Academic Council Meeting No. and Date: 9/ July 02, 2024
Agenda Number: 3 Resolution Number: 41,42 /3.2,3.22

Vidya Prasarak Mandal's
N. Bandodkar College of Science
(Autonomous), Thane

Syllabus for

Programme Code: BUCH

Programme: Bachelor of Science

Specific Programme: Chemistry

(Major/Minor/Generic)

[S. Y. B. Sc. Chemistry]

Level 5.0

CHOICE BASED GRADING SYSTEM

Revised under NEP

From academic year 2024-2025

Preamble

Continuing the Choice Based Credit System (CBCS) implemented by the esteemed University of Mumbai from the academic year 2016-2017, the existing syllabus of S.Y.B.Sc.(level 5.0) is restructured according to the NEP reforms for its effective implementation in level 5.0 from 2024-25 under the autonomous status of VPM's B. N. Bandodkar College of Science

The B.Sc. (Chemistry) programme is aimed to make the students employable and impart industry-oriented training. The main objectives of the course are:

- Encourage curiosity about the foundational principles of chemistry, sparking a desire to explore and understand the underlying concepts.
- To be capable of managing field projects in relation to chemistry and its allied branches, considering human, financial, and environmental factors.
- To excel in effective communication, analytical thinking, teamwork towards shared objectives, and cultivating managerial prowess.
- To leverage their knowledge and skills for successful employment and advancement in chemical industrial work.
- To effectively communicate with both technical and non-technical audiences.

The syllabus is aimed to achieve the objectives. The syllabus spanning three years covers the industry relevant courses. The learners will be ready for the jobs available in different fields like:

Electrochemistry, semiconductors, Polymer chemistry, instrumentation , glassware and instruments industries, environmental chemistry, pharmaceutical and drugs chemistry, Cement industry, food and drugs industry , medicinal chemistry dyes and paint industries, oil industries , various chemical laboratories (NGO and Govt) forensic sciences, FDA, Pollution controlled Boards, Alloy and Metallurgy , Perfumery Quality control &Assurance, Research & development (R & D) ,various digital skills such as chem. Draw, chemo-informatics, bioinformatics, computational chemistry and animation. Bussiness Management Chemical technology, entrepreneur skill, pharmaceutical management, Hospital administrative management etc,

Prof. Dr. Anita S. Goswami-Giri
Chairperson, BOS Chemistry
VPM's B. N. Bandodkar College of Science (Autonomous), Thane

PROGRAMME OUTCOMES (POs) OF BACHELOR OF SCIENCE (B.Sc.)

The Undergraduate Programmes of Science are intended to cater quality education and attain holistic development of learners through the following programme outcomes:

PO1 - Disciplinary Knowledge

Lay a strong foundation of conceptual learning in science. Instill ability to apply science in professional, social and personal life.

PO2 - Inculcation of Research Aptitude

Ignite spirit of inquiry, critical thinking, analytical skills and problem-solving approach which will help learners to grasp concepts related to research methodology and execute budding research ideas.

PO3 - Digital Literacy

Enhance ability to access, select and use a variety of relevant information e-resources for curricular, co-curricular and extracurricular learning processes.

PO4 - Sensitization towards Environment

Build a cohesive bond with nature by respecting natural resources, encouraging eco-friendly practices and creating awareness about sustainable development.

PO5 - Individuality and Teamwork

Encourage learners to work independently or in collaboration for achieving effective results through practical experiments, project work and research activities.

PO6 - Social and Ethical Awareness

Foster ethical principles which will help in developing rational thinking and becoming socially aware citizens. Build an attitude of unbiased, truthful actions and avoid unethical behavior in all aspects of life.

Eligibility: Level 4.5 (F.Y. B.Sc)
Duration: 3 years (Syllabus for Second Year semester III & IV)
Mode of Conduct: Laboratory Practicals /Offline lectures/ Online lectures
Discipline/Subject: Chemistry
Specific Programme: B.Sc. CHEMISTRY
Level: 5.0
Qualification Title: UG certificate

Discipline/Subject: CHEMISTRY

Program Specific Outcomes-Chemistry

1.	**PSO 1: Core Chemical Knowledge** Students will acquire a strong foundational understanding of inorganic, organic, physical, and analytical chemistry, enabling them to explain chemical principles, molecular behavior, and reaction patterns across all three years.	L2
2.	**PSO 2: Laboratory Skills & Instrumentation** Students will develop competency in classical and modern laboratory techniques, including titrimetry, chromatography, spectroscopy, and safe handling of chemicals, ensuring precise experimentation and reliable data generation.	L3

3.	**PSO 3: Chemical Calculations & Data Interpretation** Students will master stoichiometric calculations, concentration units, titration curves, spectral interpretation, and other quantitative tools required for scientific reasoning and problem-solving.	L4
4.	**PSO 4: Synthetic and Analytical Problem-Solving** Students will learn to plan, execute, and troubleshoot organic and inorganic syntheses, purifications, and qualitative/quantitative analyses using logical thinking and evidence-based approaches.	L4
5.	**PSO 5: Application of Chemistry to Industry, Environment & Society** Students will understand the role of chemistry in pharmaceuticals, materials, environment, agriculture, energy, and sustainability, fostering responsible thinking and real-world application.	L5
6.	**PSO 6: Scientific Communication, Ethics & Teamwork** Students will develop skills to record, analyze, and present scientific information effectively while demonstrating integrity, safety consciousness, and collaborative behavior in laboratory and academic settings.	L6
Specific Programme: S. Y. B. Sc. (CHEMISTRY -Major/ Minor/Generic)		

Assessment: Weightage for assessments (in percentage) For Major and Minor			
Type of Course	Formative Assessment / IA	Summative Assessment	
Theory	40%	60%	

VPM's B.N. Bandodkar College of Science (Autonomous), Thane

S. Y. B. Sc.

Curriculum Structure for the Undergraduate Degree Program S.Y.B.Sc. Chemistry

Structure of Programme

Semester-wise Titles of the Papers in S.Y.B.Sc. (Major Chemistry)

Year	Sem.	Course code	Course Title	Theory/ Practical	No. of Lectures	Credits
Second Year	III	**24BUCH3T01**	Physical and Allied Chemistry-I	Theory	30	02
		24BUCH3T02	Inorganic and Allied Chemistry-I	Theory	30	02
		24BUCH3T03	Organic and Allied Chemistry-I	Theory	30	02
		24BUCH3P01	Practicals based on 24BUCH3T01 and 24BUCH3T02	Practical	60	02
		24BUCH3P02	Practicals based on 24BUCH3T02 and 24BUCH3T03	Practical	60	02
		24BUCH3P03	Field Project In Chemistry-I	Practical	60	02
		24BU3SEC02	Separation Techniques in Analytical Chemistry	Theory +Practical	15+30	02
		Total			**315**	**14**
			Minor			
		24BUCH3T04	Principles of Analytical Chemistry and Nanomaterials	Theory	30	02
		Total			**30**	**02**
			Generic			
		24BUCH3T05	Cosmetics and Introduction to Dye Stuff Chemistry	Theory	30	02
		Total			**30**	**02**
		Total			**375**	**18**
		24BUCH4T01	Physical and Allied Chemistry-II	Theory	30	02
		24BUCH4T02	Inorganic and Allied Chemistry-II	Theory	30	02

	IV	**24BUCH4T03**	Organic and Allied Chemistry-II	Theory	30	02
		24BUCH4P01	Practicals based on 24BUCH4T01 and24BUCH4T02	Practical	60	02
		24BUCH4P02	Practicals based on 24BUCH4T02 and 24BUCH4T03	Practical	60	02
		24BUCH4P03	Field Project in Chemistry II	Practical	60	02
		24BU4SEC02	Extraction and fabrication methods	Theory +Practical	15+30	02
		Total			**315**	**14**
			Minor			
		24BUCH4T04	Electrochemistry and Green chemistry	Theory	30	02
		Total			**30**	**02**
			Generic			
		24BUCH4T05	Environmental and Pharmaceutical Chemistry	Theory	30	02
		Total			**30**	**02**
		Total			**375**	**18**

B. N. Bandodkar College of Science, (AUTONOMOUS)-Thane

S.Y.B.Sc.

