

**Academic Council Meeting No. and Date :09/02 July 2024**

**Agenda Number: 03 Resolution No: 41,41/3.2,3.22**



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



**Syllabus for**

**Programme : Bachelor of Science**

**Specific Programme : Chemistry**

**[ S.Y.B.Sc. (Chemistry Major) ]**

**Level 5.0**

<b>Initiated in Academic year 1969-1970</b>	<b>Revised under NEP academic year 2024 - 2025</b>
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## 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,

### Eligibility:

Level 4.5 ( F.Y. B.Sc)

### Program Outcome

Learners are able to -

- Apply knowledge about physical chemistry in various chemical industries
- Calculate chemical calculus apply in the filed
- Organic chemistry knowledge comforts them in handling of chemicals. Practical will distinguish crude and purified products in various preparations
- After completion of syllabus students can apply knowledge in solving societal issues.

### Program Specific Outcome

- Study of structure, properties, reaction and application of chemical systems.
- Study of safety precaution use in chemical laboratory.
- Select and apply current techniques, skills, and tools necessary in chemical laboratory.
- Study of basics of Physical chemistry, Inorganic chemistry, Organic chemistry and Analytical chemistry.

### Pedagogy:

- \$ Assignment Desk work, internal tests, Assignments, Quiz, ppt presentation You tube videos, referencing , MOOC, Problem solving, Project work, Industrial Visit, internship etc Pedagogy for student engagement is predominantly lectures. However, other pedagogies enhancing better student engagement to be recommended for each course. The list includes active learning/ course projects/ problem or project based learning/ case studies/self-study like seminar, term paper or MOOC
- \$ Every course needs to include assessment for higher order thinking skills (Applying/ Analyzing/ Evaluating/ Creating). However, this column may contain alternate assessment methods that help formative assessment (i.e. assessment for learning)
- **Assessment: Weightage for assessments (in percentage)**

Type of Course	Formative Assessment / IA	Summative Assessment
Theory	40 %	60 %
Practical	-	100 %
Experimental learning	-	100 %
Visits	-	100 %

**BOS Chairperson:** Prof. Dr. Anita.S.Goswami-Giri



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

**Reframing of COs and Mapping of COs with POs.**

**DEPARTMENT OF CHEMISTRY**

<b>Subject:</b> Chemistry								
<b>Course Name:</b> Paper 1 Physical and Allied Chemistry-I								
<b>Course Code:</b> 24BUCH3T01								
	<b>Course Outcome</b>		<b>PO 1</b>	<b>PO 2</b>	<b>PO 3</b>	<b>PO 4</b>	<b>PO 5</b>	<b>PO 6</b>
<b>CO 1</b>	Understand the basic concepts of thermodynamics, significance and properties	<b>CO 1</b>	1	0	0	0	0	0
<b>CO 2</b>	Outline the concept of conductance and their applications	<b>CO 2</b>	1	0	0	0	0	0
<b>CO 3</b>	Discuss the applications of chemical kinetics for different types of reactions, and explain- Classification of diverse types of polymers	<b>CO 3</b>	1	0	0	0	0	0
<b>CO 4</b>	Explain different types of solutions, their vapour pressure, and their correlation with temperature.	<b>CO 4</b>	1	1	0	0	0	0

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

**Reframing of COs and Mapping of COs with POs.**

<b>Subject:</b> Chemistry								
<b>Course Name:</b> Paper 2 Inorganic and Allied Chemistry-I								
<b>Course Code:</b> 24BUCH3T02								
	<b>Course Outcome</b>		<b>PO 1</b>	<b>PO 2</b>	<b>PO 3</b>	<b>PO 4</b>	<b>PO 5</b>	<b>PO 6</b>
<b>CO 1</b>	Calculate lattice energy of ionic compounds	<b>CO 1</b>	1	0	0	0	0	0
<b>CO 2</b>	Know the applications and limitations of valence bond theory with respect to chemical bonding.	<b>CO 2</b>	1	0	0	0	0	0
<b>CO 3</b>	Explain the structure, electron deficient nature and properties of compounds of boron	<b>CO 3</b>	1	0	0	0	0	0
<b>CO 4</b>	Understand preparation, structure and semiconducting properties of silicon and germanium and properties of hydrides and oxides of nitrogen family elements.	<b>CO 4</b>	0	1	0	0	0	0

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

**Reframing of COs and Mapping of COs with POs.**

<b>Subject:</b> Chemistry								
<b>Course Name:</b> Paper 3 Organic and Allied Chemistry-I								
<b>Course Code:</b> 24BUCH3T03								
	<b>Course Outcome</b>		<b>PO 1</b>	<b>PO 2</b>	<b>PO 3</b>	<b>PO 4</b>	<b>PO 5</b>	<b>PO 6</b>
<b>CO 1</b>	Discuss structure, reactions, reactivity of halogenated hydrocarbons and organometallic compounds.	<b>CO 1</b>	1	0	0	0	0	0
<b>CO 2</b>	Explain Nomenclature, Preparation, reactions and reactivity of alcohols, phenols, ethers and epoxides.	<b>CO 2</b>	1	0	0	0	0	0
<b>CO 3</b>	Illustrate nomenclature of aromatic carbonyl compounds, elaborate structure, reactivity and preparation of aldehydes and ketones,	<b>CO 3</b>	1	0	0	0	0	0
<b>CO 4</b>	Deduce the mechanism of reactions shown by aldehydes and ketones.	<b>CO 4</b>	1	1	0	0	0	0



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

**Reframing of COs and Mapping of COs with POs.**

<b>Subject:</b> Chemistry								
<b>Course Name:</b> Field Project / Apprenticeship								
<b>Course Code:</b> 24BUCH3P03								
	<b>Course Outcome</b>		<b>PO 1</b>	<b>PO 2</b>	<b>PO 3</b>	<b>PO 4</b>	<b>PO 5</b>	<b>PO 6</b>
<b>CO 1</b>	Apply theoretical knowledge to real-world situations and analyse field-specific challenges.	<b>CO 1</b>	1	0	0	0	0	0
<b>CO 2</b>	Develop practical skills in data collection, analysis, and interpretation related to the project topic.	<b>CO 2</b>	1	0	0	0	0	0
<b>CO 3</b>	Demonstrate problem-solving abilities through innovative and evidence-based approaches.	<b>CO 3</b>	1	0	0	0	0	0
<b>CO 4</b>	Work collaboratively in a team setting while managing time and resources effectively.	<b>CO 4</b>	0	1	0	0	0	0
<b>CO 5</b>	Communicate findings and recommendations clearly through written reports, presentations, or other deliverables							

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

**Reframing of COs and Mapping of COs with POs.**

**DEPARTMENT OF CHEMISTRY**

**(S. Y. B. Sc)**

<b>Subject:</b> Chemistry								
<b>Course Name:</b> Paper 1 Physical and Allied Chemistry-II								
<b>Course Code:</b> 24BUCH4 T01								
	<b>Course Outcome</b>		<b>PO 1</b>	<b>PO 2</b>	<b>PO 3</b>	<b>PO 4</b>	<b>PO 5</b>	<b>PO 6</b>
<b>CO 1</b>	Study of thermodynamic parameters of chemical systems.	<b>CO 1</b>	1	0	0	0	0	0
<b>CO 2</b>	Illustrate phase equilibria for industrial applications	<b>CO 2</b>	1	0	0	0	0	0
<b>CO 3</b>	Explain different crystal systems and their characteristics, Apply the XRD method for determination of the crystal structure	<b>CO 3</b>	1	0	0	0	0	0
<b>CO 4</b>	Understand terms involved in catalysis, mechanisms of industrially important acid-base and enzyme catalysis, applications of nanoparticles as catalysts	<b>CO 4</b>	0	0	0	0	0	1

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

**Reframing of COs and Mapping of COs with POs.**

<b>Subject:</b> Chemistry								
<b>Course Name:</b> Paper 2 Inorganic and Allied Chemistry-II								
<b>Course Code:</b> 24BUCH4 T02								
	<b>Course Outcome</b>		<b>PO 1</b>	<b>PO 2</b>	<b>PO 3</b>	<b>PO 4</b>	<b>PO 5</b>	<b>PO 6</b>
<b>CO 1</b>	Comprehend spectral and magnetic properties of transition metals	<b>CO 1</b>	1	0	0	0	1	0
<b>CO 2</b>	Define basic terms involved in coordination chemistry and understand the metal-ligand bond, Warner's theory, and electron count	<b>CO 2</b>	1	0	0	0	1	0
<b>CO 3</b>	Explain the acidic and basic behavior of cations and anions present aqueous medium	<b>CO 3</b>	1	0	0	0	1	0
<b>CO 4</b>	Understand environmental aspects of volatile oxides and oxy-acids of main group elements	<b>CO 4</b>	2	0	0	0	2	0

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

Reframing of COs and Mapping of COs with POs.

DEPARTMENT OF CHEMISTRY

(S. Y. B. Sc)

<b>Subject:</b> Chemistry								
<b>Course Name:</b> Paper 3 Organic and Allied Chemistry-II								
<b>Course Code:</b> 24BUCH 4T03								
	<b>Course Outcome</b>		<b>PO 1</b>	<b>PO 2</b>	<b>PO 3</b>	<b>PO 4</b>	<b>PO 5</b>	<b>PO 6</b>
<b>CO 1</b>	Recognize the nomenclature, preparations and reactions of carboxylic acids.	<b>CO 1</b>	1	0	0	0	1	0
<b>CO 2</b>	Understand the mechanism of nucleophilic acyl substitution, Claisen ester condensation, Dieckman ester condensation, reactivity of sulphonic acids and stereochemistry of cyclohexane.	<b>CO 2</b>	1	0	0	0	1	0
<b>CO 3</b>	Explain the nomenclature, structure, preparation, and reactivity of amines and diazonium salts.	<b>CO 3</b>	1	0	0	0	1	0
<b>CO 4</b>	Illustrate classification, nomenclature, synthesis and reactivity of five membered heterocyclic molecules. Introduction to UV spectroscopy and calculation of $\lambda_{\text{max}}$ value.	<b>CO 4</b>	1	0	0	0	1	0

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

**Reframing of COs and Mapping of COs with POs.**

<b>Subject:</b> Chemistry								
<b>Course Name:</b> Separation Techniques in Analytical Chemistry								
<b>Course Code:</b> 24BU3SEC02								
	<b>Course Outcome</b>		<b>PO 1</b>	<b>PO 2</b>	<b>PO 3</b>	<b>PO 4</b>	<b>PO 5</b>	<b>PO 6</b>
<b>CO 1</b>	Understand the basic concept in advanced analytical separation techniques like electrophoresis, solvent extraction.	<b>CO 1</b>	1	0	0	0	1	0
<b>CO 2</b>	Explain the basics of technique in Chromatography.	<b>CO 2</b>	1	0	0	0	1	0
<b>CO 3</b>	Understand the recrystallization method.	<b>CO 3</b>	1	0	0	0	1	0
<b>CO 4</b>	Demonstrate Thin Layer Chromatography technique for separation of organic compounds.	<b>CO 4</b>	1	0	0	0	1	0

**VPM's B. N. Bandodkar College of Science (Autonomous), Thane**  
**S.Y.B.Sc. (Chemistry) [Level 5.0 ]**  
**Structure of Programme**

