.2. Uses and Environmental Chemistry of volatile Oxides and oxo-acids i. Physical properties of concentrated oxo-acids like Sulphuric, Nitric and Phosphoric acid ii. Uses and environments aspects of these acids	**10**
III	**Instrumental Methods-II**	3.1 Instruments based on the electrochemical properties of the analytes 3.2 Potentiometry: 3.2.1 Principle. 3.2.2 Role of Reference and indicator electrodes 3.2.3 Applications in Neutralisation reactions with reference to the titration of a Strong acid against a Strong Base (using quinhydrone electrode) 3.2.4 Graphical methods for detection of end points 3.3 pHmetry : 3.3.1 Principle 3.3.2 Types of pH meters. 3.3.3 Principle, Construction Working and Care of Combined Glass electrode 3.3.4 Applications in Titrimetry (Strong acid-Strong Base) biological and environmental analysis. 3.4 Conductometry: 3.4.1 Principle 3.4.2 Conductivity cell its construction and care 3.4.3 Applications in Neutralisation Titrimetry with respect to i. Strong Acid-Strong Base ii. Strong Acid-Weak Base iii. Strong Base-weak Acid iv. Weak Acid- Weak Base. 3.5 Advantages and limitations of conductometric titrations.	**10**

References:
Inorganic and Analytical Chemistry

1. Quantitative Analysis – Day R. A., Underwood A.L., sixth edition.(1999) Prentice Hall of India.
2. Puri, Sharma and Kalia, Milestone publishers, Principles of Inorganic Chemistry.
3. Bruce H. Mahan, University Chemistry, Narosa Publishing house pg. 611 to 683.
4. R. Gopalan, Universities Press India Pvt. Ltd. Inorganic Chemistry for Undergraduates.
5. J. D. Lee, 4th Edn. Concise Inorganic Chemistry, ELBS, The group III elements Pg. 359-648.
6. D. F. Shriver and P. W. Atkins, Inorganic chemistry, 3rd edition, Oxford University Press (1999) page 325-446.
7. C. N. R. Rao edited, University General Chemistry, 513-578.
8. James E. Huheey, Inorganic Chemistry: Principles of Structure and Reactivity.
9. Emeleus and Anderson, Modern Aspects of Inorganic Chemistry, page no. 435-463.
10. Cotton and Wilkinson, Advanced Inorganic Chemistry, 3rd. Edition.
11. Instrumental Analysis by Douglas A. Skoog, F. James Holler, Stanley R. Crouch.
12. Instrumental methods of analysis by Willard, H.H., Merritt, L.L. Jr., Dean, J.A., Settle, 7th Edition.
13. Fundamental of Analytical Chemistry by Douglas A. Skoog, West, F. James Holler, S. R. Crouch.
14. Modern Analytical Chemistry by David Harvey, McGraw-Hill Higher Education.

Teaching Plan:

Unit No.	Unit Title	Teaching Methods	No of Hours
I	Comparative Chemistry of the transition metals and Coordination Chemistry	Lecture, PPT,	10
II	Ions in aqueous medium and Uses and Environmental Chemistry of volatile Oxides and oxo-acids	Lecture, PPT,	10
III	Instrumental Methods-II	Lecture, PPT, Demo	10

Evaluation Pattern:

A) Continuous Internal Evaluation (40%): 20 Marks

Sr. No.	Particulars	Marks
01	Unit Test (MCQ / Descriptive – Based on Theory and/or Problems - Online/Offline – 1 unit test of 10 marks	10
02	Assignment / seminar / class test / worksheets	05
03	Active participation in routine class instructional deliveries and Overall conduct as a responsible learner.	05

B. Semester End Evaluation (Paper Pattern) (60%): 30 Marks

Guidelines for paper pattern for Semester End Evaluation:

30 Marks per paper Semester End Theory Examination:
1. Duration - These examinations shall be of one hour duration.
2. Theory question paper pattern:
a. There shall be 03 questions each of 10 marks on each unit.
b. All questions shall be compulsory with internal choice within the questions.

Question Number	Unit	Marks
1	I	10
2	II	10
3	III	10

CIE	SEE	Total Marks
20	30	50

Syllabus for B.Sc. Chemistry from the year 2024-25

Nomenclature of the Course	Organic & Basics of Analytical Chemistry II
Class	S.Y.B.Sc. (Chemistry)
Semester	IV
Course Code	24_USCH403
No of Credits	02
Nature	Theory
Type	Major

Nomenclature: Organic & Basics of Analytical Chemistry II
Course Out comes: On successful completion of this course learners will be able to:

CO1 :	Understand the structure, properties, and reactivity of carboxylic acids, their derivatives, and sulfonic acids, focusing on key reaction mechanisms and synthetic transformations.
CO2 :	Understand the structure, synthesis, reactivity, and reactions of nitrogen-containing compounds (aromatic amines) and heterocyclic systems, emphasizing their applications in organic synthesis
CO3 :	Apply statistical methods to analyze and interpret analytical data, assess errors, and enhance accuracy and precision in chemical analysis.

Curriculum:

Unit	Title	Learning Points	No of Hours
I	**Carboxylic Acids and their Derivatives, Sulphonic acid.**	3.1.1. **Carboxylic Acids and their Derivatives :** Nomenclature, structure and physical properties, acidity of carboxylic acids, effects of substituents on acid strength of aliphatic and aromatic carboxylic acids. 3.1.2. Preparation of carboxylic acids: oxidation of alcohols and alkyl benzene, carbonation of Grignard and hydrolysis of nitriles. 3.1.3. Reactions: Acidity, salt formation, decarboxylation, Reduction of carboxylic acids with $LiAlH_4$, diborane, Hell-Volhard – Zelinsky reaction, Conversion of carboxylic acid to acid chlorides, esters, amides and acid anhydrides and their relative reactivity. 3.1.4. Mechanism of nucleophilic acyl substitution and acid-catalysed nucleophilic acyl substitution. Inter conversion of acid derivatives by nucleophilic acyl substitution. 3.1.5. Mechanism of Claisen condensation **3.2 Sulphonic acids:** Nomenclature, preparation of aromatic sulphonic acids by sulphonation of benzene (with mechanism), toluene and naphthalene, Reactions: Acidity of arene sulfonic acid, Comparative acidity of carboxylic acid and sulfonic acids. Salt formation, desulphonation. Reaction with alcohol, phosphorous pentachloride, IPSO substitution.	**10**
II	**Amines, Diazonium salts, Heterocyclic compounds**	**Nitrogen containing compounds and heterocyclic compounds:** **3.1 Amines :** Nomenclature, effect of substituent on basicity of aliphatic and aromatic amines; 3.1.1. Preparation: Reduction of aromatic nitro compounds using catalytic hydrogenation, chemical reduction using Fe-HCI, Sn-HCl, Zn-acetic acid ammonolysis of halides, reductive amination , Hofmann bromamide reaction. 3.1.2. Reactions- Salt Formation, N-acylation, N-alkylation, Hofmann-elimination reaction, reaction with nitrous acid, carbylamine reaction, Electrophilic substitution in aromatic amines: bromination, nitration and sulphonation. **3.2 Diazonium Salts**: Preparation and their reactions/synthetic application - Sandmeyer reaction, Gattermann reaction, Replacement of diazo group by -H,-OH. Azo coupling with phenols, naphthols and aromatic amines. **3.3 Heterocyclic Compounds:** 3.3.1. Classification, nomenclature, electronic structure, aromaticity in 5-numbered rings containing one heteroatom; 3.3.2. Synthesis of Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, and Hantzsch synthesis), Thiophene, 3.3.3. Reactivity of furan, pyrrole and thiophene towards electrophilic substitution reactions on the basis of stability of intermediate and of pyridine on the basis of electron distribution. Reactivity of pyridine	**10**

		towards nucleophilic substitution on the basis of electron distribution. 3.3.4. Reactions of furan, pyrrole and thiophene: halogenation, nitration, sulphonation, Vilsmeier-Haack reaction, Friedel-Crafts reaction. Furan: Ring opening. Pyrrole: Acidity and basicity of pyrrole. Comparison of basicity of pyrrole and pyrrolidine.	
III	**Statistical treatment of analytical data**	**Errors in Analysis and their types**: Determinate Errors, Indeterminate Errors, Absolute error and Relative error. Methods of minimizing Determinate errors in analysis, Calibration of apparatus, carrying out Control determination, Carrying out Blank determination Concept of Precision and Accuracy in Analysis, Mean, Median, Mode, Absolute deviation, Average deviation standard deviation, variance and coefficient of variation. **Distribution of random errors:** Gaussian distribution curve. Equation and salient features of Gaussian distribution curve, Concept of Confidence limits and confidence interval, Student t. Criteria for rejection of doubtful result: Q test, 2.5 d and 4d rule, F test, Graphical representation of data and obtaining best fitting straight line	**10**