Level	SEM.	Faculty - DSC							Vocational & Skill Enhancement Course (VSEC)	Ability Enhancement Course (AEC) / Indian Knowledge System (IKS)			Field Project / Apprenticeship / Community Engagement & Services		Credit	Cumulative Credits
		Subject					Subject	Any Faculty Subject								
		Major (6T + 4P)					Minor	GE & OE								
		Course - I	Course - II	Course - III	Practical Course – I	Practical Course – II	Course – I	Course – I		AEC	VEC	IKS	FP	CC		
5.0	III	02 (2T)	02 (2T)	02 (2T)	02 (2P)	02 (2P)	02 (2T)	02 (2T)	02 (1T + 1P)	02 (2P)	-	-	02 (2P)	02 (1T + 1P)	22	44
	IV	02 (2T)	02 (2T)	02 (2T)	02 (2P)	02 (2P)	02 (2T)	02 (2T)	02 (1T + 1P)	02 (2P)	-	-	02 (2P)	02 (1T + 1P)	22	

Semester III

Course Code 24BUCH3T01	Course Title: **Physical and Allied Chemistry-I**	Credit 2	No. of Lecture 30

Course Outcomes:

CO1	Outline concept of conductance, transport number and their applications	L2
CO2	Explain significance of free energy and concept of partial molar properties	L2
CO3	Understand solution behavior, Raoult's law deviations, and liquid miscibility.	L2
CO4	Understand complex reaction types, factors affecting reaction rates, and basics of polymer structures and terminology.	L2

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	0	1	0	0
CO2	3	2	0	0	0	1
CO3	3	2	0	1	0	0
CO4	3	1	0	0	0	0

UNIT I	**1. Electrochemistry: (8 L)** **1.1.** Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. **1.2.** Kohlrausch law of independent migration of ions. **1.3.** 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). **1.4.** Transference number and its experimental determination using Moving boundary method. (Numericals expected). Factors affecting transference number. 2. Chemical Thermodynamics-II: (7 L) **1.1.** Free Energy Functions: Helmholtz Free Energy, Gibb's Free Energy, Variation of Gibb's free energy with Pressure and Temperature, Gibbs-Helmholtz equation. **1.2.** Thermodynamics of Open System: Partial Molal Properties, Chemical potential and its variation with P and T, Gibb's Duhem equation. **1.3.** Concept of Fugacity and Activity.	**15**

UNIT II	**2.1 Solutions: (8L)** 2.1.1 Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law–non-ideal solutions. Vapor pressure-composition and temperature- composition curves of ideal and non-ideal solutions. Azeotropes and Zeotropes definition and significance in solution behavior 2.1.2 Partial miscibility of liquids: Definition, Effect of Temperature, effect of impurity and Intermolecular Interactions on partial miscibility, Critical solution temperature. Phenol-water, Triethanolamine – Water, and nicotine–water systems. **2 Chemical Kinetics: (5L)** 2.2 Introduction to reaction mechanism, Types of Complex Chemical reactions: Reversible or opposing, consecutive and parallel reactions. (No derivations, only examples expected) 2.2.2 Effect of temperature on reaction rate, Arrhenius equation (Numericals expected) 2.2.3 Collision theory of reaction rate (Only Postulates expected) **2.3 Polymer Chemistry: (2 L)** 2.3.1 Basic Terms: Macromolecule, monomer, repeat unit, Polymerization, (addition and condensation polymerization), Degree of Polymerization. 2.3.2 Polymer structures linear, branched and cross-linked	**15**

Reference Books:

Unit I:

1. Barrow, G.M. Physical Chemistry Tata McGraw‑Hill (2007).
2. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry Cengage Learning India Pvt.Ltd., New Delhi (2009).
4. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
5. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co., NewYork (1985).
6. K. L. Kapoor A textbook of Physical Chemistry3rd Ed. vol.1,2 Macmillan Publishing Co., New Delhi(2001)

Unit II:

1. Kenneth Connors. (1990). Chemical Kinetics. VCH Publishers.
2. Levine, Ira N. (1988). Physical Chemistry (Third edition). McGraw-Hill Inc.
3. Garde,Shekhar, Garcia, Angel, Pratt, Lawrence, Hummer, Gerhard. " Temperature Dependence of the Non-polar Solubility of Gases in Water". Biophysical Chemistry. Volume 78. Issues 1-2. 1999.

Yalkowsky, Samuel H. Solubility and Solubilization in Aqueous Media, 1st Edition

Course Code 24BUCH3T02	Course Title: Inorganic and Allied Chemistry-I	Credit 2	No. of Lecture 30

Course Outcomes:

CO1	Understand nondirectional (ionic), directional (covalent) bonding approaches, types of crystal, radius ratio rules and born haber cycle to calculate lattice energy of ionic compounds	L3
CO2	Know the applications and limitations of valence bond theory with respect to chemical bonding and concept of hybridisation, MOT and its application	L2
CO3	Explain the structure, electron deficient nature, preparation and properties of compounds of boron, its uses, lewis acid characteristics of boron halides, electronic configuration, periodic trend of boron and carbon family, understand preparation, structure, occurrence, semiconducting properties, extraction and purification techniques of silicon and germanium.	L2
CO4	Understand electronic configuration, periodic trend, properties, preparation of halides, hydrides and oxides of nitrogen family elements Synthesis of ammonia by Haber-Bosch process..	L2

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	0	1	0	0
CO2	3	2	0	0	0	0
CO3	3	2	0	1	0	1
CO4	3	2	0	1	0	1

UNIT I	**1.1 Non-Directional Bonding: (3L)** **1.1.1** Ionic Bond: Conditions for the Formation of Ionic Bond. **1.1.2** Lattice Energy, Borne-Lande Equation (Numericals) **1.1.3** Kapustinski Equation (Numericals) **1.1.4** Born-Haber Cycle and its Application **1.2 Directional Bonding: Orbital Approach: (6L)** **1.2.1** Valence Bond Theory- Introduction and basic tenets. **1.2.2** Interaction between two hydrogen atoms and the Potential energy diagram of the resultant system. **1.2.3** Corrections applied to the system of two hydrogen atoms-Formation of H_2 **1.2.4** Homonuclear diatomic molecules from He_2 to Ne_2 **1.2.5** 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. **1.2.6** Equivalent and Non-Equivalent hybrid orbitals **1.2.7** 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: (6L)** **1.3.1** Introduction to MOT, Comparing Atomic Orbitals and Molecular Orbitals. **1.3.2** Linear combination of atomic orbitals to give molecular orbitals	**15**

	LCAO- MO approach for diatomic homonuclear molecules). **1.3.3** Wave mechanical treatment for molecular orbitals (H_2^+ and H_2) **1.3.4** Molecular orbital Theory and Bond Order with reference to O_2, N_2, C_2, B_2) and magnetic property with reference to O_2, O^{2+} O^{2-}, O_2^{2-}	
UNIT II	**2.1 Chemistry of Boron compounds: (5L)** **2.1.1** Electron deficient compounds – BH_3, BF_3, BCl_3 with respect to Lewis's 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. **2.1.5** Uses of Boron compounds **2.2 Chemistry of Silicon and Germanium: (5L)** **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 **2.2.5** Importance of extra pure Silicon and Germanium in semiconductor industries **2.3 Chemistry of Nitrogen family: (5L)** **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. Uses of ammonia.	**15**

REFERENCES:

Unit I :

1. Inorganic Chemistry – Gary Wulfsberg, Viva Book, First Indian Edition 2002.
2. Quantitative Analysis – R.A.Day, A.L. Underwood, sixth edition
3. Vogel's Textbook of quantitative chemical analysis – J Mendham, R C Denny, J D Barnes, M Thomas, B Sivasankar
4. J. D. Lee, 4th Edn., Concise Inorganic Chemistry, ELBS, The group III elements Pg. 359- 648.