<b>Semester III</b>			
<b>Course Code</b>	<b>Course Title</b>	<b>No. of lectures In hrs.</b>	<b>Credits</b>
<b>24BUCH3T01</b>	Physical and Allied Chemistry-I	<b>30</b>	<b>2</b>
<b>24BUCH3T02</b>	Inorganic and Allied Chemistry-I	<b>30</b>	<b>2</b>
<b>24BUCH3T03</b>	Organic and Allied Chemistry-I	<b>30</b>	<b>2</b>
<b>24BUCH3P01</b>	Practical-I based on 24BUCH3T01 and 24BUCH3T02	<b>60</b>	<b>2</b>
<b>24BUCH3P02</b>	Practical-II based on 24BUCH3T02 and 24BUCH3T03	<b>60</b>	<b>2</b>
<b>24BU3SEC02</b>	SEC: Separation Techniques in Analytical Chemistry	<b>45</b>	<b>2</b>
<b>Total</b>		<b>255</b>	<b>12</b>
<b>Semester III: Minor</b>			
<b>Course Code</b>	<b>Course Title</b>	<b>No. of lectures In hrs</b>	<b>Credits</b>
<b>24BUCH3T04</b>	Separation Techniques	<b>30</b>	<b>2</b>
<b>Total</b>		<b>30</b>	<b>2</b>
<b>Semester III: Generic</b>			
<b>24BUCH3T05</b>	Cosmetics and Introduction to Dye Stuff Chemistry	<b>30</b>	<b>2</b>
<b>Total</b>		<b>30</b>	<b>2</b>
<b>Semester III Optional Electives -Interdisciplinary Sciences</b>			
<b>24BU3AEC01</b>	Ability Enhancement Courses (AEC)	<b>30</b>	<b>2</b>
<b>Total</b>		<b>30</b>	<b>2</b>
<b>Semester III</b>			
<b>24BUCH3P03</b>	Field Project / Apprenticeship	<b>60</b>	<b>2</b>
<b>Total</b>		<b>60</b>	<b>2</b>

<b>Semester III</b>			
23BU3CESC6	<b>Community Engagement &amp; Services /Co-curricular Courses</b>	<b>45</b>	<b>2</b>
23BU3CC601	NSS-Social science		
23BU3CC602	NCC-Defense science		
23BU3CC603	DLLE- Department of Lifelong Learning & Extension		
23BU3CC604	Sports- Physical Education		
23BU3CC605	Cultural Activities		
23BU3CC606	Departmental Activities		
23BU3CC607	Yoga for total health		
23BU3CC608	Cyber Security		
<b>Note:- Student will select any of the courses under CC mentioned above for credit 2. CC Syllabus will be viewed separately.</b>			
<b>Total</b>		<b>30</b>	<b>2</b>
<b>Total Credits</b>		<b>450</b>	<b>22</b>
<b>Semester IV</b>			
<b>Course Code</b>	<b>Course Title</b>	<b>No. of lectures In hrs.</b>	<b>Credits</b>
<b>24BUCH4T01</b>	Physical and Allied Chemistry-II	<b>30</b>	<b>2</b>
<b>24BUCH4T02</b>	Inorganic and Allied Chemistry-II	<b>30</b>	<b>2</b>
<b>24BUCH4T03</b>	Organic and Allied Chemistry-II	<b>30</b>	<b>2</b>
<b>24BUCH4P01</b>	Practical-I based on 24BUCH4T01 and 24BUCH4T02	<b>60</b>	<b>2</b>
<b>24BUCH4P02</b>	Practical-II based on 24BUCH4T02 and 24BUCH4T03	<b>60</b>	<b>2</b>
<b>24BU4SEC02</b>	<b>SEC:</b> Extraction and fabrication methods	<b>45</b>	<b>2</b>
<b>Total</b>		<b>255</b>	<b>12</b>
<b>Semester IV: Minor</b>			
<b>Course Code</b>	<b>Course Title</b>	<b>No. of lectures In hrs</b>	<b>Credits</b>

<b>24BUCH4T04</b>	Electrochemistry and Green chemistry	<b>30</b>	<b>2</b>
<b>Total</b>		<b>30</b>	<b>2</b>
<b>Semester IV: Generic</b>			
<b>24BUCH4T05</b>	Environmental Chemistry	<b>30</b>	<b>2</b>
<b>Total</b>		<b>30</b>	<b>2</b>
<b>Semester IV Ability Enhancement Courses (AEC)</b>			
<b>24BU4AEC01</b>	Ability Enhancement Courses (AEC)	<b>30</b>	<b>2</b>
<b>Total</b>		<b>30</b>	<b>2</b>
<b>Semester IV</b>			
<b>24BUCH4P03</b>	Field Project / Apprenticeship	<b>60</b>	<b>2</b>
<b>Total</b>		<b>60</b>	<b>2</b>
<b>Semester IV</b>			
<b>23BU4CESC6</b>	Community Engagement & Services /Co-curricular Courses	<b>45</b>	<b>2</b>
<b>23BU4CC601</b>	NSS-Social science		
<b>23BU4CC602</b>	NCC-Defense science		
<b>23BU4CC603</b>	DLLE- Department of Lifelong Learning & Extension		
<b>23BU4CC604</b>	Sports- Physical Education		
<b>23BU4CC605</b>	Cultural Activities		
<b>23BU4CC606</b>	Departmental Activities		
<b>23BU4CC607</b>	Yoga for total health		
<b>23BU4CC608</b>	Cyber Security		
<b>Note:- Student will select any of the courses under CC mentioned above for credit 2. CC Syllabus will be viewed separately.</b>			
<b>Total</b>		<b>45</b>	<b>2</b>
<b>Total Credits</b>		<b>450</b>	<b>22</b>



# Semester III

Course Code 24BUCH3 T01	Course Title Paper 1 Physical and Allied Chemistry-I	Credits 2	No. of lectures
<b>Course Outcomes:</b> Upon completion of this course, students will acquire knowledge about and be able to <ol style="list-style-type: none"> <li>1. Understand the basic concepts of thermodynamics, significance and properties</li> <li>2. Outline the concept of conductance and their applications</li> <li>3. Discuss the applications of chemical kinetics for different types of reactions, and explain- Classification of diverse types of polymers</li> <li>4. Explain different types of solutions, their vapour pressure, and their correlation with temperature.</li> </ol>			
Unit I :	<b>1.1 Chemical Thermodynamics-II: (7 L)</b> <b>1.1.1</b> Free Energy Functions: Helmholtz Free Energy, Gibb's Free Energy, Variation of Gibb's Free Energy with Pressure and Temperature, Gibbs-Helmholtz equation. <b>1.1.3</b> Thermodynamics of Open System: Partial Molal Properties, Chemical Potential and its Variation with P and T, Gibb's Duhem equation. <b>1.1.4</b> Concept of Fugacity and Activity. <b>1.2 Electrochemistry: (8 L)</b> <b>1.2.1</b> Conductivity, equivalent and molar conductivity, and their variation with dilution for weak and strong electrolytes. <b>1.2.2</b> Kohlrausch law of independent migration of ions. <b>1.2.3</b> Applications of conductance measurements: determination of the degree of ionization and ionization constant of weak electrolyte, solubility and solubility product of sparingly soluble salts, ionic product of water. (Numericals expected). <b>1.2.4</b> Transference number and its experimental determination using the Moving boundary method. (Numericals expected). Factors affecting transference number.	15	
Unit II :	<b>2.1 Chemical Kinetics-II: (5L)</b> <b>2.1.1</b> Introduction to reaction mechanism, Types of Complex Chemical reactions: Reversible or opposing, consecutive and parallel reactions	15	

	<p>(No derivations, only examples expected)</p> <p><b>2.1.2</b> Effect of temperature on reaction rate, Arrhenius equation (Numericals expected)</p> <p><b>2.1.3</b> Collision theory of reaction rate (Only Postulates expected)</p> <p><b>2.2 Polymer Chemistry – I: (2 L)</b></p> <p>2.2.1 Basic Terms: Macromolecule, monomer, repeat unit, Polymerization, (addition and condensation polymerization), Degree of Polymerization.</p> <p>2.2.2 Polymer structures linear, branched and cross-linked</p> <p><b>2.3 Solutions: (8L)</b></p> <p>2.3.1 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</p> <p>2.3.2 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.</p>	
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## REFERENCES:

### 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., New York (1985).
6. K. L. Kapoor A textbook of Physical Chemistry 3rd 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.
4. Yalkowsky, Samuel H. Solubility and Solubilization in Aqueous Media, 1st Edition

Course Code 24BUCH3T02	Course Title Paper 2 Inorganic and Allied Chemistry-I	Credits 2	No. of lectures
<b>Course Outcomes:</b> Upon completion of this course, students will acquire knowledge about and able to			
<div>1. Calculate lattice energy of ionic compounds</div> <div>2. Know the applications and limitations of valence bond theory with respect to chemical bonding.</div> <div>3. Explain the structure, electron deficient nature and properties of compounds of boron</div> <div>4. Understand preparation, structure and semiconducting properties of silicon and germanium and properties of hydrides and oxides of nitrogen family elements.</div>			
Unit I :	<b>1.1 Non-Directional Bonding: (3L)</b>	15	
	<b>1.1.1</b> Ionic Bond: Conditions for the Formation of Ionic Bond.		
	<b>1.1.2</b> Lattice Energy, Borne-Lande Equation (Numericals)		
	<b>1.1.3</b> Kapustinski Equation (Numericals)		
	<b>1.1.4</b> Born-Haber Cycle and its Application		
	<b>1.2 Directional Bonding: Orbital Approach: (6L)</b>		
	<b>1.2.1</b> Valence Bond Theory- Introduction and basic tenets.		
	<b>1.2.2</b> Interaction between two hydrogen atoms and the Potential energy diagram of the resultant system.		
	<b>1.2.3</b> Corrections applied to the system of two hydrogen atoms- Formation of H <sub>2</sub>		
	<b>1.2.4</b> Homonuclear diatomic molecules from He <sub>2</sub> to Ne <sub>2</sub>		
	<b>1.2.5</b> Bonding in Polyatomic Species: The role of Hybridization. And types of hybrid orbitals-sp, sp <sup>2</sup> , sp <sup>3</sup> , sp <sup>3</sup> d, sp <sup>2</sup> d <sup>2</sup> and sp <sup>2</sup> d sp <sup>3</sup> d <sup>2</sup> .		
	<b>1.2.6</b> Equivalent and Non-Equivalent hybrid orbitals		
	<b>1.2.7</b> Contribution of a given atomic orbital to the hybrid orbitals (with reference to sp <sup>3</sup> hybridisation as in CH <sub>4</sub> , NH <sub>3</sub> and H <sub>2</sub> O and series like NH <sub>3</sub> , PH <sub>3</sub> , AsH <sub>3</sub> , BiH <sub>3</sub> )		
	<b>1.3 Molecular Orbital Theory: (6L)</b>		
	<b>1.3.1</b> Introduction to MOT, Comparing Atomic Orbitals and Molecular Orbitals.		
<b>1.3.2</b> Linear combination of atomic orbitals to give molecular orbitals LCAO- MO approach for diatomic homonuclear molecules).			
<b>1.3.3</b> Wave mechanical treatment for molecular orbitals (H <sub>2</sub> <sup>+</sup> and H <sub>2</sub> )			
<b>1.3.4</b> Molecular orbital Theory and Bond Order with reference to O <sub>2</sub> , N <sub>2</sub> , C <sub>2</sub> , B <sub>2</sub> ) and magnetic property with reference to O <sub>2</sub> , O <sub>2</sub> <sup>+</sup> , O <sub>2</sub> <sup>2-</sup> , O <sub>2</sub> <sup>2-</sup>			