References:
Organic and Analytical Chemistry

1. Morrison, R. T. and Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).2012
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
4. Mc Murry, J. E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013. 5. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.
5. Graham Solomons, T.W. Organic Chemistry, John Wiley and Sons, Inc.
6. Comprehensive Organic Chemistry- The synthesis and reactions of Organic Compounds, Derek Barton, W. David Ollis.
7. Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd.
8. Eliel, E. L. and Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994.
9. Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005.
10. Fundamental of Analytical Chemistry by Douglas A. Skoog, West, F. James Holler, S. R. Crouch.

Teaching Plan:

Unit No.	Unit Title	Teaching Methods	No of Hours
I	Carboxylic Acids and their Derivatives, Sulphonic acid.	Lecture, PPT,	10
II	Amines, Diazonium salts, Heterocyclic compounds	Lecture, PPT,	10
III	Statistical treatment of analytical data	Lecture, PPT,	10

Evaluation Pattern:

A) Continuous Internal Evaluation (40%): 20 Marks

Sr. No.	Particulars	Marks
01	Unit Test (MCQ / Descriptive – Based on Theory and/or Problems - Online/Offline – 1 unit test of 10 marks	10
02	Assignment / seminar / class test / worksheets	05
03	Active participation in routine class instructional deliveries and Overall conduct as a responsible learner.	05

B. Semester End Evaluation (Paper Pattern) (60%): 30 Marks

Guidelines for paper pattern for Semester End Evaluation:

30 Marks per paper Semester End Theory Examination:

1. Duration - These examinations shall be of one hour duration.
2. Theory question paper pattern:

a. There shall be 03 questions each of 10 marks on each

b. All questions shall be compulsory with internal choice within the questions.

Question Number	Unit	Marks
1	I	10
2	II	10
3	III	10

CIE	SEE	Total Marks
20	30	50

Syllabus for B.Sc. Chemistry from the year 2024-25

Name of the Course	Chemistry Practical IV
Class	S.Y.B.Sc. (Chemistry)
Semester	IV
Course Code	24_USCH404
No of Credits	02
Nature	Practical
Type	Major

Practical:

Course Outcomes: After Completion of the course Lerner will able to

CO1	Design Danniel cell and determine standard emf.
CO2	Estimate amount of strong HCl potentiometrically.
CO3	Use of microscale technique to prepare Ni-DMG complex.
CO4	Use of PFHS technique to prepare Ca / Mg Oxalate complex.
CO5	Qualitative analysis to identify organic substance of different chemical nature containing C H (O), C H (O) N, C H (O) N S & C H (O) X element
CO6	Use of various analytical tools in quantitative analysis.
CO7	Estimate Fe (II) ions potentiometrically and strong acid conductometrially.

Group	Title	Learning points	No. of Hours
A	Physical & Analytical Chemistry	1. To determine standard EMF and the standard free energy change of Daniel cell potentiometrically. 2. To determine the amount of HCl in the given sample potentiometrically. 3. Compare the strengths of HCl and H_2SO_4 by studying kinetics of acid hydrolysis of methyl acetate. 4. Paper chromatography**:** Separation of cations like Fe(III), Ni(II) and Cu(II) in a sample. 5. Separation of a solute between two immiscible solvents to determine the distribution ratio and/or extraction efficiency. (Solutes could be as their aqueous solutions and the organic solvent ethyl acetate) Suggested solute for the distribution study: Fe (III) in aqueous solutions. 6. Conductometric titration: Estimation of given acid by conduct metric titration with strong base and calculation of % error. (The learner is expected to learn the handling of the conductometer and the conductivity cell, determination of end point by plotting a graph. They	30

		are also expected to state the error estimate of their results). 7. Determination of buffer capacity of acid buffer and basic buffer. (The learner is expected to learn the use pH meter, standardization of pH meter, use of Henderson's equation and calculation of buffer capacity) **8. Tools of Analytical Chemistry-II** a. Filtration Flasks, Funnels, Separating Funnels, Distillation apparatus, Vacuum Distillation assembly, Centrifuge machine, Electrophoresis apparatus. b. Development chamber for chromatography c. Electrodes like Reference Electrodes and Indicator Electrodes (with respect to care and maintenance.) d. Conductivity cell (with respect to care and maintenance.) e. Combined Glass electrode (with respect to care and maintenance.) f. Types of Salt Bridges and preparation of any one or use of salt bridge, its effect on the potential of a given electrode/cell (The learner should draw diagrams and write-ups providing uses of the items mentioned in (a and b) and Principle, Construction care and Uses of items (c) to (f) in his journal.)	
B	Inorganic & Organic Chemistry	1. Inorganic preparation – Nickel dimethyl glyoxime using microscale method. 2. Complex cation – *Tris* (ethylene diamine) nickel (II) thiosulphate. 3. Calcium / Magnesium Oxalate by PFHS technique. 4. Complex preparation of Tetra-ammine copper (II) sulphate / chloride. (any three) 5-8. **Qualitative Analysis of bi-functional organic compounds** on the basis of 1. Preliminary examination 2. Solubility profile 3. Detection of elements C, H, (O), N, S, X. 4. Detection of functional groups 5. Determination of physical constants (M.P/B.P) Solid or liquid Compounds containing not more than two functional groups from among the following classes may be given for analysis to be given: Carboxylic acids, phenol, carbohydrates, aldehydes, ketones, ester, amides, nitro, anilides, amines, alkyl and aryl halides. (any four)	**30**

Minimum 80 percent of practical must be completed in each term

References:

1. Khosla B. D., Garg V.C. and Gulati A., Senior Practical Physical Chemistry, R. Chand and Co., New Delhi (2011).
2. Garland C. W., Nibler J.W. and Shoemaker D.P., Experiments in Physical Chemistry, 8th Ed., McGraw-Hill, New York (2003).
3. Halpern A. M. and McBane G. C., Experimental Physical Chemistry, 3rd Ed., W.H. Freeman and Co., New York (2003).
4. Practical Inorganic Chemistry by G. Marr and B. W. Rockett van Nostrand Reinhold Company (1972)
5. Mann, F.G. and Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
6. Ahluwalia, V.K. and Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).
7. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. and Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996
8. Skoog D. A., West D. M., Holler F. J., and Crouch S. R., Analytical Chemistry: An Introduction, 7th Ed., Chapter 15, pp. 345-381.
9. Vogel A.I. "Textbook of Quantitative Inorganic Analysis," Longman, London (1961).
10. Dilts R.V. "Analytical Chemistry. Methods of Separation," van Nostrand, N.Y. (1974).
11. Shaikh G., Ravishankar L., and Ladage Savita; Experiments in Chemistry: Through Pre-Lab and Post-Lab Activities, Himalaya Publishing House (2024)

Evaluation Pattern: Practical Total Marks: 50

A) Continuous Internal Evaluation: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Performance during practical session Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of journal	15
02	Overall performance (attendance, punctuality, interaction during Practical session throughout semester	05
Total		**20**

B) Semester End Examination: 60% (30 Marks)

Sr. No.	Group	Title	Method	Marks
1.	A	Physical and Analytical experiments	Experiment performance as per the practical slip	25
2.	B	Inorganic and Organic experiments	Experiment performance as per the practical slip	
		Viva Voce and journal		05
Total				**30**

Students has to perform any one experiment either from group A or B.