Unit II:

1. R. Gopalan, Inorganic Chemistry for Undergraduates, Universities Press India Pvt. Ltd.
2. D. F. Shriver and P. W. Atkins, Inorganic chemistry, 3rd edition, Oxford University press
3. Ramesh Kapoor and R.S. Chopra, Inorganic Chemistry, R. Chand publishers, New Delhi.
4. Emeleus and Anderson, Modern Aspects of Inorganic Chemistry
5. Cotton and Wilkinson, Advanced Inorganic Chemistry
6. Puri, Sharma and Kalia, Milestone publishers, Principles of Inorganic Chemistry

Course Code 24BUCH3T03	Course Title: Organic and Allied Chemistry-I	Credit 2	No. of Lecture 30

Course Outcomes:

CO1	Discuss structure, reactions, reactivity of halogenated hydrocarbons and organometallic compounds	L2
CO2	Explain nomenclature, preparation, reactions and reactivity of alcohols, phenols, ethers and epoxides.	L3
CO3	Illustrate nomenclature of aromatic carbonyl compounds, elaborate structure, reactivity and preparation of aldehydes and ketones,	L2
CO4	Deduce the mechanism of reactions shown by aldehydes and ketones. introduction of active methylene group containing compounds and their reactions. keto-enol tautomerism	L4

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	0	1	0	0
CO2	3	2	0	1	0	0
CO3	3	2	0	0	0	0
CO4	3	3	0	0	0	0

UNIT I	**1.1 Reactions and reactivity of halogenated hydrocarbons (4L)** **1.1.1 Alkyl halides**: Nucleophilic substitution reactions: SN1,SN2, and SNi 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 (SNAr) addition- elimination mechanism and benzyne mechanism **1.1.3 Organomagnesium and Organolithium Compounds(3L)** Nomenclature, nature, type, and reactivity of carbon-metal bond. Preparation using alkyl/aryl halide. Structure, stability, and reactions with compounds containing acidic hydrogen, carbonyl compounds, CO2, cyanides and epoxides. **1.2 Alcohols, phenols ethers and epoxides (8L)** **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. **1.2.1 Phenols**:	**15**

	Preparation, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of peroxide ion. Reactions of phenols. **1.2.2 Epoxides**: Nomenclature, methods of preparation and reactions of epoxides: reactivity, ring opening reactions by nucleophiles (a) In acidic conditions: hydrolysis, reaction with halogen halide, alcohol, hydrogen cyanide. (b) In neutral or basic conditions: ammonia, amines, Grignard reagents, alkoxides. **1.2.3 Ether**: Introduction and Nomenclature of Ether, methods of Preparation and Reactions of Ether Cleavage of ethers with HI (Aliphatic and Aromatic ether)	
UNIT II	**2.1 Carbonyl Compounds** : **2.1.1** 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, hydration of alkynes, action of Grignard reagent on esters, Rosenmund reduction, gattermann- koch formylation and Friedel Craft acylation of arenes. **2.1.2** General mechanism of nucleophilic addition, and acid catalyzed Nucleophilic addition reactions. Reactions of aldehydes and ketones with NaHSO3,HCN, RMgX, alcohol, amine, phenylhydrazine, 2,4- Dinitrophenyl hydrazine, LiAlH4, and NaBH4. **2.1.3** Mechanisms of following reactions: benzoin condensation, Knoevengel condensation, Claisen-Schmidt and Cannizzaro reaction. **2.1.4** keto-enol tautomerism: Mechanism of acid and base catalyzed enolization. Active methylene compounds: Acetylacetone, ethyl acetoacetate diethyl malonate, stabilized enols. Reactions of Acetylacetone and ethyl acetoacetate (alkylation, conversion to ketone, mono- and dicarboxylic acid). Reactions of aldehydes and ketones with alcohol.	**15**

Reference Books:

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.

PRACTICALS

Course Code 24BUCH3P01	Course Title: Practicals based on 24BUCH3T01 and 24BUCH3T02	Credit 2	No. of Lecture 60

Course Outcomes:

CO1	Analyze conductometric, kinetic, and phase-equilibrium data to determine dissociation constants, critical solution temperature, solubility of sparingly soluble salts, and activation energy of chemical reactions	L4
CO2	Evaluate reaction kinetics and reaction mechanisms by interpreting experimental results obtained from acid-catalyzed hydrolysis and redox reaction systems with equal initial reactant concentrations.	L5
CO3	Analyze quantitative analytical data obtained from titrimetric, complexometric, and colorimetric techniques to determine metal ion concentrations and water hardness in real samples.	L4
CO4	Evaluate the accuracy, precision, and reliability of instrumental and volumetric analytical methods through calibration curves, error analysis, and comparison of experimental results with theoretical expectations.	L5

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	1	1	2	1
CO2	3	3	0	0	2	0
CO3	3	3	1	2	2	1
CO4	3	3	1	0	2	1

	PHYSICAL CHEMISTRY
1	To verify Ostwald's dilution law for weak acid conductometrically.
2	To determine dissociation constant of weak acid conductometrically.
3	To determine the critical solution temperature (CST) of phenol – Water System.
4	Determination of energy of activation of acid catalyzed hydrolysis of methyl acetate.
5	To investigate the reaction between $K_2S_2O_8$ and KI with equal initial concentrations of the reactants.
6	To determine solubility of sparingly soluble salts (any two) conductometrically.
	II] INORGANIC CHEMISTRY
7	To determine the Fe(II) and Fe (III) in a given mixture titrimetrically.
8	**Colorimetric** Determination of Copper Ions in a given Solution by using the calibration curve method
9	To determine the hardness of the given water sample complexometrically.
10	Determination of calcium and magnesium contents of a dolomite ore sample.
**The above list can be modified as per the need and requirement.*	

Course Code 24BUCH3P02	Course Title: Practicals based on 24BUCH3T02 and 24BUCH3T03	Credit 2	No. of Lecture 60

Course Outcomes:

CO1	Analyze qualitative inorganic mixtures by systematically identifying and analytically separating cations using selective precipitation, confirmatory tests, and logical group separation schemes.	L4
CO2	Evaluate the accuracy, precision, and suitability of gravimetric methods for quantitative estimation of metal ions by comparing experimental results obtained for Ni(II) (as Ni-DMG) and Ba(II) (as $BaCrO_4$) with theoretical values and analytical standards.	L5
CO3	Analyze organic synthesis and purification processes by correlating reaction conditions, purification methods, melting point data, and yield calculations to assess the purity and efficiency of prepared organic compounds.	L4
CO4	Analyze organic synthesis and purification processes by correlating reaction conditions, purification methods, melting point data, and yield calculations to assess the purity and efficiency of prepared organic compounds.	L5

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	0	1	2	1
CO2	3	3	0	1	1	2
CO3	3	3	1	1	2	1
CO4	3	3	1	0	1	2

	I] **INORGANIC CHEMISTRY**
1	Identification of cations in a given mixture and Analytically separating them [From a mixture containing not more than two of the following: Pb(II), Ba(II), Ca(II), Sr (II), Cu(II), Cd(II), Mg(II), Zn(II), Fe(II), Fe(III), Ni(II), Co(II) Al(III), Cr(III)] (Minimum 2 salts)
2	Gravimetric estimation of Nickel (II) as Ni-DMG.
3	Gravimetric estimation of barium ions using K2CrO4 as precipitant.
	II] ORGANIC CHEMISTRY Short organic preparation and purification: Use 0.5-1.0g of the organic compound. Purify the product by recrystallization. Report theoretical yield, percentage yield, and melting point of the purified product. Preparation of:
4	Cyclohexanone oxime from cyclohexanone.
5	Glucosazone from dextrose or fructose