Unit II :	<p><b>2.1 Chemistry of Boron compounds: (5L)</b></p> <p><b>2.1.1</b> Electron deficient compounds – <math>\text{BH}_3</math>, <math>\text{BF}_3</math>, <math>\text{BCl}_3</math> with respect to Lewis's acidity and applications.</p> <p><b>2.1.2</b> Preparation of simple boranes like diborane and tetraborane.</p> <p><b>2.1.3</b> Structure and bonding in diborane and tetraborane (2e-3c bonds)</p> <p><b>2.1.4</b> Synthesis of Borax.</p> <p><b>2.1.5</b> Uses of Boron compounds</p> <p><b>2.2 Chemistry of Silicon and Germanium: (5L)</b></p> <p><b>2.2.1</b> Silicon compounds: Occurrence, Structure and inertness of <math>\text{SiO}_2</math></p> <p><b>2.2.2</b> Preparation of structure of <math>\text{SiCl}_4</math></p> <p><b>2.2.3</b> Occurrence and extraction of Germanium</p> <p><b>2.2.4</b> Preparation of extra pure Silicon and Germanium</p> <p><b>2.2.5</b> Importance of extra pure Silicon and Germanium in semiconductor industries</p> <p><b>2.3 Chemistry of Nitrogen family: (5L)</b></p> <p><b>2.3.1</b> Trends in chemical reactivity - Formation of hydrides, halides, oxides with special reference to oxides of nitrogen.</p> <p><b>2.3.2</b> Oxides of nitrogen with respect to preparation and structure of <math>\text{NO}</math>, <math>\text{NO}_2</math>, <math>\text{N}_2\text{O}</math> and <math>\text{N}_2\text{O}_4</math>.</p> <p><b>2.3.3</b> Synthesis of ammonia by Bosch – Haber process.</p> <p><b>2.3.4</b> Uses of ammonia .</p>	15
<p><b>REFERENCES:</b></p> <p><b>Unit I :</b></p> <ol style="list-style-type: none"> <li>1. Inorganic Chemistry – Gary Wulfsberg, Viva Book, First Indian Edition 2002.</li> <li>2. Quantitative Analysis – R.A.Day, A.L. Underwood, sixth edition</li> <li>3. Vogel's Textbook of quantitative chemical analysis – J Mendham, R C Denny, J D Barnes, M Thomas, B Sivasankar</li> <li>4. Bruce H. Mahan, University Chemistry, Narosa publishing house pg. 611 to 683.</li> <li>5. R. Gopalan , Universities Press India Pvt.Ltd. Inorganic Chemistry for Undergraduates. Chemistry of Transition Elements Pg.- 608 – 679 .</li> <li>6. J. D. Lee, 4th Edn., Concise Inorganic Chemistry, ELBS, The group III elements Pg. 359-648.</li> <li>7. D. F. Shriver and P. W. Atkins, Inorganic chemistry, 3rd edition, Oxford University Press (1999) page 325- 446.</li> <li>8. Ramesh Kapoor and R.S. Chopra, Inorganic Chemistry, R. Chand publishers, New Delhi.</li> </ol>		

9. CNR Rao edited, University General Chemistry, 513-578.
10. James E. Huheey, Ellen Keiter and Richard Keiter, Inorganic Chemistry: Principles of Structure and Reactivity, 4<sup>th</sup> Edition, Harper Collins Publisher.
11. Emeleus and Anderson, Modern Aspects of Inorganic Chemistry, page no. 435-463.
12. Cotton and Wilkinson, Advanced Inorganic Chemistry, 3rd. Edition.
13. Gary Wulfsberg, Inorganic chemistry, Viva Books Pvt., Ltd. (2002).
14. Puri, Sharma and Kalia, Milestone publishers, Principles of Inorganic Chemistry, page 416-628.
15. Ramesh Kapoor and R.S. Chopra, Inorganic Chemistry, R. Chand publishers, New Delhi.

#### Unit II:

1. J. D. Lee, 4th Edn., Concise Inorganic Chemistry, ELBS
2. Bruce H. Mahan, University Chemistry, Narosa publishing house
3. R. Gopalan, Inorganic Chemistry for Undergraduates, Universities Press India Pvt. Ltd.
4. D. F. Shriver and P. W. Atkins, Inorganic chemistry, 3rd edition, Oxford University press
5. Ramesh Kapoor and R.S. Chopra, Inorganic Chemistry, R. Chand publishers, New Delhi.
6. James E. Huheey, Ellen Keiter and Richard Keiter, Inorganic Chemistry: Principles of Structure and Reactivity, 4<sup>th</sup> Edition, Harper Collins Publisher.
7. Emeleus and Anderson, Modern Aspects of Inorganic Chemistry
8. Cotton and Wilkinson, Advanced Inorganic Chemistry
9. Puri, Sharma and Kalia, Milestone publishers, Principles of Inorganic Chemistry
10. Jain and Jain, Engineering Chemistry, Dhanpat Rai Publishing Company
11. Catherine E. Housecroft, Alan G. Sharpe, Inorganic Chemistry, Pearson Education Limited.

Course Code	Course Title	Credits	No. of lectures
24BUCH3T03	Paper 3 Organic and Allied Chemistry-I	2	

**Course Outcomes:** Upon completion of this course, students will acquire knowledge about and able to

1. Discuss structure, reactions, reactivity of halogenated hydrocarbons and organometallic compounds.
2. Explain Nomenclature, Preparation, reactions and reactivity of alcohols, phenols, ethers and epoxides.
3. Illustrate nomenclature of aromatic carbonyl compounds, elaborate structure, reactivity

and preparation of aldehydes and ketones, <b>4. Deduce the mechanism of reactions shown by aldehydes and ketones.</b>		
<b>Unit I :</b>	<p><b>1.1 Reactions and reactivity of halogenated hydrocarbons (4L)</b></p> <p><b>1.1.1 Alkyl halides:</b></p> <p>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.</p> <p><b>1.1.2 Aryl halides:</b></p> <p>Reactivity of aryl halides towards nucleophilic substitution reactions. Nucleophilic aromatic substitution (SNAr) addition-elimination mechanism and benzyne mechanism</p> <p><b>1.1.3 Organomagnesium and Organolithium Compounds(3L)</b></p> <p>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.</p>	<b>15</b>
	<p><b>1.2 Alcohols, phenols ethers and epoxides (8L)</b></p> <p><b>1.2.1 Alcohols:</b> 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.</p> <p><b>1.2.1 Phenols:</b></p> <p>Preparation, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of peroxide ion. Reactions of phenols.</p> <p><b>1.2.2 Epoxides:</b> 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.</p>	

	<b>1.2.3 Ether:</b> Introduction and Nomenclature of Ether, methods of Preparation and Reactions of Ether Cleavage of ethers with HI (Aliphatic and Aromatic ether)	
<b>Unit II :</b>	<p><b>2.1 Carbonyl Compounds :</b></p> <p><b>2.1.1</b> 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.</p> <p><b>2.1.2</b> General mechanism of nucleophilic addition, and acid catalyzed Nucleophilic addition reactions. Reactions of aldehydes and ketones with NaHSO<sub>3</sub>, HCN, RMgX, alcohol, amine, phenylhydrazine, 2,4- Dinitrophenyl hydrazine, LiAlH<sub>4</sub>, and NaBH<sub>4</sub>.</p> <p><b>2.1.3</b> Mechanisms of following reactions: benzoin condensation, Knoevengel condensation, Claisen-Schmidt and Cannizzaro reaction.</p> <p><b>2.1.4</b> 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).</p> <p><b>2.1.5</b> Reactions of aldehydes and ketones with alcohol.</p>	<b>15</b>
<b>References</b>	<p><b>Unit I &amp; Unit II</b></p> <ol style="list-style-type: none"> <li>1) Morrison, R. T. and Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).2012</li> <li>2) Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)</li> <li>3) Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)</li> <li>4) Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.</li> <li>5) Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.</li> <li>6) Graham Solomons, T.W. Organic Chemistry, John Wiley &amp; Sons, Inc.</li> </ol>	



	7) Comprehensive Organic Chemistry- The synthesis and reactions of Organic Compounds, Derek barton ,W. David Ollis. 8) Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub. 9) Eliel, E. L. and Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994. 10) Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005.		
Course Code	Course Title Chemistry Practical	Credits	No. of lectures
24BUCH3P01	BASED ON 24BUCH3T01 and 24BUCH3T02	2	60 hrs
24BUCH3P02	BASED ON 24BUCH3T02 and 24BUCH3T03	2	60 hrs
<b>Course Outcomes:</b> Upon completion of this course, students will acquire knowledge about and able to <ul style="list-style-type: none"><li>• Develop experimental and analytical skills by conducting practical applications of physical and chemical experiments</li><li>• Develop commercial analysis of various organic and inorganic compounds.</li><li>• Analyse different chemical reactions.</li></ul>			
24BUCH3P01	<b>I] PHYSICAL CHEMISTRY</b> <ol style="list-style-type: none"><li>1. To verify Ostwald’s dilution law for weak acid conductometrically.</li><li>2. To determine dissociation constant of weak acid conductometrically.</li><li>3. To determine the critical solution temperature (CST) of phenol – Water System.</li><li>4. Determination of energy of activation of acid catalyzed hydrolysis of methyl acetate.</li><li>5. To investigate the reaction between K<sub>2</sub>S<sub>2</sub>O<sub>8</sub> and KI with equal initial concentrations of the reactants.</li><li>6. To determine solubility of sparingly soluble salts (any two) conductometrically.</li></ol> <b>II] INORGANIC CHEMISTRY</b> <ol style="list-style-type: none"><li>1. To determine the Fe(II) and Fe (III) in a given mixture titrimetrically.</li><li>2. <b>Colorimetric</b> Determination of Copper Ions in a given Solution by using the calibration curve method.</li><li>3. To determine the hardness of the given water sample complexometrically.</li><li>4. Determination of calcium and magnesium contents of a dolomite</li></ol>	60	

	ore sample.	
<b>24BUCH3P02</b>	<p><b>I] INORGANIC CHEMISTRY</b></p> <ol style="list-style-type: none"> <li>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)</li> <li>2. Gravimetric estimation of Nickel (II) as Ni-DMG.</li> <li>3. Gravimetric estimation of barium ions using K<sub>2</sub>CrO<sub>4</sub> as precipitant.</li> </ol> <p><b>II] ORGANIC CHEMISTRY</b></p> <p>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:</p> <ol style="list-style-type: none"> <li>1. Cyclohexanone oxime from cyclohexanone.</li> <li>2. Glucosazone from dextrose or fructose</li> <li>3. Tribromoaniline from aniline.</li> <li>4. β-Naphthyl benzoate</li> <li>5. m-Dinitrobenzene from nitrobenzene</li> <li>6. Phthalic anhydride from phthalic acid by sublimation</li> <li>7. Acetanilide from aniline</li> <li>8. p-Bromoacetanilide from acetanilide</li> <li>9. Iodoform from acetone.</li> <li>2. (minimum Six preparations)</li> </ol>	<b>60</b>

**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)
6. R.V. Dilts. "Analytical Chemistry. Methods of Separation," van Nostrand, N.Y. (1974).
7. Senior Practical Physical Chemistry, B. D. Khosla(2011)
8. Vogel's *Quantitative Chemical Analysis*, J. Mendham, 6<sup>th</sup> edition (2009)

**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)
6. A. I. Vogel, Textbook of Practical Organic Chemistry( 1996)

24BUCH3P03	Field Project / Apprenticeship	60	2
	After the successful completion of the course, the learner will be able to: <ol style="list-style-type: none"> <li>1) Apply theoretical knowledge to real-world situations and analyse field-specific challenges.</li> <li>2) Develop practical skills in data collection, analysis, and interpretation related to the</li> </ol>		