CIE	SEE	Total
20	**30**	**50**

Syllabus for B.Sc. Chemistry from the year 2024-25

Nomenclature of the Course	Basics in Analytical Chemistry I
Course Code	24_USCH305
Class	S.Y.B.Sc. (Chemistry)
Semester	III
No. of Credits	02
Nature	Theory
Type	Minor

Nomenclature: Basics in Analytical Chemistry

Course Out comes:

On successful completion of this course, learners will be able to:

CO1: Gain knowledge of analytical chemistry, covering key terminology and its significance, explore various chemical analysis methods based on information type and sample size, including proximate, trace and complete analyses, differentiate between classical and non-classical methods and learn essential sampling techniques for solids and liquids, identify the challenges in sample collection.

CO2: Define and explain titrimetric methods including key principles and types of titrations, with hands-on experience in using graduated glassware and preparing standard solutions, explore gravimetric analysis, focusing on its principles, types, and steps in precipitation gravimetry, along with factors influencing precipitation and the role of digestion.

CO3: Elaborate the fundamental principles of instrumental analysis, focusing on the relationship between the analyte, stimulus, and observable property changes, explore techniques like Beer's Law, Lambert's Law and the operation of colorimeters and spectrophotometers, apply mathematical concepts to solve problems related to absorption spectroscopy and explain the components and workings of these instruments.

Curriculum:

Unit No.	Unit Title	Sub titles (Learning Points)	No. of Hours
I	**Introduction to Analytical Chemistry**	**1.1 Role of Analytical Chemistry** 1.1.1 Language of analytical chemistry: Important terms and their significance in analytical chemistry. 1.1.2 Purpose of chemical analysis; Analysis based on i) The nature of information required: (Proximate, partial, trace, complete analysis) ii) On the size of the sample used (Macro, semi- micro and microanalysis). 1.1.3 Classical and non-classical methods of analysis, their types and importance. **1.2 Significance of Sampling in Analytical Chemistry** 1.2.1 Terms involved in sampling, purpose of sampling, and difficulties encountered in sampling. 1.2.2 Types of sampling: Random sampling, systematic sampling. Sampling of solids: Sample size – bulk ratio, size to weight ratio, multistage and sequential sampling, size reduction methods, sampling of compact solids, equipments and methods of sampling	10

		of compact solids, sampling of particulate solids 1.2.3 Sampling techniques: Sampling of liquids: Homogeneous and heterogeneous, static and flowing liquids.	
II	**Classical Methods of Analysis**	**2.1 Titrimetric Methods** 2.1.1 Terms involved in titrimetric methods of analysis. comparing volumetric and titrimetric 2.1.2 The conditions suitable for titrimetry. 2.1.3 Types of titrimetry i) Neutralisation (Acidimetry, Alkalimetry) ii) Redox (Iodometry, Iodimetry) iii) Precipitation iv) Complexometric titrations 2.1.4 Tools of titrimetry: Graduated glassware and calibration. **2.2 Standard solutions** Primary and secondary standards titrimetry, calculations based on preparation of primary and secondary standards **2.3 Neutralization Titration** 2.3.1 Concept of pH and its importance in neutralization titrations 2.3.2 End point and equivalence point of neutralization titrations, 2.3.3 Determination of end point by using (i) Indicators causing colour change - Selection of indicators – Ostwald's theory of indicators. **2.4 Gravimetric analysis** 2.4.1 Introduction and principle of gravimetric analysis 2.4.2 Types of gravimetric methods i) Precipitation gravimetry ii) Volatilisation gravimetry 2.4.3 Precipitation gravimetry: i) Steps analysis involved in precipitation gravimetry ii) Factors affecting precipitation iii) Concept of nucleation (Homogenous and heterogeneous) and crystal growth iv) Impurities involved in precipitates a) Co-precipitation b) Post precipitation c) Simultaneous precipitation d) Role of Digestion and its importance, filtration washing, drying and ignition of precipitate. v) Applications of gravimetric analysis: Estimation of Nickel in Cu-Ni alloy using dimethyl glyoxime.	10
III	**Instrumental Methods-I**	**3.1 Basic Concepts in Instrumental methods** 3.1.1 Relation between the analyte, stimulus and measurement of change in the observable property. 3.1.2 Block diagram of an analytical instrument. 3.1.3 Types of analytical instrumental methods based on i) Optical interactions spectrometry: UV-Visible, polarimetry ii) Electrochemical interactions (e.g. Potentiometry, conductometry,) iii) Thermal interactions (e.g. Thermogravimetry)	10

		3.2 Spectrometry 3.2.1 Interaction of electromagnetic radiation with matter: Absorption and emission spectroscopy 3.2.2 Basic terms: Radiant power, absorbance, transmittance, monochromatic light, polychromatic light, wavelength of maximum absorbance, absorptivity and molar absorptivity 3.2.3 Statement and derivation of Beer's Law and Lambert's Law, Combined mathematical expression of Beer Lambert's Law, validity and deviations from Beer-Lambert's Law *(Numerical problems based on Beer Lambert's Law)* 3.2.4 Instrumentation for Absorption Spectroscopy: Colorimeters and Spectrophotometers. 3.2.5 Block Diagrams for single beam and double beam colorimeter (Principle, construction and working -Details of components expected, i.e. source, sample holder, filter, detectors), block diagrams for single beam and double beam spectrophotometer (Principle, construction and working (Details of components expected i.e. source, sample holder, monochromator, detectors).	

References:

1. Skoog et al. "Fundamentals of Analytical chemistry" Cengage Learning, Eight Edition.
2. Instrumental Analysis by Douglas A. Skoog, F. James Holler, Stanley R. Crouch.
3. Day and Underwood, "Quantitative analysis" prentice hall 1991.
4. Instrumental Methods of Analysis by Willard, H.H.; Merritt, L.L. Jr.; Dean, J.A.; Settle, 7th Edition.
5. Fundamental of Analytical Chemistry by Douglas A. Skoog, West, F. James Holler, S. R. Crouch.
6. Principles of Instrumental Analysis by Skoog, Holler, Nieman, 5th Edition pp 143-172.
7. Modern Analytical Chemistry by David Harvey, McGraw-Hill Higher Education.
8. Gary D. Christan, "Analytical Chemistry", VIth Edition, Wiley Students Edition.
9. Instrumental Methods of Chemical Analysis by Gurdeep R. Chatwal, Sham K. Anand pp 2.107-2.148.
10. S.M. Khopkar, "Basic Concepts of Analytical Chemistry", IInd Edition New Age International Publisher.

Teaching Plan:

Unit No.	Unit Title	Teaching Methods	No. of Hours
I	Introduction to Analytical Chemistry	Lecture, PPT	10
II	Classical Methods of Analysis	Lecture, PPT	10
III	Instrumental Methods-I	Lecture, PPT	10

Evaluation Pattern:

A. Continuous Internal Evaluation (40%) : 20 Marks

Sr. No.	Particulars	Marks
1	Unit Test (MCQ / Descriptive – Based on Theory and/or Problems - Online/Offline – 1 unit test of 10 marks	10
2	Assignment / seminar / class test / worksheets	05
3	Active participation in routine class instructional deliveries and Overall conduct as a responsible learner.	05
	Total	**20**

B. Semester End Evaluation (60%): 30 Marks

Guidelines for paper pattern for Semester End Examination 30 marks per paper semester end theory examination:

a. Duration – This examination shall be of one hour duration.
b. Theory question paper pattern:

There shall be three questions each of 10 marks on each unit.