6	Tribromoaniline from aniline.
7	β-Naphthyl benzoate
8	m-Dinitrobenzene from nitrobenzene
9	Phthalic anhydride from phthalic acid by sublimation
10	Acetanilide from aniline
11	p-Bromoacetanilide from acetanilide
12	Iodoform from acetone
	(minimum Six preparations)
**The above list can be modified as per the need and requirement.*	

References

24BUCH3P01

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. Athawale V.D. and Mathur P., Experimental Physical Chemistry, New Age International, New Delhi (2001)
5. *Practical Inorganic Chemistry* by G. Marrand B. W. Rockett van Nostrand Reinhold Company (1972)

24BUCH3P02

1. Practical Inorganic Chemistry by G. Marr and B. W. Rockett van Nostrand Reinhold Company (1972)
2. D. A. Skoog, D. M. West, F. J. Holler, and S. R. Crouch, Analytical Chemistry: An Introduction, 7th ed., Chapter 15, pp. 345-381.
3. A.I. Vogel. “Textbook of Quantitative Inorganic Analysis,” Longman, London (1961).
4. Some Experiments for B. Tech in Chemistry & Chemical Technology compiled by Prof. J.B.BARUAH, Mrs. Abhilasha Mohan Baruah and Mr. Parikshit Gogoi.
5. Practical Organic Chemistry, F.G. Mann, (2009)

Course Code 24BUCH3P03	Course Title: Field Project In Chemistry- I	Credit 2	No. of Lecture 60

Course Outcomes:

CO1	Apply theoretical knowledge to real-world situations and analyse field-specific challenges	L4
CO2	Develop practical skills in data collection, analysis, and interpretation related to the project topic.	L4
CO3	Develop a research technique.	L5
CO4	Demonstrate an innovative and evidence-based solution.	L6

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	1	1	1	1
CO2	3	3	2	0	2	1
CO3	2	3	1	0	0	1
CO4	3	3	2	1	2	2

Description:

The field project involves applying theoretical knowledge to practical, real-world challenges in a chosen area of study. Students will work on a project relevant to their discipline, incorporating data collection, analysis, problem-solving, and reporting. The project encourages collaboration, critical thinking, and the development of professional skills.

Week 1-2: Orientation and Topic Selection

- Overview of field project requirements and objectives.
- Guidance on selecting project topics.
- Introduction to research methods and tools.

Week 3-4: Literature Review and Proposal Development

- Conduct a literature review related to the chosen topic.
- Develop a project proposal outlining objectives, methodology, and expected outcomes.
- Submit the proposal for approval.

Week 05-06: Data Collection and Fieldwork

- Design and execute data collection strategies (e.g., surveys, observations, experiments).
- Conduct field visits and gather data as per the approved methodology.
- Maintain a fieldwork journal/logbook.

Week 07-08: Data Analysis and Interpretation

- Analyze collected data using relevant tools and techniques.
- Interpret results to address the project's objectives.

Week 09-10: Report Writing and Presentation Preparation

- Prepare a detailed project report including background, methodology, findings, discussion, and recommendations.

Design and rehearse a presentation of the project outcomes.

Week 11-12: Final Submission and Evaluation

- Submit the final project report.

- Deliver an oral or poster presentation to peers and faculty.

Receive feedback and final evaluation.

Course Code 24BU3SEC02	Skill Enhancement Course Course Title Separation Techniques in Analytical Chemistry	Credit 1	No. of Lecture 15

Course Outcomes:

CO1	Analyze and justify the selection of appropriate analytical separation techniques—such as electrophoresis, solvent extraction, chromatography, and ion exchange—based on underlying physicochemical principles.	L4
CO2	Analyze chromatographic techniques by classifying them based on the nature of the stationary and mobile phases and relating these classifications to their separation efficiency and applications. .	L4

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	1	1	1	0
CO2	3	3	1	0	0	0

UNIT I	**1.1 Separation Techniques in Analytical Chemistry (02L)** **1.1.1** An Introduction to Analytical Separations and its importance in analysis. **1.1.2** Estimation of an analyte without effecting separation. **1.1.3** Types of separation methods Based on- **1.1.4** Solubility (Precipitation, Filtration Crystallisation) **1.1.5** Gravity- Centrifugation **1.1.6** Volatility-Distillation ; **1.1.7** Electrical effects-Electrophoresis **1.1.8** Retention capacity of a Stationary Phase -Chromatography; **1.1.9** Distribution in two immiscible phases-Solvent Extraction; **1.1.10** Based on capacity to exchange with a resin-Ion Exchange; **1.2 Electrophoresis**: **(02L)** Principles, Basic Instrumentation, Working and Application in separation of bio molecules like enzymes and DNA. **1.3 Solvent extraction (05 L)** **1.3.1** Introduction, Nernst distribution Law, Distribution Ratio, Partition Coefficient. **1.3.2** Conditions of extraction: Equilibration time, Solvent volumes, temperature, pH. **1.3.3** Single step and multi-step extraction, Percentage extraction for single step and multistep extraction. Separation factor. **1.3.4** Batch and continuous extraction **1.4. Chromatography : (06L)** **1.4.1** Introduction **1.4.3** 1.4.2 Classification of chromatographic methods based on stationary and mobile phase. Paper Chromatography: Principle, techniques and applications of Paper Chromatography in separation of cations. **1.4.4** Thin layer Chromatography Principle, technique and Applications in determining the purity of a given solute; Following progress of a given reaction.	**15**

Course Code 24BU3SEC02	Skill Enhancement Course Course Title: Separation Techniques in Analytical Chemistry	Credit 1	No. of Lecture 30

Course Outcomes:

CO3	Analyze chromatographic and extraction techniques to separate metal ions, monitor reaction progress, and evaluate separation efficiency.	L4
CO4	Analyze solvent extraction and centrifugation techniques to determine solute distribution, extraction efficiency, and phase separation behavior in immiscible liquid systems.	L4

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO3	3	3	1	1	1	0
CO4	3	3	0	1	1	0

1.	**Paper Chromatography:** Separation of cations like Fe (III), Ni (II) and Cu (II) in a sample by using paper chromatography.
2.	**Thin Layer Chromatography (TLC)** To check progress of reaction between Aldehydes + Aniline using TLC (Imine formation) **Column Chromatography (Demonstration)**
3.	Ion Exchange chromatography: Determination of ion exchange capacity ($AgNO_3 + NaCl^-$ ⟶ $AgCl + NaNO_3$)
4.	Solvent Extraction (Water-Ether)
5.	**Solvent Extraction (Water- Ethyl Acetate** 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 (II) in aqueous solutions. (The learner is expected to learn the technique of the solvent extractions by using separating funnel, method of estimate the concentration of solute distributed in two immiscible phases, determination of the extraction efficiency)
6.	Centrifuge (Water) (Demonstration depends on gravitational force)
7.	Centrifuge (Ethanol/ Methanol)

**The above list can be modified as per the need and requirement.*

Reference Book:

1) **H. H. Willard; L. L. Merritt Jr.; J. A. Dean; F. A. Settle Jr.**
Instrumental Methods of Analysis, 7th Ed., CBS Publishers & Distributors, New Delhi.
2) **A.DayJr.;A.L.Underwood**
Quantitative Analysis, 6th Ed., Pearson Education.