	<p>project topic.</p> <ol style="list-style-type: none"> <li>3) Demonstrate problem-solving abilities through innovative and evidence-based approaches.</li> <li>4) Work collaboratively in a team setting while managing time and resources effectively.</li> <li>5) Communicate findings and recommendations clearly through written reports, presentations, or other deliverables</li> </ol>		
	<p>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.</p> <p><b>Week 1-2: Orientation and Topic Selection</b></p> <ul style="list-style-type: none"> <li>• Overview of field project requirements and objectives.</li> <li>• Guidance on selecting project topics.</li> <li>• Introduction to research methods and tools.</li> </ul> <p><b>Week 3-4: Literature Review and Proposal Development</b></p> <ul style="list-style-type: none"> <li>• Conduct a literature review related to the chosen topic.</li> <li>• Develop a project proposal outlining objectives, methodology, and expected outcomes.</li> <li>• Submit the proposal for approval.</li> </ul> <p><b>Week 05-06: Data Collection and Fieldwork</b></p> <ul style="list-style-type: none"> <li>• Design and execute data collection strategies (e.g., surveys, observations, experiments).</li> <li>• Conduct field visits and gather data as per the approved methodology.</li> <li>• Maintain a fieldwork journal/logbook.</li> </ul> <p><b>Week 07-08: Data Analysis and Interpretation</b></p> <ul style="list-style-type: none"> <li>• Analyze collected data using relevant tools and techniques.</li> <li>• Interpret results to address the project's objectives.</li> </ul> <p><b>Week 09-10: Report Writing and Presentation Preparation</b></p> <ul style="list-style-type: none"> <li>• Prepare a detailed project report including background, methodology, findings, discussion, and recommendations.</li> <li>• Design and rehearse a presentation of the project outcomes.</li> </ul>		

	<b>Week 11-12: Final Submission and Evaluation</b> <ul style="list-style-type: none"> <li>• Submit the final project report.</li> <li>• Deliver an oral or poster presentation to peers and faculty.</li> <li>• Receive feedback and final evaluation.</li> </ul> <hr/>		
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## Semester IV

Course Code 24BUCH4 T01	Course Title Paper 1 Physical and Allied Chemistry-II	Credits 2	No. of lectures 30 in hrs.
<p><b>Course Outcomes:</b> Upon completion of this course, students will acquire knowledge about and be able to-</p> <ul style="list-style-type: none"> <li>• Study of thermodynamic parameters of chemical systems.</li> <li>• Illustrate phase equilibria for industrial applications</li> <li>• Explain different crystal systems and their characteristics, Apply the XRD method for determination of the crystal structure</li> <li>• Understand terms involved in catalysis, mechanisms of industrially important acid-base and enzyme catalysis, applications of nanoparticles as catalysts.</li> </ul>			

<p><b>Unit I :</b></p>	<p><b>1.1 Electrochemistry-II: (8 L)</b></p> <p><b>1.1.1</b> Electrochemical conventions, Reversible and irreversible cells.</p> <p><b>1.1.2</b> Nernst equation and its importance, Types of electrodes, Standard electrode potential, Electrochemical series (Numericals expected).</p> <p><b>1.1.3</b> Thermodynamics of a reversible cell, calculation of thermodynamic properties: <math>\Delta G</math>, <math>\Delta H</math> and <math>\Delta S</math> from EMF data. (Numericals expected)</p> <p><b>1.1.4</b> Calculation of equilibrium constant from EMF data. (Numericals expected)</p> <p><b>1.1.5</b> Chemical and Concentration cells (only classifications), Liquid junction potential and salt bridge.</p> <p><b>1.1.6</b> pH determination using hydrogen electrode and quinhydrone electrode. (Numericals expected)</p> <p><b>1.2 Phase Equilibria: (7L)</b></p> <p><b>1.2.1</b> Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation.</p> <p><b>1.2.2</b> Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. (Numericals expected)</p> <p><b>1.2.3</b> Phase diagrams of one-component systems (water and sulphur). Two component systems involving eutectics (lead-silver system), congruent and incongruent melting points.</p>	<p><b>15</b></p>
<p><b>Unit II :</b></p>	<p><b>2.1 Solid State: (7L)</b></p> <p><b>2.1.1</b> Laws of Crystallography and Types of Crystals</p> <p><b>2.1.2</b> Characteristics of simple cubic, face-centered cubic and body-centered cubic systems, interplanar distance in a cubic lattice (only expression for the ratio of interplanar distances are expected)</p> <p><b>2.1.3</b> 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)</p> <p><b>2.2 Catalysis: (8L)</b></p> <p><b>2.2.1</b> Types of catalysis, catalytic activity, specificity and selectivity, inhibitors, catalyst poisoning and deactivation</p> <p><b>2.2.2</b> Mechanisms and kinetics of acid-base catalyzed reactions, the effect of pH.</p> <p><b>2.2.3</b> Mechanisms and kinetics of enzyme-catalyzed reactions (Michaelis-Menten equation)</p>	<p><b>15</b></p>

	2.2.4 Nanoparticles as catalyst – basic concepts, their importance in chemical reactions, properties Challenges associated with nanoparticles as catalysts.		
<p><b>REFERENCES</b></p> <p><b>Unit I:</b></p> <ol style="list-style-type: none"> <li>1. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).</li> <li>2. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).</li> <li>3. Kotz, J.C., Treichel, P.M. &amp; Townsend, J.R. General Chemistry Cengage Learning India Pvt.Ltd., New Delhi (2009)</li> <li>4. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).</li> <li>5. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co., NewYork (1985).</li> <li>6. K.L.Kapoor A textbook of Physical Chemistry3rd Ed. vol.1,2Macmillan Publishing Co., NewDelhi(2001)</li> </ol> <p><b>Unit II:</b></p> <ol style="list-style-type: none"> <li>1. Barrow, G.M. Physical Chemistry Tata McGraw- Hill (2007).</li> <li>2. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).</li> <li>3. Kotz, J.C., Treichel, P.M. &amp; Townsend, J.R. General Chemistry CengageLearning India Pvt.Ltd., New Delhi (2009).</li> <li>4. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).</li> <li>5. Pfenning, Brian W. (2015). Principles of Inorganic Chemistry. Hoboken: John Wiley &amp; Sons, Inc. pp. 195.</li> <li>6. M. Bowker, The Basis and Applications of Heterogeneous Catalysis (1998), Oxford University Press, Oxford</li> <li>7. Leach, Bruce. E.,(1983) Industrial Catalysis: Chemistry applied to your life-style and environment, In Applied industrial catalysis, vol 1, New York, Academic press, Inc.</li> </ol>			
Course Code 24BUCH4 T02	Course Title Paper 2 Inorganic and Allied Chemistry-II	Credits 2	No. of lectures30 in hrs
Course Outcomes: Upon completion of this course, students will acquire knowledge about and be able to			
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	<ul style="list-style-type: none"> <li>• Comprehend spectral and magnetic properties of transition metals</li> <li>• Define basic terms involved in coordination chemistry and understand the metal-ligand bond, Warner's theory, and electron count</li> <li>• Explain the acidic and basic behavior of cations and anions present aqueous medium</li> <li>• Understand environmental aspects of volatile oxides and oxy-acids of main group elements.</li> </ul>	
<b>Unit I :</b>	<p><b>1.1 Comparative Chemistry of the transition metals: (8L)</b></p> <p><b>1.1.1</b> Position in the periodic table; Natural occurrence principal ores and minerals</p> <p><b>1.1.2</b> Significance of special stability of <math>d^0</math>, <math>d^5</math>, and <math>d^{10}</math> leading to variable oxidation states; Unusual oxidation states and their stabilities in aqueous solutions (with special reference to vanadium, and chromium.)</p> <p><b>1.1.3</b> 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).</p> <p><b>1.1.4</b> 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.</p> <p><b>1.1.5</b> Variation of magnetic properties with temperature: Curie (<math>T_c</math>) and Neel (<math>T_N</math>) temperature</p> <p><b>1.1.6</b> Qualitative tests for transition metal ions: General considerations in devising tests (concerning Chromium, Manganese, iron, Cobalt Nickel and Copper)</p> <p><b>1.2 Coordination Chemistry: (7L)</b></p> <p><b>1.2.1</b> Introduction to Chemistry of Coordination Compound</p> <ol style="list-style-type: none"> <li>i) Historical perspectives: Early ideas on coordination compounds</li> <li>ii) Basic terms and nomenclature.</li> <li>iii) Types of ligands</li> <li>iv) Isomerism: General Types with special reference to stereoisomerism of coordination compounds (C.N=6)</li> <li>v) Evidence for the formation of coordination compounds</li> </ol> <p><b>1.2.2 Theories of coordination compounds</b></p> <ol style="list-style-type: none"> <li>i) Werner's Theory of coordination compounds,</li> <li>ii) Effective atomic number rule.</li> <li>iii) Eighteen electron Rule</li> </ol> <p><b>1.2.3 Nature of the Metal-Ligand Bond:</b></p> <ol style="list-style-type: none"> <li>i) Valence Bond Theory; Hybridisation of the central metal orbitals <math>sp^3</math>, <math>sd^3/d^3s</math> <math>sp^3d^2/d^2sp^3</math>, <math>sp^2d</math>,</li> </ol>	<p style="text-align: center;"><b>15</b></p>

	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 <b>1.2.4</b> Application of coordination compounds.	
<b>Unit II :</b>	<b>2.1 Ions in aqueous medium: (8L)</b> <b>2.1.1</b> Acidity of Cations and Basicity of Anions <b>2.1.2</b> Hydration of Cations; Hydrolysis of Cations predicting degree of hydrolysis of Cations-effect of Charge and Radius. <b>2.1.3</b> Latimer Equation. Relationship between pKa, acidity, and $z^2 / r$ ratios of metal ions graphical Presentation <b>2.1.4</b> Classification of cations based on acidity category – Nonacidic, Moderately acidic, strongly acidic, very strongly acidic with pKa values range and examples <b>2.1.5</b> Hydration of Anions; Effect of Charge and Radius; Hydration of anions- concept, diagram classification based on Basicity <b>2.1.6</b> Importance of acidity and basicity of cations and anions in reaction Mechanism Uses and Environmental <b>2.2 Chemistry of volatile Oxides and oxo-acids: (7L)</b> <b>2.2.1</b> Physical properties of concentrated oxo-acids like sulfuric, Nitric, and Phosphoric acid <b>2.2.2</b> Uses and environments aspects of these acids	<b>15</b>
<b>REFERENCES:</b>		
<b>Unit I</b> 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. 6. Chemistry of Transition Elements Pg.- 608 – 679 . 8. J. D. Lee, 4th Edn., Concise Inorganic Chemistry, ELBS, The group III elements Pg. 359- 648. 9. D. F. Shriver and P. W. Atkins, Inorganic chemistry, 3rd edition, Oxford University Press (1999)		

page 325-446.

10. Ramesh Kapoor and R.S. Chopra, Inorganic Chemistry, R. Chand publishers, New Delhi.
11. CNR Rao edited, University General Chemistry, 513-578.
12. James E. Huheey, Ellen Keiter and Richard Keiter, Inorganic Chemistry: Principles of Structure and Reactivity, 4<sup>th</sup> Edition, Harper Collins Publisher.
13. Emeleus and Anderson, Modern Aspects of Inorganic Chemistry, page no. 435-463.
14. Cotton and Wilkinson, Advanced Inorganic Chemistry, 3rd. Edition.
15. Gary Wulfsberg, Inorganic chemistry, Viva Books Pvt., Ltd. (2002).
16. Puri, Sharma and Kalia, Milestone publishers, Principles of Inorganic Chemistry, page 416-628.
17. Bruce H. Mahan, University Chemistry, Narosa publishing house.