All questions shall be compulsory with internal choice within the questions

Question Number	Unit	Marks
1	I	10
2	II	10
3	III	10

CIE	SEE	Total Marks
20	30	50

Syllabus for B.Sc. Chemistry from the year 2024-25

Nomenclature of the Course	Basics in Analytical Chemistry
Course Code	24_USCH306
Class	S.Y.B.Sc. (Chemistry)
Semester	III
No. of Credits	02
Nature	Practical
Type	Minor

Nomenclature: Basics in Analytical Chemistry

Course Outcomes:

On successful completion of this course learners will be able to

CO1: Know the various analytical tools used in laboratory.

CO2: Handle different equipments like, digital one pan balance, muffle furnace, electrical incenreters.

CO3: Prepare standard succinic acid solution and standardize supplied NaOH solution.

CO4: Determine hardness of water by complexometric titration method.

CO5: Apply the concept of neutralization titration to estimate aspirin in a given tablet.

CO6: Estimate Nickel content gravimetrically.

CO7: Handle photoelectric colorimeter effectively.

CO8: Verify Beer Lambert's law.

Curriculum:

Sr. No.	Title	Learning points	No. of Hours
1	**Tools of Analytical Chemistry-I**	a) Analytical glassware like burettes, pipettes, standard flasks, separating funnels. b) Weighing tools such as two pan balance and mono pan balance, digital balances. c) Incineration devices: Burners, electrical incinerators, muffle furnace. d) Drying devices: Hot air oven, microwave oven, desiccators, vacuum desiccators. e) Monochromators, filters, sample holders, prisms, diffraction gratings, photo emissive cells, photomultiplier tubes. (The learner should draw diagrams and write-ups providing uses, care and maintenance of the items mentioned in (a) and principle, construction and uses of items (b) to (e) in his / her journal)	60

2	**Classical Analysis**	a) To standardize supplied NaOH solution. b) To determine strength of supplied commercial sulphuric acid. c) To determine strength of supplied weak acid by titrimetric method. d) To determine the hardness of water complexometrically e) Estimation of Aspirin. f) Estimation of Fe(II) in the given solution by titrating against $K_2Cr_2O_7$ g) Gravimetric estimation of Nickel (II) as Ni-DMG and calculation of % error. (The learner is expected to know the role of the various reagents/chemicals used in the estimation, the various steps involved. They should write the complete and balanced chemical reaction for the formation of the Ni(DMG) complex. h) Gravimetric estimation of barium ions using K_2CrO_4 as precipitant. Calculation of % error. (The learner is expected to learn the skills of using the counterpoise technique used in this gravimetric estimation; Using counterpoise method whatman No.42 for filtration. In such a case no incineration or use of silica crucible is required.)	
3	**Colourimetry/ Spectrophotometry**	a) To determine λ_{max} for the supplied sample solution. b) To verify Beer Lambert's law. c) Colorimetric determination of copper ions in a given solution by using calibration curve method and calculation of % error. d) Estimation of concentration of iron from a given sample calorimetrically by using 1, 10 phenanthroline. (The learner is expected to learn the handling of the colorimeter.)	

References:

1. Fundamentals of Analytical Chemistry, 8th edition D.A. Skoog, D.M. West, F. J. Holler and CX. R. Crouch.
2. Modern Analytical Chemistry, David Harvey (page numbers 596-606).
3. Text book of Quantitative Inorganic Analysis", A.I. Vogel. "Longman, London (1961).
4. "Analytical Chemistry. Methods of Separation", R.V. Dilts van Nostrand, N.Y. (1974).
5. Some Experiments for B. Tech in Chemistry & Chemical Technology compiled by Prof. J.B. BARUAH, Mrs. Abhilasha Mohan Baruah and Mr. Parikshit Gogoi.

Evaluation Pattern: Practical Total Marks: 50

A. Continuous Internal Evaluation: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Performance during practical session Skill, accuracy, precision of measurement, record of observation, calculations, graph, result and conclusion. Timely submission of journal.	15
02	Overall performance (attendance, punctuality, interaction during practical session throughout semester)	05
Total		**20**

B. Semester End Examination: 60% (30 Marks)

Sr. No.	Title	Method	Marks
1.	Classical Analysis Colorimetric / Spectrophotometry	Any one experiment to be performed as per the practical slip	25
Viva voce and journal			05
Total			**30**

CIE / Internal	SEE	Total
20	30	50

Syllabus for B.Sc. Chemistry from the year 2024-25

Nomenclature of the Course	Basics in Analytical Chemistry II
Course Code	24_USCH405
Class	S.Y.B.Sc. (Chemistry)
Semester	IV
No. of Credits	02
Nature	Theory
Type	Minor

Nomenclature: Basics in Analytical Chemistry

Course outcomes:

On successful completion of this course learners will be able to:

CO1: Describe separation techniques in analytical chemistry, estimate analytes without affecting separation and explore principles like the Nernst distribution law and partition coefficient, describe chromatography techniques, such as paper and thin-layer chromatography and their applications in determining solute purity and studying reaction progress.

CO2: Define and explain potentiometric titrations, including principles, applications, and techniques for endpoint detection using reference and indicator electrodes. explores pH metry, focusing on combined glass electrodes in titrimetry and environmental analysis, describe conductometric titrations, their principles, applications in acid-base reactions and the methods advantages and limitations.

CO3: Identify and minimize errors in analysis, including determinate and indeterminate errors, through calibration and blank determinations, evaluate precision and accuracy using statistical measures such as mean, standard deviation and variance, describe random error distribution via Gaussian curves, criteria for rejecting doubtful results and techniques for graphical data representation and fitting straight lines.

Curriculum:

Unit	Title	Sub titles (Learning points)	No. of Hours
I	**Methods of Separation**	**1. Separation Techniques in Analytical Chemistry** **1.1 An Introduction to Analytical Separations and its importance in analysis.** **1.2 Estimation of an analyte without affecting separation.** **1.3 Types of separation methods :** 1.3.1 Based on solubilities (Precipitation, Filtration Crystallisation) 1.3.2 Based on gravity - Centrifugation 1.3.3 Based on volatility - Distillation 1.3.4 Based on electrical effects-Electrophoresis 1.3.5 Based on retention capacity of a stationary phase - Chromatography 1.3.6 Based on distribution in two immiscible phases-Solvent extraction. 1.3.7 Based on capacity to exchange with a Resin-Ion Exchange.	10