Course Code 23BUCH3T04	Course Title: Principles of Analytical Chemistry and Nanomaterials	Credit 2	No. of Lecture 30

Course Outcomes:

CO 1	Classify and explain chromatographic techniques, paper chromatography and TLC technique.	L4
CO 2	Discuss electrophoresis techniques, its application and explain different method of expressing concentration of solutions.	L4
CO 3	Classify nanomaterials and study their synthesis.	L4
CO 4	Explain characterisation of nanomaterials, their properties and applications.	L4

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	1	0	0	0
CO2	3	3	1	0	0	1
CO3	3	3	0	1	0	1
CO4	3	3	0	1	0	1

UNIT I	**Separation Techniques and Chemical Calculations** **1. Chromatography :** 1.1. Introduction to Chromatography. 1.2. Classification of chromatographic methods based on stationary and mobile phase 1.3. **Paper Chromatography:** Principle, techniques and applications of Paper Chromatography in Separation of cations. 1.4. **Thin layer Chromatography**: Principle, technique and Applications in determining the purity of a given solute; following progress of a given reaction. **2. Electrophoresis**: Principles, Basic Instrumentation, Working and Application in separation of biomolecules like enzymes and DNA **3. Chemical Calculations** Normality, Molarity, Molality, Formality, ppm, ppb, Millimoles, Milliequivalents, Mole fraction, Weight ratio, Volume ratio and weight to volume ratio.	**15**

UNIT II	**Nanomaterials. Introduction** to nanomaterial 2.1 **Classification of nanomaterial** 2.2 **Chemical methods** of synthesis of nanomaterials (any one) 2.3 **Characterization** of nanomaterials(UV and XRD techniques) 2.4 **Dimensions** and forms of Nanomaterials: Nanofilms, Nanolayers, Nanotubes, Nanowires and Nanoparticales 2.5 **Properties:** Optical, Electrical and mechanical properties	**15**

Reference Books:

1. D. A. Skoog; F. J. Holler; S. R. Crouch
   Principles of Instrumental Analysis, 6th Ed., Cengage Learning, USA.
2. R. A. Day Jr.; A. L. Underwood
   Quantitative Analysis, 6th Ed., Pearson Education.
3. H. H. Willard; L. L. Merritt Jr.; J. A. Dean; F. A. Settle Jr.
   Instrumental Methods of Analysis, 7th Ed., CBS Publishers.
4. C. N. R. Rao; A. Müller; A. K. Cheetham (Eds.)
   The Chemistry of Nanomaterials: Synthesis, Properties and Applications, Wiley-VCH.
5. B. S. Murty; P. Shankar; B. Raj; B. B. Rath; J. Murday
   Textbook of Nanoscience and Nanotechnology, Springer.

Course Code 24BUCH3T05	Course Title: Cosmetics and Introduction to Dye Stuff Chemistry	Credit 2	No. of Lecture 30

Course Outcomes:

CO1	Describe preparation methods and applications of skin care, herbal, and cleansing cosmetics.	L2
CO2	Understand market trades in the cosmetics and toiletries industry and describe emulsifiers, preservatives, thickeners, moisturizer and fragrance.	L3
CO3	Understand the characteristics, types, and historical development of natural and synthetic dyes.	L2
CO4	Classify dyes and pigments based on constitution and application, and explain their key characteristics and uses.	L4

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	0	1	0	1
CO2	3	1	1	0	0	2
CO3	3	2	0	1	0	1
CO4	3	1	0	1	0	1

UNIT I	**1 COSMECTICS** 1.1 Basic Cosmetic Skin Care Products- Emulsions, Cream and Lotions, Specialty products- Sun protection, Skin lightening etc 1.2 Herbal Cosmetics, Cosmeceuticals and ISI Guidelines Manufacturing Processes of Cosmetics 1.3.Cosmetic cleansing preparations, Soaps, Cleansing preparation for skin, hair and teeth 1.4 Market Trends in Cosmetics and Toiletries. 1.5. Emulsifier, Preservatives, Thickeners- Definition and types of thickeners, Moisturizer, Fragrance	**15**

UNIT II	**2. INTRODUCTION TO DYESTFF CHEMISTRY** **2.1** Definition of dyes, requirements of a good dye i.e. Colour, Chromophore and Auxochrome, Solubility, Linearity, Coplanarity, Fastness, Substantivity, Economic viability. **2.2 Natural and Synthetic Dyes** **2.2.1 Natural Dyes:** Definition and limitations of natural dyes. Examples and uses of natural dyes w.r.t Heena, Turmeric, Saffron, Indigo, Madder, Chlorophyll –**names** of the chief dyeing material/s in each natural dye **[structures not expected]**, **2.2.2 Synthetic dyes:** Definition of synthetic dyes, primaries and intermediates. E.g Mauve, Aniline Yellow, Congo Red Important milestones in the development of synthetic dyes – Emphasis on Name of the Scientist, dyes and the year of the discoveryis required. (**structure is not expected**) **2.2.3 Optical Brighteners, Dye and pigments:** General idea, important characteristics of optical brighteners and pigments **2.2.4 Classification of dyes based on constitution -** (i) Nitro Dyes-Napyhol yellow S (ii) Nitroso Dye-Gambine Y (iii) Azo Dyes- (a) Monoazo Dyes- Metanil yellow (b) DiazoDyes- Napthol Blue Black (c) Triazodyes - Chloroamine Green B (iv) Diphenymethane Dyes-Auramine G (vi) Heterocyclic Dyes (a) Xanthene-Rhodamine 6G (b) Acridines-Acriflavine (c) Azines- SafranineB (d) Oxazines-Capri blue (e) Thiazines-Methylene Green (f) Quiolines- Quinoline Yellow **2.2.5 Classification Based on Application -** Definition, fastness properties & applicability on substrates examples with structures (a) Acid Dyes- Orange II, (b) Basic Dyes-methyl violet, Victoria Blue B (c) Direct cotton Dyes- Benzofast Yellow 5GL (d) Azoic Dyes-Diazo components; Fast yellow G, Fast orange R, Naphtol AS, Naphthol ASG (e) Mordant Dyes-Erichrome Black A, Alizarin. (f) Vat Dyes- Indanthrene brown RRD, Indanthrene Red 5GK. Sulphur Dyes- Sulphur Black T **[structures not expected]**,	**15**

Reference Books :

1) Natural skin care and cosmetic formulation, Alice Burrel, 2022.
2) A-Z natural cosmetic formulation, Gail Francombe, 2019
3) Cosmetic – A Practice manual, Dr. Shailendra Saraf. BSP, 2019
4) Introduction to Synthetic drugs and dyes, R S Rao, Gomathi Shridhar, Bholanath Mukharjee, Tanuja Parulekar

Semester IV

Course Code 24BUCH4T01	Course Title: Physical and Allied Chemistry-II	Credit 2	No. of Lecture 30

Course Outcomes:

CO 1	Study of electrochemistry and calculation of thermodynamic properties of chemical systems.	L2
CO 2	Illustrate phase equilibria with examples for industrial applications	L2
CO 3	Explain types and kinetics of catalysis, including acid–base, enzyme, and nanoparticle-mediated reactions with their applications and challenges.	L2
CO 4	Explain different crystal systems and their characteristics, Apply the XRD method for determination of the crystal structures.	L3

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	0	1	0	0
CO2	3	1	0	1	0	1
CO3	3	1	0	1	0	1
CO4	3	2	1	0	0	0

UNIT I	**1.1Electrochemistry-II: (8 L)** **1.1.1** Electrochemical conventions, Reversible and irreversible cells. **1.1.2** Nernst equation and its importance, Types of electrodes, Standard electrode potential, Electrochemical series (Numericals expected). **1.1.3** Thermodynamics of a reversible cell, calculation of thermodynamic properties: ΔG, ΔH and ΔS from EMF data. (Numericals expected) **1.1.4** Calculation of equilibrium constant from EMF data. (Numericals expected) **1.1.5** Chemical and Concentration cells (only classifications), Liquid junction potential and salt bridge. **1.1.6** pH determination using hydrogen electrode and quinhydrone electrode. (Numericals expected) **1.2 Phase Equilibria: (7L)** **1.2.1** Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. **1.2.2** Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. (Numericals expected) Phase diagrams of one-component systems (water and sulphur). Two component systems involving eutectics (lead-silver system), congruent and incongruent melting points.	**15**