#### **Unit II:**

1. J. D. Lee, 4th Edn., Concise Inorganic Chemistry, ELBS .
2. Bruce H. Mahan, University Chemistry, Narosa publishing house.
3. R. Gopalan , Inorganic Chemistry for Undergraduates, Universities Press India Pvt. Ltd.
4. D. F. Shriver and P. W. Atkins, Inorganic chemistry, 3rd edition, Oxford University press.
5. Ramesh Kapoor and R.S. Chopra, Inorganic Chemistry, R. Chand publishers, New Delhi.
6. James E. Huheey, Ellen Keiter and Richard Keiter, Inorganic Chemistry: Principles of Structure and Reactivity, 4<sup>th</sup> Edition, Harper Collins Publisher.
7. Emeleus and Anderson, Modern Aspects of Inorganic Chemistry.
8. Cotton and Wilkinson, Advanced Inorganic Chemistry.
9. Puri, Sharma and Kalia, Milestone publishers, Principles of Inorganic Chemistry
10. Jain and Jain, Engineering Chemistry, Dhanpat Rai Publishing Company Catherine E. Housecroft, Alan G. Sharpe, Inorganic Chemistry, Pearson Education Limited.

Course Code	Course Title	Credits	No. of lectures30 in hrs
24BUCH 4T03	Paper 3 Organic and Allied Chemistry-II	2	
<b>Course Outcomes:</b> Upon completion of this course, learners will achieve knowledge related to ➤ Recognize the nomenclature, preparations and reactions of carboxylic acids.			

<ul style="list-style-type: none"> <li>➤ Understand the mechanism of nucleophilic acyl substitution, Claisen ester condensation, Dieckman ester condensation, reactivity of sulphonic acids and stereochemistry of cyclohexane.</li> <li>➤ Explain the nomenclature, structure, preparation, and reactivity of amines and diazonium salts.</li> <li>➤ Illustrate classification, nomenclature, synthesis and reactivity of five membered heterocyclic molecules. Introduction to UV spectroscopy and calculation of <math>\lambda_{\text{max}}</math> value.</li> </ul>		
<b>Unit I :</b>	<p><b>3.1 Carboxylic Acids and their Derivatives: (10 Lectures)</b></p> <p><b>3.1.1.</b> Nomenclature, structure and physical properties, acidity of carboxylic acids, effects of substituents on acid strength of aliphatic and aromatic carboxylic acids.</p> <p><b>3.1.2.</b> Preparation of carboxylic acids: oxidation of alcohols and alkyl benzene, carbonation of Grignard and hydrolysis of nitriles.</p> <p><b>3.1.3.</b> Reactions: Acidity, salt formation, decarboxylation, Reduction of carboxylic acids with <math>\text{LiAlH}_4</math>, diborane, Hell-Volhard-Zelinsky reaction, Conversion of carboxylic acid to acid chlorides, esters, amides and acid anhydrides and their relative reactivity.</p> <p><b>3.1.4.</b> Mechanism of nucleophilic acyl substitution and acid-catalysed nucleophilic acyl substitution. Interconversion of acid derivatives by nucleophilic acyl substitution.</p> <p><b>3.1.5.</b> Mechanism of Claisen condensation and Dieckmann condensation.</p> <p><b>3.2 Sulphonic acids: [2L]</b> Physical and Chemical properties preparation of aromatic sulphonic acids by sulphonation of benzene toluene and naphthalene, Comparative acidity of carboxylic acid and sulfonic acids.</p> <p><b>3.3 Stereochemistry: [3L]</b> Stereochemistry of Cyclohexane, Bayer's Strain theory, heat of combustion of cyclohexenes, Conformation and Stability of cycloalkanes.</p>	<b>15</b>
<b>Unit II :</b>	<p><b>3.1 Amines: (4L)</b></p> <p><b>3.1.1.</b> Nomenclature, effect of substituent on the basicity of aliphatic and aromatic amines: Preparation: Reduction of aromatic nitro compounds using catalytic hydrogenation, chemical reduction using <math>\text{Fe-HCl}</math>, <math>\text{Sn-HCl}</math>, <math>\text{Zn}</math> acetic acid, reduction of nitriles, ammonolysis of halides, reductive amination, Hofmann bromamide reaction.</p> <p><b>3.2.2. Reactions-</b> 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.</p> <p><b>3.2 Diazonium Salts: (3L)</b></p>	<b>15</b>

	<p>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</p> <p><b>3.3 Heterocyclic Compounds: (5L)</b></p> <p><b>3.3.1.</b> Classification, nomenclature, electronic structure, aromaticity in 5- numbered and 6-membered rings containing one heteroatom.</p> <p><b>3.3.2.</b> Synthesis of Furan, Pyrrole (Paal- Knorr synthesis, Knorr pyrrole synthesis, and Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis).</p> <p><b>3.3.3.</b> 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.</p> <p><b>3.3.4.</b> Reactions of furan, pyrrole and thiophene: halogenation, nitration, sulphonation, Vilsmeier-Haack reaction, Friedel-Crafts reaction.</p> <p><b>3.4. UV-Visible spectroscopy</b></p> <p>3.4.1 Introduction (3L)</p> <p>3.4.2 Terms used in UV Spectroscopy: Chromophore, Auxochrome, Bathochromic shift, hypsochromic shift, hyperchromic shift and hypochromic effect.</p> <p>3.4.3 Modes of transitions</p> <p>3.4.4 Calculation of <math>\lambda_{\text{max}}</math> by Woodward and Fischer rules for dienes.</p>	
<b>Reference</b>	<p><b>REFERENCES</b></p> <p><b>UNIT - I</b></p> <ol style="list-style-type: none"> <li>1. Morrison, R. T. and Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).2012</li> <li>2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)</li> <li>3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)</li> <li>4. Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.</li> <li>5. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.;</li> </ol>	

	<p>Organic Chemistry, Oxford University Press.</p> <ol style="list-style-type: none"><li>Graham Solomons, T.W. Organic Chemistry, John Wiley &amp; Sons, Inc.</li><li>Comprehensive Organic Chemistry- The synthesis and reactions of Organic Compounds, Derek barton ,W. David Ollis.</li><li>Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub.</li><li>Eliel, E. L. and Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994.</li><li>Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005.</li></ol> <p><b>UNIT - II</b></p> <ol style="list-style-type: none"><li>Morrison, R. T. and Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education),2012</li><li>Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)</li><li>Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)</li><li>Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.</li><li>Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.</li><li>Graham Solomons, T.W. Organic Chemistry, John Wiley &amp; Sons, Inc.</li><li>Comprehensive Organic Chemistry- The synthesis and reactions of Organic Compounds, Derek barton ,W. David Ollis.</li><li>Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub.</li><li>Eliel, E. L. and Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994.</li><li>Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005.</li></ol>		
<b>Course Code</b>	<b>Course Title</b> <b>Chemistry Practical</b>	<b>Credits</b>	<b>No. of lectures</b>
<b>24BUCH4P01</b>	<b>BASED ON 24BUCH4T01 AND 24BUCH4T02</b>	<b>2</b>	<b>60 hrs</b>
<b>24BUCH4P02</b>	<b>BASED ON 24BUCH4T02 AND 24BUCH4T03</b>	<b>2</b>	<b>60 hrs</b>

<b>Course Outcomes:</b> Upon completion of this course, students will acquire knowledge about and able to <ul style="list-style-type: none"> <li>• Build analytical thinking chemical behavior of different chemical reactions.</li> <li>• Demonstrate different instruments used in chemical laboratory</li> <li>• Perform organic qualitative analysis</li> <li>• Understand Calibration and standardization of instruments.</li> </ul>		
24BUCH4P01	<b>I] Physical Chemistry</b> <ol style="list-style-type: none"> <li>1. To determine standard EMF and the standard free energy change of Daniel cell potentiometrically.</li> <li>2. To determine the amount of HCl in the given sample potentiometrically.</li> <li>3. Compare the strengths of HCl and H<sub>2</sub>SO<sub>4</sub> by studying kinetics of acid hydrolysis of methyl acetate.</li> <li>4. Determination of Vitamin C content in a given tablet by pH meter.</li> <li>5. Determination of buffer capacity of acid buffer and basic buffer.</li> <li>6. Estimation of given acid by conductometric titration method with strong base.</li> </ol> <b>II] Inorganic Chemistry</b> <ol style="list-style-type: none"> <li>7. Estimation of Fe(II) in the given solution by titrating against K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> potentiometry.</li> <li>8. To carry out assay of a saline sample by Mohr's method.</li> <li>9. To draw lattice planes [(100), (110) and (111)] for primitive, body centered and face centered cubic crystal system.</li> <li>10. Industrial visit report</li> </ol>	
24BUCH4P02	<b>I] Inorganic Chemistry</b> <ol style="list-style-type: none"> <li>1. To prepare tris (ethylene diamine) nickel (II) thioisulphate.</li> <li>2. To prepare nickel dimethyl glyoximate by using microscale method.</li> <li>3. Gravimetric estimation of sulphate ions using Barium sulphate as precipitant.</li> </ol> <b>II] Organic Chemistry Qualitative Analysis of bi-functional organic compounds on the basis of:</b> <ol style="list-style-type: none"> <li>1. Preliminary examination</li> <li>2. Solubility profile</li> <li>3. Detection of elements C, H, (O), N, S, X.</li> <li>4. Detection of functional groups</li> <li>5. Determination of physical constants (M.P/B.P)</li> </ol> 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).		
<b>24BUCH4P03</b>	<b>Field Project / Apprenticeship</b>	<b>No. of Hours</b>  <b>60</b>	<b>Credits</b>  <b>02</b>
	<p>After the successful completion of the course, the learner will be able to:</p> <ol style="list-style-type: none"> <li>1) Apply theoretical knowledge to real-world situations and analyse field-specific challenges.</li> <li>2) Develop practical skills in data collection, analysis, and interpretation related to the project topic.</li> <li>3) Demonstrate problem-solving abilities through innovative and evidence-based approaches.</li> <li>4) Work collaboratively in a team setting while managing time and resources effectively.</li> </ol> <p>Communicate findings and recommendations clearly through written reports, presentations, or other deliverables</p>		
	<p>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.</p> <p><b>Week 1-2: Orientation and Topic Selection</b></p> <ul style="list-style-type: none"> <li>• Overview of field project requirements and objectives.</li> <li>• Guidance on selecting project topics.</li> <li>• Introduction to research methods and tools.</li> </ul> <p><b>Week 3-4: Literature Review and Proposal Development</b></p> <ul style="list-style-type: none"> <li>• Conduct a literature review related to the everyday Chemistry-society topics.</li> <li>• Develop a project proposal outlining objectives, methodology, and expected outcomes.</li> <li>• Submit the proposal for approval from internal mentor.</li> </ul> <p><b>Week 05-06: Data Collection and Fieldwork</b></p> <ul style="list-style-type: none"> <li>• Design and execute data collection strategies (e.g., surveys, observations, experiments).</li> <li>• Conduct field visits and gather data as per the approved methodology.</li> <li>• Maintain a fieldwork journal/logbook.</li> </ul> <p><b>Week 07-08: Data Analysis and Interpretation</b></p> <ul style="list-style-type: none"> <li>• Analyze collected data using relevant tools and techniques.</li> <li>• Interpret results to address the project's objectives.</li> </ul>		



	<p><b>Week 09-10: Report Writing and Presentation Preparation</b></p> <ul style="list-style-type: none"> <li>• Prepare a detailed project report including background, methodology, findings, discussion, and recommendations.</li> <li>• Design and rehearse a presentation of the project outcomes.</li> </ul> <p><b>Week 11-12: Final Submission and Evaluation</b></p> <ul style="list-style-type: none"> <li>• Submit the final project report.</li> <li>• Deliver an oral or poster presentation to peers and faculty.</li> <li>• Receive feedback and final evaluation.</li> </ul>	
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## REFERENCES:

### 24BUCH4P01

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)

### 24BUCH4P02

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.