		1.4 Solvent extraction: 1.4.1 Introduction, Nernst distribution Law, distribution Ratio, partition coefficient and separation factor. 1.4.2 Conditions of extraction: Equilibration time, solvent volumes, temperature, pH. 1.4.3 Single-step and multistep extraction, Percentage extraction for single step and multistep extraction. 1.4.4 Batch and continuous extraction. **1.5 Chromatography:** 1.5.1 Introduction to Chromatography 1.5.2 Classification of chromatographic methods based on stationary and mobile phase 1.5.3 Paper chromatography: Principle, technique, applications 1.5.4 Thin layer chromatography-Principle, technique, applications with special reference to a) Determination of the purity of a given solute. b) Study of the progress of a given reaction.	
II	**Instrumental Methods-II**	**Instruments based on the electrochemical properties of the analytes** **2.1 Potentiometry:** 2.1.1 Principle 2.1.2 Role of reference and indicator electrodes 2.1.3 Applications in neutralization reactions with reference to the titration of strong acid against strong base (using quinhydrone electrode) 2.1.4 Graphical methods for detection of end points i) Graph of EMF against Volume of titrant added ii) First derivative graph **2.2 pH metry:** 2.2.1 Principle, construction, working and maintenance of combined glass electrode 2.2.2 Application (i) In titrimetry (Strong acid-strong base) (ii) Biological and Environmental analysis **2.3 Conductometry:** 2.3.1 Principle 2.3.2 Applications in Neutralization Titrimetry with respect to i) Strong Acid-Strong Base ii) Strong Acid-Weak Base iii) Weak Acid -Strong Base iv) Weak Acid- Weak Base 2.3.3 Advantages and limitations of conductometric titrations.	10
III	**Statistical Treatment of analytical data II**	**3.1 Errors in Analysis and their types**: 3.1.1 Determinate errors, indeterminate errors, absolute error and relative error. 3.1.2 Methods of minimizing determinate errors in analysis 3.1.3 Calibration of apparatus, carrying out control determination, carrying out blank determination 3.1.4 Concept of precision and accuracy in analysis, mean, median, mode, absolute deviation, average deviation standard	10

		deviation, variance and coefficient of variation. **3.2 Distribution of random errors:** 3.2.1 Gaussian distribution curve. 3.2.2 Equation and salient features of Gaussian distribution curve **3.3 Criteria for rejection of doubtful result:** i) 2.5 d ii) 4d rule iii) Q test **3.4 Graphical representation of data and obtaining best fitting straight line** i) For line passing through origin. ii) For line not passing through origin. (Numerical problems wherever possible, expected)	

References:

1. Instrumental Analysis by Douglas A. Skoog, F. James Holler, Stanley R.Crouch.
2. D. A. Skoog, D. M. West, F. J. Holler, and S. R. Crouch, Analytical Chemistry: An Introduction, 7th Edition., Chapter 15, pp. 345-381.
3. Instrumental Methods of Analysis by Willard, H.H.; Merritt, L.L. Jr.; Dean, J. A.; Settle, 7th Edition.
4. Gary D. Christan, "Analytical Chemistry", VIth Edition, Wiley Students Edition.
5. Fundamental of Analytical Chemistry by Douglas A. Skoog, West, F . James Holler, S. R. Crouch.
6. Modern Analytical Chemistry by David Harvey, McGraw-Hill Higher Education.
7. S. M. Khopkar, "Basic Concepts of Analytical Chemistry", IInd Edition New Age International Publisher.
8. R.V. Dilts. "Analytical Chemistry. Methods of Separation," van Nostrand, N.Y. (1974).

Teaching Plan:

Unit No.	Unit Title	Teaching Methods	No. of Lectures.
I	Methods of Separation	Lecture, PPT	10
II	Instrumental Methods-II	Lecture, PPT	10
III	Statistical Treatment of analytical data	Lecture, PPT, Demo	10

Evaluation Pattern:

A. Continuous Internal Evaluation (40%) : 20 Marks

Sr. No.	Particulars	Marks
1	Unit Test (MCQ / Descriptive – Based on Theory and/or Problems - Online/Offline – 1 unit test of 10 marks	10
2	Assignment / seminar / class test / worksheets	05
3	Active participation in routine class instructional deliveries and Overall conduct as a responsible learner.	05
	Total	**20**

B. Semester End Evaluation (Paper Pattern) (60%): 30 Marks

Semester End Examination (paper pattern) (30 marks- 1 hour): 30 Marks

Guidelines for paper pattern for Semester End Examination 30 marks per paper semester end theory examination:

a. Duration – This examination shall be of one hour duration.

b. Theory question paper pattern:

There shall be three questions each of 10 marks on each unit.

All questions shall be compulsory with internal choice within the questions

Question Number	Unit	Marks
1	I	10
2	II	10
3	III	10

CIE	SEE	Total Marks
20	30	50

Syllabus for B.Sc. Chemistry from the year 2024-25

Nomenclature of the Course	Basics in Analytical Chemistry
Course Code	24_USCH406
Class	S.Y.B.Sc. (Chemistry)
Semester	IV
No. of Credits	02
Nature	Practical
Type	Minor

Nomenclature: Basics in Analytical Chemistry

Course Outcomes:

On successful completion of this course learners will be able to

CO1: Know the various analytical tools used in laboratory.

CO2: Handle different equipments like, vacuum distillation assembly, centrifuge machine.

CO3: Understand construction and working of conductivity cell and glass electrode.

CO4: Separate components in a mixture using paper chromatography and TLC.

CO5: Apply the Solvent extraction for extraction of Fe (III).

CO6: Handle Potentiometer and pH meter effectively.

CO7: Estimate strength of HCl acid potentiometrically using quinhydrone electrode.

CO8: Able to handle a conductometer.

CO9: Determine strength of weak acid against strong base conductometrically.

CO10: Calculate the mean, mode and median from the given data.

CO11: Draw best fitting straight line by using method of least square and method of averages from given data.

Curriculum:

Sr. No.	Title	Sub title (Learning points)	No. of Hours
1	**Tools of Analytical Chemistry-II**	Filtration flasks, funnels, separating funnels, distillation apparatus, vacuum distillation assembly, centrifuge machine, electrophoresis apparatus. Development chamber for chromatography Electrodes like reference electrodes and indicator electrodes (with respect to care and maintenance) Conductivity cell (with respect to care and maintenance) combined glass electrode (with respect to care and maintenance) Types of Salt bridges and preparation of anyone or use of a salt	60

		bridge, its effect on the potential of a given electrode/cell (The learner should draw diagrams and write-ups of the items including principle, construction care and uses of items in his /her journal.)	
2	**Separation techniques**	a) Paper chromatography: Separation of cations like Fe (III), Ni (II) and Cu (II) in a sample. b) Separation of a solute between two immiscible solvents to determine the distribution ratio and/or extraction efficiency. (Solutes could be as their aqueous solutions and the organic solvent ethyl acetate) Suggested solute for the distribution study: Fe(III) in aqueous solutions. (The learner is expected to learn the technique of solvent extraction by using a separating funnel, method to estimate the concentrations of the solute distributed in the two immiscible phases, determination of the extraction efficiency) c) TLC: Separation of given mixture of two solutes by TLC method.	
3	**Instrumental methods**	a) To determine the amount of HCl using quinhydrone electrode potentiometrically. b) Estimation of Fe (II) in the given solution by titrating against $K_2Cr_2O_7$ potentiometrically and calculation of % error. (The learner is expected to learn the handling of the potentiometer, use of Platinum electrode and reference electrode like SCE. They will learn to determine endpoints by plotting a graph. They are also expected to state the error estimate of their results). c) To determine the amount of acetic acid in vinegar by titrating against the standard solution of NaOH pHmetrically. d) Determination of buffer capacity of acid buffer and basic buffer. (The learner is expected to learn the use of pH meter, standardization of pH meter, use of Henderson's equation and calculation of buffer capacity.) e) To determine the amount of strong acid in the given solution by titrating against strong base conductometrically. f) To determine the amount of weak acid in the given solution by titrating against weak base conductometrically.	
4	**Graphical Representation of data**	a) To calculate the mean, mode and median from the given data. (The learner is expected to learn the central tendency) b) To draw a best fitting straight line by using 'method of least square' (Linear Regression of y on x) from given data. (The learner is expected to learn the graph plotting skill for the line not passing through the origin) c) To draw a best fitting straight line by using 'method of averages' from given data.(The learner is expected to learn the graph plotting skill for the line passing through the origin)	

References:

1. Fundamentals of Analytical Chemistry, 8th edition D.A. Skoog, D.M. West, F.J. Holler and CX. R. Crouch.
2. Solvent Extraction in Analytical Chemistry G. H. Morrison and H. Freiser.
3. Chromatographic Separations, Analytical chemistry by open learning, P.G. Swell and B. Clarke, John Wiley and sons, 1987.
4. Modern Analytical Chemistry, David Harvey (page numbers 596-606).
5. "Analytical Chemistry. Methods of Separation", R.V. Dilts van Nostrand, N.Y. (1974).
6. Some Experiments for B. Tech in Chemistry & Chemical Technology compiled by Prof. J.B. BARUAH, Mrs. Abhilasha Mohan Baruah and Mr. Parikshit Gogoi.