UNIT II	**2.1 Catalysis: (8L)** **2.1.1 Types of catalysis, catalytic activity, specificity and** selectivity, inhibitors, catalyst poisoning and deactivation **2.1.2** Mechanisms and kinetics of acid-base catalyzed reactions, the effect of pH. **2.1.3** Mechanisms and kinetics of enzyme-catalyzed reactions (Michaelis-Menten equation) 2.1.4 Nanoparticles as catalyst – basic concepts, their importance in chemical reactions, properties Challenges associated with nanoparticles as catalysts. 2.2 Solid State : (7L) 2.2.1 Laws of crystallography and types of crystals 2.2.2 Characteristics of simple cubic , face-centered cubic and BCC systems, interplanar distances are expected.) 2.2.3 Use of X-rays in the study of crystal structure, Bragg's equation (derivation expected). X-ray diffraction method of studying crystal lattice structure, structure of NaCl, and KCl. Determination of Avogadro's number (Numericals expected)	

Reference Books:

Unit I:

1. Barrow, G.M. Physical Chemistry Tata McGraw‑Hill (2007).
2. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry Cengage Learning India Pvt.Ltd., New Delhi (2009)
4. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
5. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co., NewYork (1985).
6. K.L.Kapoor A textbook of Physical Chemistry3rd Ed. vol.1,2Macmillan Publishing Co., NewDelhi(2001)

Unit II:

1. Barrow, G.M. Physical Chemistry Tata McGraw‑ Hill (2007).
2. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry CengageLearning India Pvt.Ltd., New Delhi (2009).
4. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
5. Pfenning, Brian W. (2015). Principles of Inorganic Chemistry. Hoboken: John Wiley & Sons, Inc. pp. 195.
6. M. Bowker, The Basis and Applications of Heterogeneous Catalysis (1998), Oxford University Press, Oxford

Course Code 24BUCH4T02	Course Title: Inorganic and Allied Chemistry-II	Credit 2	No. of Lecture 30

Course Outcomes:

CO1	Comprehend spectral and magnetic properties of transition metals	L2
CO2	Define basic terms involved in coordination chemistry and understand the metal-ligand bond, Warner's theory, and electron count	L2
CO3	Explain the acidic and basic behavior of cations and anions present aqueous medium	L2
CO4	Understand environmental aspects of volatile oxides and oxy-acids of main group elements.	L2

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	0	0	0	0
CO2	3	1	0	0	0	0
CO3	3	1	0	1	0	1
CO4	3	1	0	3	0	2

UNIT I	**1.1 Comparative Chemistry of the transition metals: (8L)** **1.1.1** Position in the periodic table; Natural occurrence principal ores and minerals **1.1.2** 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.) **1.1.3** Origin of color 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). **1.1.4** 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. **1.1.5** Variation of magnetic properties with temperature: Curie (Tc) and Neel (TN) temperature **1.1.6** Qualitative tests for transition metal ions: General considerations in devising tests (concerning Chromium, Manganese, iron, Cobalt Nickel and Copper) **1.2 Coordination Chemistry: (7L)** **1.2.1** Introduction to Chemistry of Coordination Compound **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 (C.N=6) **v)** Evidence for the formation of coordination compounds	**15**

	1.2.2 Theories of coordination compounds i) Werner's Theory of coordination compounds, ii) Effective atomic number rule. iii) Eighteen electron Rule **1.2.3 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 **1.2.4 Application of coordination compounds.**	
UNIT II	**2.1 Ions in aqueous medium: (8L)** **2.1.1** Acidity of Cations and Basicity of Anions **2.1.2** Hydration of Cations; Hydrolysis of Cations predicting degree of hydrolysis of Cations-effect of Charge and Radius. **2.1.3** Latimer Equation. Relationship between pKa, acidity, and z^2 /r ratios of metal ions graphical Presentation **2.1.4** Classification of cations based on acidity category – Nonacidic, Moderately acidic, strongly acidic, very strongly acidic with pKa values range and examples **2.1.5** Hydration of Anions; Effect of Charge and Radius; Hydration of anions- concept, diagram classification based on Basicity **2.1.6** Importance of acidity and basicity of cations and anions in reaction Mechanism Uses and Environmental **2.2 Chemistry of volatile Oxides and oxo-acids: (7L)** **2.2.1** Physical properties of concentrated oxo-acids like sulfuric, Nitric, and Phosphoric acid **2.2.2** Uses and environments aspects of these acids	**15**

Reference Books:

Unit I

1. Inorganic Chemistry – Gary Wulfsberg, Viva Book, First Indian Edition 2002
2. Quantitative Analysis – R.A.Day, A.L. Underwood, sixth edition
3. Vogel's Textbook of quantitative chemical analysis – J Mendham, R C Denny, J D Barnes, M Thomas, B Sivasankar
4. Bruce H. Mahan, University Chemistry, Narosa publishing house pg. 611 to 683.
5. R. Gopalan, Universities Press India Pvt.Ltd. Inorganic Chemistry for Undergraduates.

Unit II:

1. J. D. Lee, 4th Edn., Concise Inorganic Chemistry, ELBS .

2. Bruce H. Mahan, University Chemistry, Narosa publishing house.

3. D. F. Shriver and P. W. Atkins, Inorganic chemistry, 3rd edition, Oxford University press.

4. Ramesh Kapoor and R.S. Chopra, Inorganic Chemistry, R. Chand publishers, New Delhi.

Course Code 24BUCH4T03	Course Title: Organic and Allied Chemistry-II	Credit 2	No. of Lecture 30

Course Outcomes:

CO1	Recognize the nomenclature, preparations and reactions of carboxylic acids, Understand the mechanism of nucleophilic acyl substitution, Claisen ester condensation, Dieckman ester condensation	L2
CO2	Understand the reactivity of sulphonic acids and stereochemistry of cyclohexane	L2
CO3	Explain the nomenclature, structure, preparation, and reactivity of amines and diazonium salts.	L2
CO4	Illustrate classification, nomenclature, synthesis and reactivity of five membered heterocyclic molecules. Introduction to UV spectroscopy and calculation of λmax value.	L3

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	0	0	0	0
CO2	3	1	0	0	0	0
CO3	3	1	0	0	0	1
CO4	3	2	1	0	0	0

UNIT I	**1.1 Carboxylic Acids and their Derivatives: (10 Lectures)** 1.1.1 Nomenclature, structure and physical properties, acidity of carboxylic acids, effects of substituents on acid strength of aliphatic and aromatic carboxylic acids. 1.1.2 Preparation of carboxylic acids: oxidation of alcohols and alkyl benzene, carbonation of Grignard and hydrolysis of nitriles. 1.1.3 Reactions: Acidity, salt formation, decarboxylation, Reduction of carboxylic acids with LiAlH4, diborane, Hell-Volhard-Zelinsky reaction, Conversion of carboxylic acid to acid chlorides, esters, amides and acid anhydrides and their relative reactivity. 1.1.4 Mechanism of nucleophilic acyl substitution and acid- catalysed nucleophilic acyl substitution. Interconversion of acid derivatives by nucleophilic acyl substitution. 1.1.5 Mechanism of Claisen condensation and Dieckmann condensation. **1.2 Sulphonic acids: [2L]** Physical and Chemical properties preparation of aromatic sulphonic acids by sulphonation of benzene toluene and naphthalene, Comparative acidity of carboxylic acid and sulfonic acids. **1.3 Stereochemistry: [3L]** Stereochemistry of Cyclohexane, Bayer's Strain theory, heat of combustion of cyclohexenes, Conformation and Stability of cycloalkanes.	**15**