**Evaluation Scheme 40:60 [Total marks 50 = Internals 20: External 30]**

#### Internals

Attendance	Group discussion	Assignments	Leadership qualities	Total
05	05	05	05	20
Certification of Swayam / NPTEL in concern course/ Class Test				

**Theory Examination: Suggested Format of Question paper**

**Duration: 1.30 Hours**

**Total Marks : 30**

**All questions are compulsory**

<b>Q.1</b>	<b>Attempt ANY TWO of the following</b>	<b>(10)</b>
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(A)	Unit 1	
(B)	Unit 1	
(C)	Unit 1	
(D)	Unit 1	
<b>Q.2</b>	<b>Attempt ANY TWO of the following</b>	<b>(10)</b>
(A)	Unit 2	
(B)	Unit 2	
(C)	Unit 2	
(D)	Unit 2	
<b>Q.3</b>	<b>Answers the following (Attempt ANY TWO)</b>	<b>(10)</b>
(A)	<b>Fill in the blanks.</b>	
	i) Unit 1	
	ii) Unit 1	
	iii) Unit 2	
	iv) Unit 2	
	v) Unit 2	
(B)	<b>Multiple choice questions.</b>	
	i) Unit 1	
	ii) Unit 1	
	iii) Unit 1	
	iv) Unit 2	
	v) Unit 2	
(C)	<b>Match the following</b>	
	i) Unit 1	
	ii) Unit 1	
	iii) Unit 2	
	iv) Unit 2	
	v) Unit 2	
(D)	<b>True and False</b>	
	i) Unit 1	
	ii) Unit 1	

	<b>iii)</b>	Unit 1	
	<b>iv)</b>	Unit 2	
	<b>v)</b>	Unit 2	

**Marks Distribution and Passing Criterion for Each Semester**  
**Semester III**

<b>Theory</b>				
Course Code	Internal	Min marks for passing	Theory Examination	Min marks for passing
24BUCH3T01	<b>20</b>	<b>08</b>	<b>30</b>	12
24BUCH3T02	<b>20</b>	<b>08</b>	<b>30</b>	12
24BUCH3T03	<b>20</b>	<b>08</b>	<b>30</b>	12
24BUCH3P01	-	-	<b>50</b>	24
24BUCH3P02	-	-	<b>50</b>	24

**Semester IV**

<b>Theory</b>				
Course Code	Internal	Min marks for passing	Theory Examination	Min marks for passing
24BUCH4T01	<b>20</b>	<b>08</b>	<b>30</b>	12
24BUCH4T02	<b>20</b>	<b>08</b>	<b>30</b>	12
24BUCH4T03	<b>20</b>	<b>08</b>	<b>30</b>	12
24BUCH4P01	-	-	<b>50</b>	24
24BUCH4P02	-	-	<b>50</b>	24

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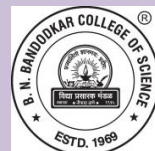
Academic Council Meeting No. and Date:

Agenda Number:

Resolution Number:



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



**Syllabus for**

**Skill based Course (SEC) in Chemistry:**

Separation Techniques in Analytical Chemistry  
Extraction and fabrications methods

**[S.Y.B.Sc. Chemistry / (Semester III & IV)]**

**CHOICE BASED GRADING SYSTEM**

**Revised under NEP and Autonomy**

**Level 5.0**

**From academic year 2024-25**

## **PREAMBLE:**

The Department of Chemistry has introduced a specialized SEC course in level 5.0 which augments the skills of learners alongside their academic degrees. This initiative acknowledges the adage that emphasizes the significance of skills over mere degrees in professional success.

The learners not only gain theoretical knowledge but also practical expertise that is directly applicable in professional settings. This course aims to equip learners with practical skills in chemistry which is required for societal demands. The experiments were designed with various apparatus /non instrumental experimental work.

The course serves as a platform for increasing their employability and effectiveness in the workplace. By integrating these skill development initiatives with traditional academic pursuits, the department strives to prepare students comprehensively for the challenges of the modern job market.

## **OBJECTIVES:**

- To build up a confidence and skills in learners to conduct non instrumental experiments.
- To understand the basics in advanced analytical separation techniques like chromatography, electrophoresis, solvent extraction etc
- To learn the small scale manufacturing skills
- To build up confidence and skills in handling any instruments used in various estimations.

### **Eligibility :**

Level 4.5 ( F.Y. B.Sc)

**Duration:** 3 years

### **Mode of Conduct:**

Offline lectures / Laboratory practicals

## SEC - Chemistry Programme structure

# Semester III

Course Code	Course Title	Credits	No. of lectures
	Separation Techniques in Analytical Chemistry	2	
24BU3SEC02	(1T+1P)	15+30	45
<b>Course Outcomes:</b> Upon completion of this course, students will acquire knowledge about and able			
<ul style="list-style-type: none"><li>• Understand the basic concept in advanced analytical separation techniques like electrophoresis, solvent extraction.</li><li>• Explain the basics of technique in Chromatography.</li><li>•</li></ul>			
<b>Unit I :</b>	<b>1.1 Separation Techniques in Analytical Chemistry (02L)</b>	<b>15</b>	
	<b>1.1.1</b> An Introduction to Analytical Separations and its importance in analysis.		
	<b>1.1.2</b> Estimation of an analyte without effecting separation.		
	<b>1.1.3</b> Types of separation methods Based on-		
	<b>1.1.4</b> Solubility (Precipitation, Filtration Crystallisation)		
	<b>1.1.5</b> Gravity- Centrifugation		
	<b>1.1.6</b> Volatility-Distillation ;		
	<b>1.1.7</b> Electrical effects-Electrophoresis		
	<b>1.1.8</b> Retention capacity of a Stationary Phase -Chromatography;		
	<b>1.1.9</b> Distribution in two immiscible phases-Solvent Extraction;		
	<b>1.1.10</b> Based on capacity to exchange with a resin-Ion Exchange;		
	<b>1.2 Electrophoresis: (02L)</b>		
	Principles, Basic Instrumentation, Working and Application in separation of bio molecules like enzymes and DNA.		
	<b>1.3 Solvent extraction (05 L)</b>		
	<b>1.3.1</b> Introduction, Nernst distribution Law, Distribution Ratio, Partition Coefficient.		
<b>1.3.2</b> Conditions of extraction: Equilibration time, Solvent volumes, temperature, pH.			
<b>1.3.3</b> Single step and multi-step extraction, Percentage extraction for single step and multistep extraction.			
Separation factor.			
<b>1.3.4</b> Batch and continuous extraction			
<b>1.4. Chromatography : (06L)</b>			
<b>1.4.1</b> Introduction			
<b>1.4.2</b> Classification of chromatographic methods based on stationary and mobile phase			

	<b>1.4.3 Paper Chromatography:</b> Principle, techniques and applications of Paper Chromatography in separation of cations. <b>1.4.4 Thin layer Chromatography Principle, technique and Applications</b> in determining the purity of a given solute; Following progress of a given reaction.	
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<b>Course code</b> <b>24BU3SEC02</b>	<b>Course title</b> <b>SEC Practical</b>	<b>Credits 1</b>	<b>Lectures</b> <b>30 hrs.</b>
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(ANY FIVE)

**1. Paper Chromatography:**

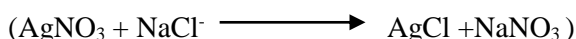
Separation of cations like Fe (III), Ni (II) and Cu (II) in a sample by using paper chromatography.

**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



**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)**

## Semester IV

<b>24BU4SEC02</b>	<b>Course Title</b> <b>Extraction and fabrications methods</b>	<b>Credits</b> <b>2</b>	<b>No. of lectures</b> <b>45</b>
	<b>(1T+1P)</b>	<b>15+30</b>	<b>45</b>

**Course Outcomes:** Upon completion of this course, students will acquire knowledge about and able -

- Illustrate the extraction methods of natural essential oils, saponification.
- Demonstrate the techniques detergents, laboratory waste management, Perfume manufacturing techniques.

<b>Unit I :</b>	<b>1.1Extraction methods of natural essential oils</b> Sources of natural essential oil, Methods of Producing Essential Oils, Hydrodistillation, Three Types of Hydrodistillation, Fats and oils <b>1.2 Saponification:</b> The Chemistry of Soap-Making, Materials and Equipment,	<b>15</b>
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	<p>Experimental Observations, Uses</p> <p><b>1.3 Detergents:</b> Anionic detergents, Non-ionic detergents, Cationic detergents,</p> <p><b>1.4 Testing Hardness of Soap and Detergent</b></p> <p><b>1.5 Laboratory Waste Management:</b> Waste Separation: Hazardous chemical wastes, Non-hazardous chemical wastes, Disposal of lab waste.</p> <p><b>1.6 Perfume manufacturing techniques:</b> Understanding the Science of Perfume, Using Essential Oils, Using Fresh Flowers, Leaves or Herbs</p>	
<b>24BU4SEC02</b>	<b>SEC practical</b>	<b>30hrs</b>
<p>(Any Six)</p> <ol style="list-style-type: none"> <li>1. Oil Extraction (Water distillation)</li> <li>2. Oil extraction (Steam Distillation)</li> <li>3. Ubtan Preparation using natural sources</li> <li>4. Soap Preparation/ Saponification</li> <li>5. Detergent Preparation</li> <li>6. Non-dust chalk preparation</li> <li>7. Laboratory Waste Management</li> <li>8. Perfume Preparation</li> <li>9. Industrial visit</li> </ol>		



## Evaluation Scheme

**Duration: 1.0 Hours**

**Total Mark: 50**

### 1. Practical Examination Sem III and Sem IV

Particular	Practical	Viva	Journal	Total
Practical	20	3+2	05	25
Theory	Theory	Internal		Total
25 marks Theory + 25 marks Practical	15	10		25

**Theory Examination: Suggested Format of Question paper**

**Duration: 1 Hours**

**Total Mark: 15**

**All questions are compulsory**

<b>Q. 1</b>	<b>Multiple Choice Questions (Any five)</b>	<b>05</b>
	i)	
	ii)	
	iii)	
	iv)	
	v)	
	vi)	
	vii)	
<b>Q. 2</b>	<b>Match the following (Any four)</b>	<b>04</b>
	i)	
	ii)	
	iii)	
	iv)	
	v)	
<b>Q. 3</b>	<b>Answer the following (Any two)</b>	<b>06</b>
	i)	
	ii)	
	iii)	
	iv)	

**Total of Internal Examination**

**10 Marks**

**Total of Theory Examination**

**15 Marks**

**Total of Practical Examination**

**25 Marks**

**Grand Total**

**50 Marks**

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Academic Council Meeting No. and Date : \_\_\_\_\_

Agenda Number : \_\_\_\_\_



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



**Syllabus for  
Programme : Bachelor of Science  
Specific Programme : Chemistry**

**[ S.Y.B.Sc. (Chemistry Minor) ]  
Level 5.0**

<b>Initiated in</b> <b>Academic year 1969-1970</b>	<b>Revised under NEP</b> <b>academic year 2024 - 2025</b>
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## Preamble

The S.Y.B.Sc. (Chemistry minor) Level 5.0 syllabus aims to prepare learners who have chosen chemistry as a minor subject, enhancing their employability and readiness for industry demands.

This course provides a comprehensive overview of modern techniques used in the separation of natural products and chemical mixtures.

Students will gain knowledge in

- Preparing reagents and solutions, and learn the theoretical principles behind these techniques.
- study the sparingly soluble salt, migration of ions
- They acquire the knowledge of green chemistry and synthesis of compound.

### Eligibility :

Level 4.5 ( F.Y. B.Sc)

**Duration:** 3 years

### Mode of Conduct:

Offline lectures / hybrid mode

### Program Specific Outcome

Learners will able to understand

- In the realm of chemical science, key practices encompass research and development (R&D), quality management, and assurance within laboratory settings.
- Proficiency in effective chemical preparation is essential for ensuring accurate experimental outcomes and reliable analyses.
- Expertise in the principles, instrumentation, and applications of diverse techniques is crucial for conducting precise chemical analyses and advancing scientific understanding.