Evaluation Pattern: Practical Total Marks: 50

A. Continuous Internal Evaluation: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Performance during practical session Skill, accuracy, precision of measurement, record of observation, calculations, graph, result and conclusion. Timely submission of journal	15
02	Overall performance (attendance, punctuality, interaction during practical session throughout semester)	05
Total		**20**

B. Semester End Examination: 60% (30 Marks)

Sr. No.	Title	Method	Marks
1.	Separation techniques Instrumental methods	Any one Experiment to be performed as per the practical slip	25
Viva voce and journal			05
Total			**30**

Marks in SEE practical examination will be converted into 30 marks.

CIE / Internal	SEE	Total
20	30	50

Nomenclature of the Course	Skills in Classical method Analysis II
Class	S.Y. B.Sc.
Semester	III
Course Code	24_USCHS307
No. of Credits	02
Nature	Practical
Type	SEC

Nomenclature: Skills in Classical method Analysis II

Course Outcomes:

On successful completion of this course learners will be able to**:**

CO1: Understand the concept of stoichiometry and different methods of expressing solution concentrations, interconvert various concentration units.
CO2: Explain concept of redox reactions, theory of redox indicators and use of redox indictors.
CO3: Grasp the principles underlying complex formation between metal ions and complexing agents, theory of EDTA titrations.
CO4: Acquire experimental skills in classical methods of analysis.

Curriculum:

Unit No.	Unit Title	Sub titles (Learning Points)	No. of Hours
Unit I	**1.1 Chemical Calculations**	**1.1.1** Stoichiometry: Balanced chemical reaction, calculation based on chemical equation. **1.1.2** Inter conversion of various concentrationunits. (Conversion of concentration from one unit to another unit with examples) (Numerical andword problems are expected)	60
	1.2 Redox Titrations	**1.2.1** Introduction, Construction of the titration curves and calculation of E_{system} in aqueous medium in case of: (1) One electron system (2) Multi electron system. **1.2.2** Theory of redox indicators, Criteria for selection of an indicator Use of diphenyl amine and ferroin as redox indicators	
	1.3 Complexometric Titrations	**1.3.1** Introduction, construction of titration curve, Use of EDTA as titrant and its standardisation, absolute and conditional formation constants of metal EDTA complexes, Selectivity of EDTA as a titrant. **1.3.2** Factors enhancing selectivity with examples. Advantages and limitations of EDTA as a titrant. Types of EDTA titrations. Metallochromic indicators, theory, examples and applications	

Unit II	**Practicals**	1. To determine the normality of given sample of sodium thiosulphate 2. To determine the normality of given sample of potassium dichromate 3. To determine the normality of given sample of potassium permanganate 4. To determine the amount of coppersulphate in the given solution iodometrically. 5. To determine the amount of persulphate in the given sample solution by back titration with standard Fe (II) ammonium sulphatesolution. 6. To determine the amount of copper in thegiven solution complexometrically. 7. To determine the amount of Barium in thegiven solution complexometric alloy. 8. To determine the amount of Calcium and lead in a mixture complexometrically. 9. To determine amount of Calcium in milk powder complexometric alloy. 10. To determine amount of Calcium in antacid tablet complexometric alloy.	

References:

1) Analytical Chemistry Skoog, West, Holler, 7th Edition.
2) Fundamentals of Analytical Chemistry by Skoog and West, 8th edition.
3) Stoichiometry by By B I. *Bhatt*, S.B. Thakore McGraw Hill India 6th edition.
4) 3000 solved problems in Chemistry, David E. Goldberg, PhD., Schaums Outline.
5) Basic Concepts of Analytical Chemistry, by S M Khopkar, new Age International (p)Limited.
6) Vogel's Textbook of Quantitative Chemical Analysis 5th edition 1996 Longman.

Teaching Plan:

Unit No.	Unit Title	Teaching Methods	No. of Lectures
Unit I	Chemical Calculations,Redox Titrations & Complexometric Titrations	Lecture, PPT	15 Hrs.
Unit II	Practicals	Lecture, Demo, Experimentation	30 Hrs.

Evaluation Pattern:

A. Continuous Internal Evaluation (40%) : 20 Marks

Sr. No.	Particulars	Marks
1	Performance during practical session Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of journal.	15
2	Overall performance (attendance, punctuality, interaction during practical session throughout semester.	05
Total		**20**

B. Semester End Examination: 60% (30 Marks)

Sr. No.	Group	Title	Method	Marks
1.	A	Complexometric titration and redox titration	Experiment performance as per the practical slip	25
		Viva Voce and journal		05
Total				**30**

CIE	SEE	Total Marks
20	30	50

Syllabus for B.Sc. Chemistry from the year 2024-25

Nomenclature of the Course	Industrial Organic Chemistry
Class	S.Y. B.Sc.
Semester	IV
Course Code	24_USCHS407
No. of Credits	02
Nature	Practical
Type	SEC

Nomenclature: Industrial Organic Chemistry

Course Outcomes:

On successful completion of this course learners will be able to**:**

CO1: Understand the processes involved in refining crude oil into valuable products.

CO2: Grasp the fundamental principles of various unit processes in industries.

CO3: Acquire experimental skills in synthesis of raw materials using unit processes

Curriculum:

Unit No.	Unit Title	Sub titles (Learning Points)	No. of Hours
Unit I	**1.1 Raw materials for organic compounds**	Petroleum, Natural gas. Fractionation of crude oil, cracking, reforming, hydroforming, isomerisation. Coal: Types, structure, properties, Advantages and Disadvantages of coal.	60
	1.2 Unit Processes in Org. Chem. Manufacture-I	**1.2.1 Nitration:** Introduction-Nitrating agents, Kinetics and mechanism of nitration processes suchas nitration of: Paraffinic hydrocarbons, Benzene to nitrobenzene and m-dinitrobenzene, Chlorobenzene to o-and p-nitrochlorobenzenes, Acetanilide to p- nitro acetanilide, Toluene Continuous vs batch nitration. **1.2.2 Oxidation:** Introduction-Types of oxidation reactions, oxidizing agents, Kinetics and mechanism of oxidation of organic compounds Liquid phase oxidation, Vapor phase oxidation Commercial manufacture of benzoic acid maleic anhydride, phthalic anhydride, acetaldehyde, acetic acid.	
	1.3 Unit Processes in Org. Chem. Manufacture-I	**1.3.1 Alkylation:** Introduction, Types of alkylation, Alkylating agents., Thermodynamics and mechanism of alkylation reactions Manufacture of- alkylbenzenes (for detergent manufacture), ethylbenzene, phenyl ethyl alcohol, **1.3.2 Sulphonation:** Introduction- Sulphonating agents sulphonating agents, Chemical and physical factors in sulphonation. Kinetics and mechanism of sulphonation reaction, Commercial Sulphonation of benzene, naphthalene, Alkyl benzene, Batch vs continuous extraction **1.3.3 Esterification:** commercial manufacture of- ethyl	

		acetate, dioctyl phthalate, vinyl acetate, cellulose acetate **1.3.4 Hydrolysis:** Introduction, hydrolyzing agents, Kinetics thermodynamics and mechanism of hydrolysis	
Unit II	**Practicals**	1. Nitration of Nitrobenzene/acetanilide 2. Sulphonation: To prepare sulphanilic acidfrom aniline 3. Oxidation reactions: To prepare Benzoic acid from Benzaldehyde. 4. Esterification: Conversion of acetic acid intoethyl acetate 5. Hydrolysis: To prepare p-nitroaniline fromp-nitroacetanilide 6. Polymerization: Preparation of Nylon 6.6 Industrial visit & its report	

References:

1. Unit Process in Organic Synthesis, by Groggins P.M., 5th edition, International studentedition, Pubs: McGraw-Hill Book Co., New York, 1998.
2. Text Book on Chemical Technology, Vol.1 and 2, by Pandey G.N. Pubs: VikasPublishing Company, 1997.
3. Dryden's outlines of Chemical Technology, edited and revised by Gopala Rao M. andMarshall S, Pubs: East-West Press, New Delhi, 3 rd edition, 2008.
4. Laboratory Manual of Organic chemistry; by Bansal, R.K., 3rd edition, Pubs: WileyEastern Limited, 1994.