UNIT II	**2.1 Amines: (4L)** Nomenclature, effect of substituent on the basicity of aliphatic and aromatic amines: Preparation: Reduction of aromatic nitro compounds using catalytic hydrogenation, chemical reduction using Fe-HCI, Sn-HCl, Zn acetic acid, reduction of nitriles, ammonolysis of halides, reductive amination, Hofmann bromamide reaction. **2.1.1.Reactions-** Salt Formation, N-acylation, N-alkylation, Hofmann's exhaustive methylation (HEM), Hofmann- elimination reaction, reaction with nitrous acid, carbylamine reaction, Electrophilic substitution in aromatic amines: bromination, nitration and sulphonation. **2.2 Diazonium Salts: (3L)** Preparation and their reactions/synthetic application - Sandmeyer reaction, Gattermann reaction, Gomberg reaction, Replacement of diazo group by -H,-OH. Azo coupling with phenols, naphthols and aromatic amines, reduction of diazonium salt to aryl hydrazine and hydroazobenzene **2.3 Heterocyclic Compounds: (5L)** 2.3.1 Classification, nomenclature, electronic structure, aromaticity in 5- numbered and 6-membered rings containing one heteroatom. 2.3.2 Synthesis of Furan, Pyrrole (Paal- Knorr synthesis, Knorr pyrrole synthesis, and Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis). 2.3.3 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 towards nucleophilic substitution on the basis of electron distribution. 2.3.4 Reactions of furan, pyrrole and thiophene: halogenation, nitration, sulphonation, Vilsmeier-Haack reaction, Friedel-Crafts reaction. **2.4 UV-Visible spectroscopy** 2.4.1 Introduction (3L) 2.4.2 Terms used in UV Spectroscopy: Chromophore, Auxochrome, Bathochromic shift, hypsochromic shift, hyperchromic shift and hypochromic effect. 2.4.3 Modes of transitions Calculation of λmax by Woodward and Fischer rules for dienes.	**15**

Reference Books:

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. Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005.
4. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)

PRACTICALS

Course Code 24BUCH4P01	Course Title: Practicals Based On 24BUCH4T01 And 24BUCH4T02	Credit 2	No. of Lecture 60

Course Outcomes:

CO1	Analyze electrochemical, potentiometric, kinetic, and conductometric experimental data to determine standard EMF, free energy change, acid strength, buffer capacity, and analyte concentration in real samples.	L4
CO2	Evaluate the accuracy, sensitivity, and applicability of electroanalytical techniques such as potentiometry, pH metry, kinetics, and conductometric titration by comparing experimental results with theoretical and standard reference values.	L5
CO3	Analyze quantitative inorganic analytical data obtained from potentiometric titration and argentometric (Mohr's) methods, and interpret crystallographic features by constructing and comparing lattice planes for cubic crystal systems.	L4
CO4	Evaluate the applicability, accuracy, and industrial relevance of inorganic analytical and crystallographic techniques by critically assessing laboratory results and insights gained from industrial visits.	L5

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	1	1	1	1
CO2	3	3	1	0	0	2
CO3	3	3	1	0	0	0
CO4	3	3	0	1	1	2

	I] Physical 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 H2SO4 by studying kinetics of acid hydrolysis of methyl acetate.
4	Determination of Vitamin C content in a given tablet by pH meter.
5	Determination of buffer capacity of acid buffer and basic buffer.
6	Determination of buffer capacity of acid buffer and basic buffer.
	Inorganic Chemistry
7	Estimation of Fe(II) in the given solution by titrating against K2Cr2O7 potentiometry.
8	To carry out assay of a saline sample by Mohr's method.
9	To draw lattice planes [(100), (110) and (111)] for primitive, body centered and face centered cubic crystal system
10	Industrial visit report

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. Athawale V.D. and Mathur P., Experimental Physical Chemistry, New Age International, New Delhi (2001)

Course Code 24BUCH4P02	Course Title: Practicals Based On 24BUCH4T02 And 24BUCH4T03	Credits 2	No. of Lecture 60

Course Outcomes:

CO1	Analyze coordination compound synthesis and gravimetric analytical data by correlating reaction conditions, stoichiometry, and precipitation principles to evaluate the purity, yield, and accuracy of inorganic preparations and sulphate estimation.	L4
CO2	Analyze bi-functional organic compounds by systematically interpreting preliminary tests, solubility behavior, elemental analysis, and functional group reactions to identify the given organic substance.	L4
CO3	Analyze experimental observations and physical constants (melting point/boiling point) in conjunction with chemical test results to differentiate among closely related organic functional groups.	L4
CO4	Evaluate the identity and purity of organic compounds by correlating experimental data with balanced chemical reactions, standard reference values, and logical elimination of alternative functional groups.	L5

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	0	0	0	2	0
CO2	2	1	0	0	2	0
CO3	2	1	0	0	2	0
CO4	2	1	0	0	2	0

	I]Inorganic Chemistry
1	To prepare tris (ethylene diamine) nickel (II) thoisulphate.
2	To prepare nickel dimethyl glyoximate by using microscale method.
3	Gravimetric estimation of sulphate ions using Barium sulphate as precipitant.
	II] Organic Chemistry 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. Students are expected to write balanced chemical reactions wherever necessary. (Minimum 6 compounds to be analyzed).

References

1. Practical Inorganic Chemistry by G. Marr and B. W. Rockett van Nostrand Reinhold Company (1972)
2. D. A. Skoog, D. M. West, F. J. Holler, and S. R. Crouch, Analytical Chemistry: An Introduction, 7th ed., Chapter 15, pp. 345-381.

3. A.I. Vogel. “Textbook of Quantitative Inorganic Analysis,” Longman, London (1961).
4. R.V. Dilts. “Analytical Chemistry. Methods of Separation,” 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.

Course Code **24BUCH4P03**	**Course Title: Field Project in Chemistry-II**	**Credits 2**	**No. of Lecture 60**

Course Outcomes:

CO1	Analyze the research problem.	L4
CO2	Choose a Scientific methodology.	L5
CO3	Develop a research technique.	L6
CO4	Demonstrate an innovative and evidence-based solution.	L2

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	0	0	2	0
CO2	2	1	0	0	2	0
CO3	2	1	0	0	2	0
CO4	2	1	0	0	2	0

Course Code	Skill Enhancement Course Course Title: Extraction and fabrications methods	Credit	No. of Lecture
24BU4SEC02		1	15

Course Outcomes:

CO 1	Illustrate the extraction methods of natural essential oils, saponification.	L2
CO 2	Demonstrate the techniques detergents, laboratory waste management, Perfume manufacturing techniques.	L3

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	1	0	1	0	0
CO 2	3	2	0	3	1	2

UNIT I	1.1 **Extraction methods of natural essential oils** Sources of natural essential oil, Methods of Producing Essential Oils, Hydrodistillation, Three Types of Hydrodistillation, Fats and oils 1.2 **Saponification**: The Chemistry of Soap-Making, Materials and Equipment, Experimental Observations, Uses 1.3 **Detergents**: Anionic detergents, Non-ionic detergents, Cationic detergents, 1.4 Testing Hardness of Soap and Detergent 1.5 **Laboratory Waste Management**: Waste Separation: Hazardous chemical wastes, Non-hazardous chemical wastes, Disposal of lab waste. **1.6 Perfume manufacturing techniques:** Understanding the Science of Perfume, Using Essential Oils, Using Fresh Flowers, Leaves or Herbs	**15**

Reference Books:

1) G. B. Shah
Handbook of Soap Manufacture, 5th Ed., CBS Publishers & Distributors, New Delhi.

2) Julia Lawless
The Illustrated Encyclopedia of Essential Oils, Element Books Ltd., UK.