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

**S.Y.B.Sc. (Chemistry)**

**Minor**

**Structure of Programme**

<b>Semester III</b>			
<b>Course Code</b>	<b>Course Title</b>	<b>No. of lectures</b>	<b>Credits</b>
<b>24BUCH3T04</b>	Separation Techniques	<b>30</b>	<b>2</b>
<b>Total</b>		<b>30</b>	<b>2</b>

<b>Semester IV</b>			
<b>Course Code</b>	<b>Course Title</b>	<b>No. of lectures</b>	<b>Credits</b>
<b>24BUCH4T04</b>	Electrochemistry and Green chemistry	<b>30</b>	<b>2</b>
<b>Total</b>		<b>30</b>	<b>2</b>

## Semester III

Course Code <b>24BUCH3 T04</b>	Course Title <b>Paper 1 Separation Techniques</b>	Credits <b>2</b>	No. of lectures
<b>Course Outcomes:</b> Upon completion of this course, students will acquire knowledge about and able to <ol style="list-style-type: none"> <li>1. Classify and explain chromatographic techniques, paper chromatography and TLC technique.</li> <li>2. Discuss electrophoresis techniques and its application.</li> <li>3. Classify nanomaterials and study their synthesis.</li> <li>4. Explain characterization of nanomaterials, their properties and applications.</li> </ol>			
<b>Unit I :</b>	<ol style="list-style-type: none"> <li><b>1. Separation Techniques and Chemical Calculations</b></li> <li><b>2. Chromatography :</b> <ol style="list-style-type: none"> <li>2.1. Introduction to Chromatography.</li> <li>2.2. Classification of chromatographic methods based on stationary and mobile phase</li> <li>2.3. <b>Paper Chromatography:</b> Principle, techniques and applications of Paper Chromatography in Separation of cations.</li> <li>2.4. <b>Thin layer Chromatography:</b> Principle, technique and Applications in determining the purity of a given solute; Following progress of a given reaction.</li> </ol> </li> <li><b>3. Electrophoresis:</b></li> <li>4. Principles, Basic Instrumentation, Working and Application in separation of biomolecules like enzymes and DNA</li> </ol>	<b>15</b>	
	<ol style="list-style-type: none"> <li><b>5. 3. Chemical Calculations</b></li> <li>6. Normality, Molarity, Molality, Formality, ppm, ppb, Millimoles,</li> <li>7. Milliequivalents, Mole fraction, Weight ratio, Volume ratio and weight to volume ratio.</li> </ol>		

Unit II	<b>Nanomaterials.</b> <b>Introduction</b> to nanomaterial 1.1. <b>Classification of nanomaterial</b> 1.2. <b>Chemical methods</b> of synthesis of nanomaterials (any one) 1.3 <b>Characterization</b> of nanomaterials(UV and XRD techniques) 1.3. <b>Dimensions</b> and forms of Nanomaterials: Nanofilms, Nanolayers, Nanotubes, Nanowires and Nanoparticales 1.4. <b>Properties:</b> Optical, Electrical and mechanical properties 1.6 <b>Application</b>	15	
Semester IV			
Course Code	Course Title	Credits	No. of lectures
24BUCH4 T04	Paper 2 Electrochemistry and Green chemistry	2	
<b>Course Outcomes:</b> Upon completion of this course, students will acquire knowledge about  1. Define Conductivity, equivalent and molar conductivity. 2. Evaluate and illustrate Kohlrausch law and its application, Transference number 3. Explain twelve principles of green chemistry with examples 4. Discuss atom economy, synthesis of adipic acid and disodium-iminodiacetate on the basis of green approach.			
Unit I :	<b>Unit I: Electrochemistry</b> <b>1.2.1</b> Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. <b>1.2.2</b> Kohlrausch law of independent migration of ions. <b>1.2.3</b> 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). <b>1.2.4</b> Transference number and its experimental determination using Moving boundary method. (Numericals expected).	15	

	<b>1.2.5 Factors affecting transference number.</b>	
<b>Unit II :</b>	<b><u>Unit II :Principle of Green Chemistry.</u></b>  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 uneconomic reactions Reducing Toxicity. 5. Green synthesis of following compound: Adipic acid, disodium -iminodiacetate	<b>15</b>

### References for practical

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)
6. R.V. Dils. "Analytical Chemistry. Methods of Separation," van Nostrand, N.Y. (1974).
7. Senior Practical Physical Chemistry, B. D. Khosla(2011)  
Vogel's *Quantitative Chemical Analysis*, J. Mendham, 6<sup>th</sup> edition (2009)

Semester III					
Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Analysis of food and Beverages	George Charalanbous	Academic press	1 <sup>st</sup>	1978
2.	An Advance Dairy chemistry	P. F. Fox, P. L. H. McSweeney	Springer	Volume 3	1997
3.	Food Analysis: Theory and practice	Yeshajahu Pomeranz,	Springer	3 <sup>rd</sup>	1978



		Clifton E. Meloan			
4.	Food Analysis	Edited by S. Suzanne Nielsen	Springer	5 <sup>th</sup>	2017
5.	Government of India publications of food drug cosmetic act and rules.	-	-	-	-

Semester IV					
Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Safety and Hazards Management in Chemical Industries	M N Vyas	Atlantic Publisher	Ch:4, Ch:5 & Ch:19	2020
2.	Industrial Hygiene and Chemical Safety	M H Fulekar	IK International Pvt. Ltd.	Ch:9, Ch:11 & Ch:15	2006
3.	Quality Management	Donna C S Summers	Pearson	2 <sup>nd</sup> , Ch:3	2008
4.	Quality in the Analytical Laboratory	Elizabeth Pichard	Wiley India	Ch: 5, Ch: 6 & Ch: 7	1995
5.	ISO 9000 Quality Systems Handbook	David Hoyle	Butterworth-Heinemann publications	Fourth Edition, Chapter: 3 & 4	2001
6.	Quality in Totality: A Manager's Guide To TQM and ISO 9000	Parag Diwan	Deep & Deep Publications	1st Edition	2000
7	OECD Principles of Good Laboratory Practice (as revised in 1997)"	-	OECD Environmental Health and Safety Publications, OECD.	1 <sup>st</sup>	1998
8	A systematic approach for evaluating the quality of experimental toxicological & eco-toxicological	Klimisch, HJ; Andreae, M; Tillmann, U	REGULATORY TOXICOLOGY AND PHARMACOLOGY 25, 1-5 (1997)	doi:10.1006/rtp.1996.1076. PMID 9056496.	1997

	data".		ARTICLE NO. RT961076		
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### Evaluation Scheme [40:60 pattern]

Internals 20 Mrk

Attendance	Group discussion	Assignments	Leadership qualities	Total
05	05	05	05	20
Certification of Swayam / NPTEL in concern course/ class test				

Theory Examination: Suggested Format of Question paper

Duration: 2 Hours

Total Marks : 30

- All questions are compulsory

<b>Q. 1</b>	Answer <i>any four</i> of the following		<b>20</b>
	a	Based on Unit I	
	b	Based on Unit I	
	c	Based on Unit I	
	d	Based on Unit I	
	e	Based on Unit I	
	f	Based on Unit I	
	g	Based on Unit I	
	h	Based on Unit I	
<b>Q. 2</b>	Answer <i>any four</i> of the following		<b>20</b>
	A	Based on Unit II	
	B	Based on Unit II	
	C	Based on Unit II	
	D	Based on Unit II	
	E	Based on Unit II	
	F	Based on Unit II	
	G	Based on Unit II	
	H	Based on Unit II	
<b>Q. 3</b>			<b>20</b>
	A	Multiple choice questions	<b>10</b>
	B	One sentence question	<b>5</b>
	C	True and False	<b>5</b>

### Marks Distribution and Passing Criterion for Each Semester

#### Semester III

Theory				
Course Code	Internal	Min marks for passing	Theory Examination	Min marks for passing
24BUCH3T04	40	16	60	24

#### Semester IV

Theory				
Course Code	Internal	Min marks for passing	Theory Examination	Min marks for passing
24BUCH4T04	40	16	60	24

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Academic Council Meeting No. and Date : \_\_\_\_\_

Agenda Number : \_\_\_\_\_



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



**Syllabus for**  
**Programme : Bachelor of Science**  
**Specific Programme : Chemistry**

**[S.Y.B.Sc.(Chemistry-Generic)]**  
**level 5.0**

<b>Initiated in Academic year 1969-1970</b>	<b>Revised under NEP academic year 2024 - 2025</b>
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## **Preamble**

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

- Theoretical knowledge in formulating cosmetic products, understanding ingredient chemistry and compatibility for safe and effective formulations.
- Continual research to explore new ingredients, technologies, and formulations that meet consumer expectations and advance the industry.
- Deep understanding of color theory, including principles of color mixing, dye interaction, and factors affecting final color outcomes.
- Proficiency in identifying environmental pollutants, their sources, and their impacts on ecosystems and human health.

The syllabus is aimed to achieve the objectives. The syllabus spanning Second year students who opted chemistry as a generic subject will be ready for the jobs available in different fields.

**Eligibility:** Level 4.5 ( F.Y. B.Sc)

**Duration:** 3 years

**Mode of Conduct:**

Offline lectures / hybrid mode

### **Program Outcome**

- The learners will demonstrate expertise in formulating cosmetic products, understanding the chemistry and compatibility of ingredients for effective and safe formulations.
- Engaging in the continuous studies/ research to explore new ingredients, technologies and formulations that align with that align with consumer expectations and industry advancement.
- The learners will have a deep understanding of colour theory, including the principles of colour mixing, dye interaction and the impact of different factors on the final colour outcome.
- The learner will be proficient in identifying different types of environmental pollutants, their sources and their potential impacts on ecosystem and human health.

### **Program Specific Outcome**

- Study of Cosmetics skin care products
- Study of dyestuff chemistry
- Select and apply current techniques, skills, and tools necessary in chemical laboratory and use it for food and cosmetics analysis.
- Study of pharmaceutical and common drugs and their uses.