Teaching Plan:

Unit No.	Unit Title	Teaching Methods	No. of Lectures
Unit I	Raw materials for organic compounds, Unit Processes in Org. Chem. Manufacture-I	Lecture, PPT	15 Hrs.
Unit II	Practicals	Lecture, Demo, Experimentation	30 Hrs.

Evaluation Pattern:

A. Continuous Internal Evaluation (40%) : 20 Marks

Sr. No.	Particulars	Marks
1	Performance during practical session Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of journal.	15
2	Overall performance (attendance, punctuality, interaction during practical session throughout semester.	05
Total		**20**

B. Semester End Examination: 60% (30 Marks)

Sr. No.	Group	Title	Method	Marks
1.	A	One step preparation of raw material	Experiment performance as per the practical slip	25
		Viva Voce and journal		05
Total				**30**

CIE	SEE	Total Marks
20	30	50

Syllabus for B.Sc. Chemistry from the year 2025-26

Name of the Course	Skill Course in Water Quality testing
Course Code	25_USCHS308
Class	UG
Semester	III
No of Credits	2
Nature	Practical
Type	Skill Enhancement Course
Relevance with Employability/ Entrepreneurship/ Skill development	This course equips students with essential skills in water quality analysis, aligning with job roles in environmental labs, municipal water departments, and pollution control boards. It enhances employability in sectors such as environmental consultancy and industrial quality control. The hands-on training also fosters entrepreneurship by enabling students to offer basic water testing services in rural and urban areas, promoting safe water awareness.

Course Outcomes:

- To develop hands-on skills in analyzing water samples.
- To make students aware of water quality standards and pollution indicators.
- To train students in using basic instruments and chemical methods for water analysis.
- To connect laboratory skills with environmental chemistry applications.

Curriculum:

Unit	Learning points	No. of hours
Unit 1	**Introduction to Water Analysis** • Types of water: surface, groundwater, wastewater, potable water. • Parameters of water quality: physical, chemical, and biological. • BIS and WHO standards for drinking water. **Sampling and Preservation** • Sampling techniques for water from different sources. • Sample preservation and storage **Physical Parameters** • Temperature, color, turbidity, pH, conductivity. • Use of pH meter and conductivity meter. **Chemical and Physico-Chemical Parameters** water quality parameters viz. chlorides, Turbidity – TDS, Hardness, sulphates, calcium, magnesium, sodium, potassium, BOD, COD, DO	60
Unit II	Practicals	
	Water Quality Testing Experiments	
1	To determine pH, conductivity of given water sample.	
2	To determine alkalinity of water.	
3	To determine TDS of given sample of water.	
4	To determine hardness of water.	

5	To determine potassium in water sample by flame photometric method.	
6	To determine Calcium water sample by complexometric titration.	
7	To determine sulphate in water sample.	
8	To determine Chloride water sample by argentometric titration.	
9	To determine dissolved oxygen in water sample.	
10	To determine COD in water sample.	
11	To determine BOD in water sample.	
12	Demonstration of Digital Water analysis Kit.	
Unit III	**Field Visit / Project Work / Mini Report** • Visit to municipal water treatment plant / river monitoring site. • Submission of short report based on water sample analysis or field visit.	

References:

1. APHA, AWWA, WEF, *Standard Methods for the Examination of Water and Wastewater*, 23rd Ed.
2. S.K. Jain and S. Chourasia, *Water Pollution and Health*, CBS Publishers.
3. R.C. Rajagopalan, *Environmental Studies*, Oxford University Press.
4. Sawyer, McCarty, Parkin, *Chemistry for Environmental Engineering and Science*, McGraw-Hill.
5. BIS and WHO Guidelines for Drinking Water Quality (latest editions).

Evaluation Pattern: Practical Total Marks: 50

A) Internal Assessment (Unit I and III): 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	One written class test (objective)	10
02	Project report / field report	10
Total		**20**

B) Semester End Examination (Unit II): 60% (30 Marks)

Sr. No.	Group	Title	Method	Marks
1.	Major Experiment	Any one of the experiment	Experiment performance as per the practical slip	20
2.	Viva Voce & Journal			10
Total				**30**

CIE / Internal	SEE	Total
20	**30**	**50**

Syllabus for B.Sc. Chemistry from the year 2025-26

Name of the Course	Skill Course in Soil Analysis
Course Code	25_USCHS408
Class	UG
Semester	IV
No of Credits	2
Nature	Practical
Type	Skill Enhancement Course
Relevance with Employability/ Entrepreneurship/ Skill development	This course equips students with essential skills in soil quality analysis, aligning with job roles in environmental labs, municipal soil departments, and pollution control boards. It enhances employability in sectors such as environmental consultancy and industrial quality control. The hands-on training also fosters entrepreneurship by enabling students to offer basic soil testing services in rural and urban areas, promoting safe soil testing awareness.

Course Outcomes:

- To develop hands-on skills in analysing soil samples.
- To make students aware of soil quality standards and pollution indicators.
- To train students in using basic instruments and chemical methods for soil analysis.
- To connect laboratory skills with environmental chemistry applications.

Curriculum:

Unit	Skill Enhance Course in Soil Testing	No. of Hours
I	**1.1 Introduction to Soil Chemistry** Definition of soil, Overview of Soil composition and properties, Types of soil and their significance, Importance of soil analysis for agricultural and environmental purposes. Relationship Between Soil Chemistry and Plant Nutrient Uptake. Role of Soil Chemical Analysis in Sustainable Agriculture. **1.2. Basic laboratory techniques in soil analysis** Collection of soil samples and Importance of soil sampling. Soil sample preparation method Safety protocols in the laboratory.	**60**
	2.1 Physical properties of soil Soil texture, structure and porosity. Bulk density and water retention capacity. **2.2 Soil pH and Electrical Conductivity (EC)** Methods to measure soil pH and Electrical Conductivity **(**EC) Interpreting pH and EC in relation to soil fertility.	