Course Code	Course Title:	Credit	No. of Lecture
24BU4SEC02	Extraction and fabrications methods	1	30

Course Outcomes:

CO3	Analyze extraction, formulation, and preparation processes of consumer chemical products such as oils, soaps, detergents, perfumes, and related materials.	L4
CO4	Evaluate environmental, safety, and industrial relevance of chemical preparation techniques and laboratory waste management practices.	L5

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO3	3	3	0	1	1	1
CO4	3	3	0	3	1	3

1.	Oil Extraction (Water distillation)
2.	Oil extraction (Steam Distillation)
3.	Ubtan Preparation using natural sources
4.	Soap Preparation/ Saponification
5.	Detergent Preparation
6.	Non-dust chalk preparation
7.	Laboratory Waste Management
8.	Perfume Preparation
9.	Industrial visit

Reference Books:

1. **P.C.Jain;MonikaJain**
   Engineering Chemistry, 16th Ed., Dhanpat Rai Publishing Company, New Delhi.
2. **B.K.Sharma**
   Industrial Chemistry, 16th Ed., Krishna Prakashan Media, Meerut.

Course Code	Course Title:	Credit	No. of Lecture
23BUCH4T04	Electrochemistry and Green chemistry	2	30

Course Outcomes:

CO1	Understand electrochemistry and basic terms such conductivity, equivalent and molar conductivity.	L2
CO2	Evaluate and illustrate Kohlrausch law and its application, Transference number.	L2
CO3	Explain twelve principles of green chemistry with examples	L2
CO4	Discuss atom economy, synthesis of adipic acid and disodium-iminodiacetate on the basis of green approach.	L2

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	P3	PO4	PO5	PO6
CO1	2	1	0	0	0	0
CO2	3	3	0	0	0	0
CO3	2	1	0	3	0	2
CO4	3	2	0	3	0	2

UNIT I	**Unit I: Electrochemistry** **1.2.1** Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. **1.2.2** Kohlrausch law of independent migration of ions. **1.2.3** 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). **1.2.4** Transference number and its experimental determination using Moving boundary method. (Numericals expected). Factors affecting transference number.	**15**
UNIT II	**<u>Unit II :Principle of Green Chemistry.</u>** 1. Introduction to Green chemistry 2. Twelve principles of green chemistry 3. Sustainable development and green chemistry, atom economy, biodegradation of obtained products. 4. Example of atom economy and atom unecomic reactions Reducing Toxicity. Green synthesis of following compound: Adipic acid, disodium – iminodiacetate	**15**

Reference Books:

1) P. W. Atkins; Julio de Paula
Physical Chemistry, 10th Ed., Oxford University Press.
2) S. Glasstone
An Introduction to Electrochemistry, East-West Press Pvt. Ltd., New Delhi.
3) P. T. Anastas; J. C. Warner
Green Chemistry: Theory and Practice, Oxford University Press.

Course Code 24BUCH4T05	Course Title: Environmental and Pharmaceutical Chemistry	Credit 2	No. of Lecture 30

Course Outcomes:

CO1	Explain chemistry in contemporary society, pharmaceutical chemistry.	L2
CO2	Discuss common drugs and their uses.	L2
CO3	Understand types of natural resources, their challenges, and issues related to their sustainable use.	L2
CO4	Identify types of pollution, their impact, and understand solid waste management and environmental assessment.	L2

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	0	0	0	2
CO2	3	1	0	0	0	3
CO3	3	1	0	3	0	2
CO4	3	1	0	3	0	3

UNIT I	**1. Environmental Chemistry** Chemistry in Contemporary Society **1.1 Pharmaceuticals:** Importance of quality control, drugs and pharmaceuticals, sources of impurities in pharmaceutical chemicals, analytical quality control in finished / final products, common methods of assay. **1.2 Common drugs and their uses:** Analgesics-aspirin, paracetamol; Antheimentics-mebendazole; Antiallergies -chlorpenneramine malleate; Antibiotics-pencillin, chloromecytin; Anti-inflammatory agents-oxyphenbutazone; Antimalarials -primaquine phosphate; Antituber culosis -INH; Narcotics -nicotine, morphine; Expectorants -Benadryl; Sedatives -diazepam; Vitamins -B1, B2, B6, niacin and folic acid.	**15**

UNIT II	**ENVIRONMENTAL POLLUTION** **2.1. Natural resources and non-renewable resources (8L)** An overview of natural resources and associated problems with references to a) Forest resources b) Water resources c) Mineral resources d) Food resources e) Energy resources f) Land resources **2.2. Definition (3L)** a) Air pollution b) Water pollution c) Soil pollution d) Marine pollution e) Noise pollution f) Thermal pollution g) Nuclear pollution **2.3.Solid waste management (4L)** Causes, effects and control measures of urban and industrial wastes. Environmental impact assessment.	**15**

Reference Books :

1) Environmental pollution and control, Peirce J Jeffry, Ruth F Weiner, Arne Vesilind, 4th edition, 1998.
2) Renewable energy sources, Sinduja S, Anuradha Publication, 2012.

V P M's B. N. Bandodkar College of Science (Autonomous), Thane

Curriculum Structure for the Undergraduate Degree Programme S. Y. B.Sc. Chemistry

	SEMESTER–III	**Course imparts Employability (EM), Entrepreneurship (EN), Skill Development (SD)**			**Course integrates with Professional Ethics (PE), Gender Equity (GE), Human Value (HV), Environmental Sustainability (ES)**			
Course Code	**Major Course Title**	**EM**	**EN**	**SD**	**PE**	**GE**	**HV**	**ES**
24BUCH3T01	Physical and Allied Chemistry-I	√	--	--	--	--	--	--
24BUCH3T02	Inorganic and Allied Chemistry-I	√	--	--	--	--	--	--
24BUCH3T03	Organic and Allied Chemistry-I	√	--	--	--	--	--	--
24BUCH3P01	Practical-I based on 24BUCH3T01 and 24BUCH3T02	√	--	√	--	--	--	--
24BUCH3P02	Practical-II based on 24BUCH3T02 and 24BUCH3T03	√	--	√	--	--	--	--
24BU3SEC02	SEC: Separation Techniques in Analytical Chemistry	√	√	√	√	--	--	√
	Minor Course Title							
24BUCH3T04	Principles of Analytical Chemistry and Nanomaterials	√	--	√	--	--	--	--
Course Code	**Generic-Course Title**							
24BUCH3T05	Cosmetics and Introduction to Dye Stuff Chemistry	√	√	√	--	--	--	--

SEM-III								
24BUCH3P03	Field Project in Chemistry-I	√	**--**	√	**--**	**--**	**--**	√
	Total	**09**	**02**	**07**	**01**	**00**	**00**	**02**

	SEMESTER–IV	Course imparts Employability (EM), Entrepreneurship (EN), Skill Development (SD)			Course integrates with Professional Ethics (PE), Gender Equity (GE), Human Value (HV), Environmental Sustainability (ES)			
Course Code	**Major Course Title**	**EM**	**EN**	**SD**	**PE**	**GE**	**HV**	**ES**
24BUCH4T01	Physical and Allied Chemistry-II	√	--	--	--	--	--	--
24BUCH4T02	Inorganic and Allied Chemistry-II	√	--	--	--	--	--	--
24BUCH4T03	Organic and Allied Chemistry-II	√	--	--	--	--	--	--
24BUCH4P01	Practical-I based on 24BUCH4T01 and24BUCH4T02	√	--	√	--	--	--	--
24BUCH4P02	Practical-II based on 24BUCH4T02 and 24BUCH4T03	√	--	√	--	--	--	--
24BU4SEC02	Extraction and fabrication methods	√	√	√	--	--	--	√
Course Code	**Minor Course Title**							
24BUCH4T04	Electrochemistry and Green chemistry	√	--	--	--	--	--	√
Course Code	**Generic Course Title**							
24BUCH4T05	Environmental and Pharmaceutical Chemistry	√	--	--	--	--	--	√
Ability Enhancement Courses (AEC)								
24BUCH4P03	Field Project in Chemistry-II	√	√	√	--	--	--	√
	Total	**09**	**02**	**05**	**00**	**00**	**5**	**4**

Dr. A. S. Goswami-Giri

Professor and Head Dept. Of Chemistry