**Dr. Anita S. Goswami-Giri**

**BOS-Chairperson**

**VPM's B. N. Bandodkar College of Science (Autonomous), Thane**  
**S.Y.B.Sc. -Level 5.0 (Chemistry Generic)**

**Structure of Programme**

<b>Semester III</b>			
<b>Course Code</b>	<b>Course Title</b>	<b>No. of lectures</b>	<b>Credits</b>
<b>24BUCH3T05</b>	Cosmetics and Introduction to Dye Stuff Chemistry	<b>30</b>	<b>2</b>
<b><i>Total</i></b>		<b>30</b>	<b>2</b>

<b>Semester IV</b>			
<b>Course Code</b>	<b>Course Title</b>	<b>No. of lectures</b>	<b>Credits</b>
<b>24BUCH4T05</b>	<b>Environmental Chemistry</b>	<b>30</b>	<b>2</b>
<b><i>Total</i></b>		<b>30</b>	<b>2</b>

## Semester III

Course Code <b>24BUCH3 T05</b>	Course Title <b>Paper 1</b>	Credits <b>2</b>	No. of lectures
<b>Course Outcomes:</b> Upon completion of this course, students will acquire knowledge about and able to <ul style="list-style-type: none"> <li>Identify physical, chemical properties, and application of different cosmetics products.</li> <li>Define and classify different cosmetics product: Emulsifier, Preservatives, Thickeners, Cream, Lotion, Soaps.</li> <li>Understand various criterions of ideal dye.</li> <li>Classify dyes according to its source, constitutes and applications.</li> </ul>			
<b>Unit I :</b>	<b>1 .COSMECTICS</b> 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	<b>15</b>	
<b>Unit II :</b>	<b>2. INTRODUCTION TO DYESTFF CHEMISTRY</b> <b>2.1</b> Definition of dyes, requirements of a good dye i.e. Colour, Chromophore and Auxochrome, Solubility, Linearity, Coplanarity, Fastness, Substantivity, Economic viability. <b>2.2 Natural and Synthetic Dyes</b> <b>2.2.1Natural Dyes:</b> 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 [ <b>structures not expected</b> ], <b>2.2.2 Synthetic dyes:</b> 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 discovery is required. ( <b>structure is not expected</b> ) <b>2.2.3 Optical Brighteners, Dye and pigments:</b> General idea, important characteristics of optical brighteners and pigments <b>2. 2.4 Classification of dyes based on constitution -</b> (i) Nitro Dyes-Napyhol yellow S (ii) Nitroso Dye-Gambine Y	<b>15</b>	



	<p>(iii) Azo Dyes- (a) Monoazo Dyes- Metanil yellow  (b) DiazoDyes- Naphthol Blue Black (c) Triazodyes - Chloroamine Green B  (iv) Diphenylmethane Dyes-Auramine G  (vi) Heterocyclic Dyes  (a) Xanthene-Rhodamine 6G  (b) Acridines-Acriflavine  (c) Azines- Safranin B  (d) Oxazines-Capri blue  (e) Thiazines-Methylene Green  (f) Quinolines- Quinoline Yellow</p> <p><b>2.2.5 Classification Based on Application -</b>  Definition, fastness properties &amp; 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, Naphthol AS, Naphthol ASG  (e) Mordant Dyes-Erichrome Black A, Alizarin.  (f) Vat Dyes- Indanthrene brown RRD, Indanthrene Red 5GK.  (g) Sulphur Dyes- Sulphur Black T [<b>structures not expected</b>],</p>	
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## Semester IV

Course Code 24BUCH4T05	Course Title Paper 2	Credits 2	No. of lectures
<b>Course Outcomes:</b> Upon completion of this course, students will acquire knowledge about and able to <ul style="list-style-type: none"> <li>• Explain Chemistry in Contemporary Society, pharmaceutical chemistry.</li> <li>• Discuss common drugs and their uses.</li> <li>• Define various types of environmental pollutions and types of natural resources</li> <li>• To understand, causes, effects and control measures of urban and industrial waste.</li> </ul>			
Unit I :	<b>1. Environmental Chemistry</b> Chemistry in Contemporary Society <b>1.1 Pharmaceuticals:</b> Importance of quality control, drugs and pharmaceuticals, sources of impurities in pharmaceutical chemicals, analytical quality control in finished / final products, common methods of assay. <b>1.2 Common drugs and their uses:</b> Analgesics – aspirin, paracetamol; Anthelmintics – mebendazole ; Antiallergies – chlorpheniramine maleate; Antibiotics-penicillin, chloramphenicol; Anti-inflammatory agents-oxyphenbutazone; Antimalarials – primaquine phosphate; Antituberculosis – INH; Narcotics – nicotine, morphine; Expectorants – Benadryl; Sedatives – diazepam; Vitamins – B1, B2, B6, niacin and folic acid.	15	
Unit II :	<b>ENVIRONMENTAL POLLUTION</b> <b>2.1. Definition (3L)</b> a) Air pollution b) Water pollution c) Soil pollution d) Marine pollution e) Noise pollution f) Thermal pollution g) Nuclear pollution <b>2.2.Solid waste management (4L)</b> Causes, effects and control measures of urban and industrial wastes. Environmental impact assessment. <b>2.3. Natural resources and non-renewable resources (8L)</b> 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	15	

## References

Semester 1					
Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Natural skin care and cosmetics formulation	Alice Burrell	-	-	2022
2.	A-Z natural cosmetic formulation	Gail Francombe	-	-	2019
3.	Cosmetics – A Practical manual	Dr. Shailendra Saraf	BSP	-	2019
4.	Introduction to Synthetic drugs and dyes	R S Rao Gomathi Shridhar Bholanath Mukherjee Tanuja Parulekar	Himalaya	14 <sup>th</sup>	2023
Semester 2					
Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Pharmaceuticals Analysis	T. Higuchi and E.B Hanseen, John Wiley and Sons	-	-	-
2.	Quantitative analysis of drugs	P. D. Sethi	CBS	3 <sup>rd</sup>	1997
3.	Environmental pollution and control	Peirce J Jeffery Ruth F Weiner Arne Vesilind	Butterworth Heinman	4 <sup>th</sup>	1998
4.	Renewable energy sources	Sinduja S	Anuradha publication	-	2012

**Evaluation Scheme****Internals -20M**

Attendance	Group discussion	Assignments	Leadership qualities	Total
05	05	05	05	20
Certification of Swayam / NPTEL in concern course/ Class Test				

**Theory Examination: Suggested Format of Question paper****Duration: 1.5 Hours****Total Marks : 30**

- All questions are compulsory

<b>Q. 1</b>	Answer <i>any two</i> of the following		<b>10</b>
	A	Based on Unit I	
	B	Based on Unit I	
	C	Based on Unit I	
	D	Based on Unit I	
<b>Q. 2</b>	Answer <i>any two</i> of the following		<b>10</b>
	A	Based on Unit II	
	B	Based on Unit II	
	C	Based on Unit II	
	D	Based on Unit II	
<b>Q. 3</b>	Answer <i>any two</i> of the following		<b>10</b>
	A	Multiple choice questions (Based on Unit I)	<b>5</b>
	B	One sentence question (Based on Unit II)	<b>5</b>
	C	True and False Based on (Based on Unit I and U nit II)	<b>5</b>

## Marks Distribution and Passing Criterion for Each Semester

### Semester III

Theory				
Course Code	Internal	Min marks for Passing	Theory Examination	Min marks for Passing
<b>24BUCH3T05</b>	<b>20</b>	<b>08</b>	<b>30</b>	12

### Semester IV

Theory				
Course Code	Internal	Min marks for Passing	Theory Examination	Min marks for Passing
<b>24BUCH4T05</b>	<b>20</b>	<b>08</b>	<b>30</b>	12

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V P M's B. N. Bandodkar College of Science (Autonomous), Thane  
Curriculum Structure for the Undergraduate Degree Programme S. Y. B.Sc. Chemistry

	<b>SEMESTER-III</b>	<b>Course imparts Employability (EM), Entrepreneurship (EN), Skill Development (SD)</b>			<b>Course integrates with Professional Ethics (PE), Gender Equity (GE), Human Value (HV), Environmental Sustainability (ES)</b>			
<b>Course Code</b>	<b>Major Course Title</b>	<b>EM</b>	<b>EN</b>	<b>SD</b>	<b>PE</b>	<b>GE</b>	<b>HV</b>	<b>ES</b>
<b>24BUCH3T01</b>	Physical and Allied Chemistry-I	√	--	--	--	--	--	--
<b>24BUCH3T02</b>	Inorganic and Allied Chemistry-I	√	--	--	--	--	--	--
<b>24BUCH3T03</b>	Organic and Allied Chemistry-I	√	--	--	--	--	--	--
<b>24BUCH3P01</b>	Practical-I based on 24BUCH3T1 and 24BUCH3T2	√	--	√	--	--	--	--
<b>24BUCH3P02</b>	Practical-II based on 24BUCH3T2 and 24BUCH3T3	√	--	√	--	--	--	--

<b>24BU3SEC02</b>	SEC: Separation Techniques in Analytical Chemistry	√	√	√	√	--	--	√
	<b>Minor Course Title</b>							
<b>24BUCH3T04</b>	Separation Techniques	√	--	√	--	--	--	--
<b>Course Code</b>	<b>Generic-Course Title</b>							
<b>24BUCH3T05</b>	Cosmetics and Introduction to Dye Stuff Chemistry	√	√	√	--	--	--	--
<b>Optional Electives Semester1-Interdisciplinary Sciences</b>								
<b>24BU3AEC01</b>	Ability Enhancement Courses (AEC)	--	--	√	--	--	--	--
<b>SEM-III</b>								
<b>24BUCH3P03</b>	Field Project / Apprenticeship	√	--	√	--	--	--	√
<b>23BU3CESC6</b>	<b>Community Engagement &amp; Services /Co-curricular Courses</b>							
<b>23BU3CC601</b>	NSS-Social science	--	--	--	---	√	√	--
<b>23BU3CC602</b>	NCC-Défense science	√	--	--	--	√	√	--
<b>23BU3CC603</b>	DLLE- Department of Lifelong Learning & Extension	--	--	--	--	√	--	--
<b>23BU3CC604</b>	Sports- Physical Education	√	--	--	--	√	--	--
<b>23BU3CC605</b>	Culture	√	--	--	--	--	√	--
<b>23BU3CC606</b>	Departmental Activities	--	--	--	--	--	√	--
<b>23BU3CC607</b>	Yoga for total health	√	--	--	--	--	√	--

<b>23BU3CC608</b>	Cyber Security	√	--	--	--	--	--	--
	<i>Total</i>	<b>14</b>	<b>02</b>	<b>07</b>	<b>01</b>	<b>04</b>	<b>05</b>	<b>02</b>

	<b>SEMESTER–IV</b>	<b>Course imparts Employability (EM), Entrepreneurship (EN), Skill Development (SD)</b>			<b>Course integrates with Professional Ethics (PE), Gender Equity (GE), Human Value (HV), Environmental Sustainability (ES)</b>			
<b>Course Code</b>	<b>Major Course Title</b>	<b>EM</b>	<b>EN</b>	<b>SD</b>	<b>PE</b>	<b>GE</b>	<b>HV</b>	<b>ES</b>
<b>24BUCH4T01</b>	Physical and Allied Chemistry-II	√	--	--	--	--	--	--
<b>24BUCH4T02</b>	Inorganic and Allied Chemistry-II	√	--	--	--	--	--	--
<b>24BUCH4T03</b>	Organic and Allied Chemistry-II	√	--	--	--	--	--	--
<b>24BUCH4P01</b>	Practical-I based on 24BUCH4T1 and 24BUCH4T2	√	--	√	--	--	--	--
<b>24BUCH4P02</b>	Practical-II based on 24BUCH4T2 and 24BUCH4T3	√	--	√	--	--	--	--
<b>24BU4SEC02</b>	<b>SEC:</b> Extraction and fabrication methods	√	√	√	--	--	--	√



Course Code	Minor Course Title							
24BUCH4T04	Electrochemistry and Green chemistry	√	--	--	--	--	--	√
Course Code	Generic Course Title							
24BUCH4T05	Environmental Chemistry	√	--	--	--	--	--	√
<b>Ability Enhancement Courses (AEC)</b>								
24BU4AEC01	Ability Enhancement Courses (AEC)	--	--	√	--	--	--	--
24BUCH4P03	Field Project / Apprenticeship	√	√	√	--	--	--	√
23BU4CES6	Community Engagement & Services /Co-curricular Courses	--	--	--	--	--	--	--
23BU4CC601	NSS-Social science	--	--	--	--	√	√	--
23BU4CC602	NCC-Defense science	√	--	--	--	√	√	--
23BU4CC603	DLLE- Department of Lifelong Learning & Extension	--	--	--	--	√	--	--
23BU4CC604	Sports- Physical Education	√	--	--	--	√	--	--
23BU4CC605	Cultural Activities	√	--	--	--	--	√	--
23BU4CC606	Departmental Activities	--	--	--	--	--	√	--
23BU4CC607	Yoga for Total health	√	--	--	--	--	√	--

<b>23BU4CC608</b>	Cyber Securuty	√	--	--	--	--	--	--
	<i>Total</i>	<b>14</b>	<b>02</b>	<b>05</b>	<b>00</b>	<b>4</b>	<b>5</b>	<b>4</b>

**Dr. A. S. Goswami-Giri**

**Professor and Head**

**Dept. Of Chemistry**