	3.1 Nutrient Analysis and Interpretation of Nutrient Levels in Soil: Nitrogen (N) Content: Kjeldahl Method for Total Nitrogen Measurement Phosphorus (P) Content: Olsen Method for Measurement of Available Phosphorus Potassium (K) Content: Flame Photometry for Potassium Measurement. Organic Carbon(C) Content: Spectrophotometric determination of Organic Carbon in Soil. Boron (B) Content: Spectrophotometric determination of Boron in Soil. **3.2 Micronutrient Analysis and Interpretation of Nutrient Levels in Soil**: Analyzing Elements: Iron (Fe), Manganese (Mn), Zinc (Zn) and Copper (Cu) in soil sample.	
	4.1 Soil Testing Equipment Introduction to Common Laboratory Equipment Used in Soil analysis. **4.2 Calibration of Instruments** pH meter, conductometer, Flame photometer, Atomic Absorption Spectroscopy and spectrophotometer. **4.3 Preparation of Standard Solutions and Reagents** Preparation of standard solutions and reagents that are essential for accurate soil chemical analysis.	
	5.1 Interpretations of Soil Test Results **5.1.1 Data Analysis and Interpretation:** Understanding Soil Test Reports, Understanding Soil Nutrient Levels in Terms of Agricultural Recommendations. **5.1.2 Fertilizer Recommendations Based on Soil Test Results:** Fertilizer Application based on Soil Chemical Analysis report. **5.1.3 Soil Fertility and Management:** Recommendations for Soil Improvement and Amendment.	
II	**Practicals**	
	1. Soil Sampling and Preparation for Analysis: Collection, Identification, and Reagent Preparation.	
	2. Determination of Water holding capacity of soil.	
	3. Determination of pH of soil sample using pH meter.	
	4. Determination of Electrical Conductivity of Soil Sample using Electrical Conductivity meter.	
	5. Determination of available Nitrogen from Soil Sample.	
	6. Determination of available phosphorus from soil sample using Olsen Method.	
	7. Determination of available Potassium from soil sample.	
	8. Determination of Organic Carbon from soil sample.	
	9. Determination of Boron from soil sample.	
	10. Determination of micronutrients (Iron (Fe), Manganese (Mn), Zinc (Zn) and Copper (Cu)) from soil sample.	
	11. Soil Sampling and Preparation for Analysis: Collection, Identification, and Reagent Preparation.	

Evaluation Pattern: Practical Total Marks: 50

A) Internal Assessment (Unit I): 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	One written class test (objective)	10
02	Project report / field report	10
Total		**20**

B) Semester End Examination (Unit II): 60% (30 Marks)

Sr. No.	Group	Title	Method	Marks
1.	Major Experiment	Any one of the experiment	Experiment performance as per the practical slip	20
2.	Viva Voce & Journal			10
Total				**30**

CIE / Internal	SEE	Total
20	**30**	**50**

Nomenclature of the Course	**Community Engagement and Service**
Class	SYBSc
Semester	IV
Course Code	24_USCHC408
No. of Credits	02
Nature	Project
Type	Elective Course

Course Outcomes:

After successful completion of this course the learner will be able to

CO1: Contribute positively to the community by addressing local needs and challenges through science-based activities such as conservation of environment, promotion of good health and STEM education initiatives.

CO2: Develop a sense of social responsibility and civic engagement by actively participating in community-based projects and understanding the importance of giving back to society.

CO3: Gain interdisciplinary perspectives by applying scientific knowledge and skills to real-world issues, collaborating with individuals from diverse backgrounds, including community members, educators and professionals.

CO4: Reflect on their experiences, challenges and accomplishments which will contribute to their personal growth, self-awareness and resilience.

CO5: Enhance their employability and career readiness by gaining practical experience, networking opportunities and exposure to real-world applications of scientific knowledge.

CO6: Cultivate a lifelong commitment to community continuing to apply their scientific expertise and skills to address societal issues and contribute to positive change throughout their lives.

Guidelines for Community Engagement and Service (CEP)

This course requires learners to participate in field-based learning /projects generally under the supervision of faculty. It will involve activities that expose learners to socio-economic issues in society.

Learner has to work 90 hours in a semester for Community Engagement and Service Project.

30 hours for classroom activities

- Classroom activities include preparation for community engagement and service, independent reading and study, analysis of data and preparation of report etc.

60 hours for Field work

- Field work includes implementation of the planned community engagement activities according to the program schedule, collection of data
- Engagement activities may include events, workshops, meetings or door-to-door outreach.

Learners can participate in activities related to National Service Scheme (NCC), National Cadet Corps (NCC), Adult education / Literacy initiatives, Mentoring of school learners / Organization of Open Day/ Celebration of day on various national and international days like National Science Day, International Day of Women and Girls in Science etc.

Evaluation Pattern

A) Continuous Internal Evaluation: Maximum Marks (20):

Method	Marks
CEP report	15
Active Participation	05

B) Semester End Examination: Maximum Marks (30):

Method	Marks
Field work Undertaking and completing community engagement and service	30

Sr. No.	*Activities for Community Engagement and Service*
1	Host science talks or webinars open to the public on topics of scientific interest
2	Anti-Drug awareness campaign in an urban/ rural area
3	Engage community members in citizen science projects
4	Organize a science fair or exhibition
5	Aids awareness campaign in an urban/ rural area
6	Environment awareness campaign
7	Water Conservation Awareness program in an urban/ rural area
8	Design and execute a waste management initiative in an urban neighborhood.
9	Conduct surveys on access to clean water and sanitation facilities in both rural and urban settings
10	Conduct / participate in workshops or seminars to provide guidance and information about career opportunities in STEM fields
11	Organize science outreach workshops for local schools or community centers on various science topics
12	Create educational materials on environmental conservation and distribute them in schools and communities.
13	Organize events for building scientific temper
14	Implement initiatives to promote sustainable energy practices in rural environment.
15	Establish community-driven initiatives for disaster preparedness and response.
16	Organize community clean-up drives in both rural and urban areas.
17	Collaborate with local businesses to provide vocational training and job opportunities.
18	Establish community-led initiatives for environmental conservation and biodiversity preservation.
19	Organize campaigns to promote responsible consumption and waste reduction.
20	Implement initiatives to address food insecurity and malnutrition in both settings.
21	Establish community-based initiatives for urban agriculture projects.
22	Organize capacity-building workshops for community-based environmental organizations.
23	Establish community-led initiatives for waste reduction and recycling.
24	Survey on quality and availability of water and awareness program.
25	Survey on quality of soil and soil fertility and awareness about sustainable farming practices.
26	Promoting safe and sustainable household cleaning products
27	Chemistry in daily life: Community Science Awareness Campaign
28	Awareness on Harmful Effects of Adulterants in Food
29	Any other subjects of your choice and get it approved by the CEP guide

Date: **Signature**

Place: Ratnagiri **Chairperson and HoD**

Ratnagiri Education Society's

R. P. Gogate College of Arts and Science and R. V. Jogalekar College of Commerce (Autonomous), Ratnagiri

Meeting of BoS in Chemistry

Date	17th April 2025
Time	11.30 AM
Venue	Department of Chemistry
Mode	Hybrid

Attendance

Sr. No.	Name and type of the Member	Present mode Online / Offline	Signature
1	Name: Dr. Mrs. Aparna M. Kulkarni Head of the Department (Chairman)	offline	
2	Name: Dr. Ghanashyam B. Sathe (VC nominee)	leave	
3	Name: Prof. Savita Ladage Dean. HBCSE, TIFR Mumbai	Online	
4	Name: Dr. Ganpat K. Naik HOD Chemistry, Parvatibai Chougule College Madgaon, Goa	Online	
5	Name: Mr. Anil Kumar Satpathy Head of QA QC Finolex Industries Pvt Ltd, Ranpar	Online	
6	Name: Dr. Vikas Kulkarni, GM, Lupin Pharmaceuticals, Mumbai Alumnus	Online	
7	Name: Mr. Maruti B. Kamble Department faculty member (1)	offline	
8	Name: Dr. Swaminath L Bhattar Department faculty member (2)	offline	
9	Name: Dr. Umesh B. Sankpal Department faculty member (3)	offline	
10	Name: Dr. Meghana E. Mhadye Department faculty member (4)	offline	
11	Name: Mrs. Pratikha Barsakar Department faculty member (5)	offline	
12	Name: Mr. Ankit A Surve Department faculty member (6)	offline	
13	Name: Trupti Gajanan Joshi Department faculty member (7)	offline	
14	Name: Miss Rina B. Shinde Department faculty member (8)	offline	
15	Name: Mr. Shirin S Limaye Department Faculty member (9)	offline	
16	Name: Mr. Ganesh M. Rathod Department faculty member (10)	offline	
17	Name: Sakshi Sanjay Chalake Department faculty member (11)	offline	