Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science & Commerce, Baramati

(Empowered Autonomous)

Department of Chemistry

(Faculty of Science)

Three/Four Year Honours/Honours with Research
B.Sc. Degree Program in Chemistry

T.Y.B.Sc. (Chemistry)
Sem-V
(Pattern 2024)

NEP-2.0

Choice Based Credit System Structure & Syllabus
(As per NEP 2020)

To be implemented from Academic Year 2026-2027

Title of the Programme: T.Y.B.Sc (Chemistry)

Preamble

AES's Tuljaram Chaturchand College has made the decision to change the syllabus of across various faculties from June, 2023 by incorporating the guidelines and provisions outlined in the National Education Policy (NEP),2020.The NEP envisions making education more holistic and effective and to lay emphasis on the integration of general (academic)education, vocational education and experiential learning. The NEP introduces holistic and multidisciplinary education that would help to develop intellectual, scientific, social, physical, emotional, ethical and moral capacities of the students. The NEP 2020 envisages flexible curricular structures and learning based outcome approach for the development of the students. By establishing a nationally accepted and internationally comparable credit structure and courses framework, the NEP 2020 aims to promote educational excellence, facilitates eamless academic mobility, and enhance the global competitiveness of Indian students. It fosters a system where educational achievements can be recognized and valued not onlywithin the country but also in the international arena, expanding opportunities and opening doors for students to pursue their aspirations on a global scale.

In response to the rapid advancements in science and technology and the evolving approaches in various domains of Chemistry and related subjects, the Board of Studies in Chemistry at Tuljaram Chaturchand College, Baramati - Pune, has developed the curriculum for the fifth semester of T.Y.B.Sc. Chemistry, which goes beyond traditional academic boundaries. The syllabus is aligned with the NEP 2020 guidelines to ensure that students receive an education that prepares them for the challenges and opportunities of the 21stcentury. This syllabus has been designed under the framework of the Choice Based CreditSystem (CBCS), taking into consideration the guidelines set forth by the National EducationPolicy(NEP)2020,LOCF(UGC),NCrF,NHEQF,Prof.R.D.Kulkarni'sReport,Governm ent of Maharashtra's General Resolution dated 20th April and 16th May 2023, andtheCircularissuedbySPPU,Puneon31st May2023.

The CBCS Course curriculum of the discipline of Chemistry is well designed andvery promising. A degree in Chemistry subject equips students with the knowledge and skillsnecessary for a diverse range of fulfilling career paths. The core course would help to enrichthe subject knowledge of the students and increase their confidence level in the field of both academia and industry. Open electives (OE) make sustainable integration among the various interdisciplinary courses to fulfill the vision and mission of designing the course. The

introduction of Skill Enhancement Courses (SEC) would help to gain more powerful knowledge not only in their core Chemistry subject but also in interrelated multidisciplinary subjects both theoretically and practically. The inclusion of Skill Enhancement Course (SEC) and Vocational Skill Course (VSC) has brought an opportunity in front of students to gain knowledge on various naturally and industrially important useful materials and also helps them to familiar and expert in handling different chemistry based software after proper training.I n brief the student graduated with this type of curriculum would be able to disseminate subject knowledge along with necessary skills to suffice their capabilities for academia, research, entrepreneurship and industry. By acquiring these comprehensive skills and knowledge, graduates are well-prepared to embark on rewarding careers that contribute to a better understanding of the subject and address the challenges of our ever-changing lifestyle.

Overall, revising the Chemistry syllabus in accordance with the NEP2020 ensures that students receive an education that is relevant, comprehensive, and prepares them to navigate the dynamic and interconnected world of today. It equips them with the knowledge, skills, and competencies needed to contribute meaningfully to society and pursue their academic and professional goals in a rapidly changing global landscape.

Programme Specific Outcomes (PSOs)

PSO1: Comprehensive Knowledge and Understanding: Graduates will possess a profound understanding of their field of study, including foundational theories, principles, methodologies, and key concepts, within a broader multidisciplinary context.

PSO2: Practical, Professional, and Procedural Knowledge: Graduates will acquire practical skills and expertise essential for professional tasks within their field. This includes knowledge of industry standards, best practices, regulations, and ethical considerations, with the ability to apply this knowledge effectively in real-world scenarios.

PSO3: Entrepreneurial Mindset and Knowledge: Graduates will cultivate an entrepreneurial mindset, identifying opportunities, fostering innovation, and understanding business principles, market dynamics, and risk management strategies.

PSO4: Specialized Skills and Competencies: Graduates will demonstrate proficiency in technical skills, analytical abilities, problem-solving, effective communication, and leadership. relevant to their field of study. They will also adapt and innovate in response to changing circumstances.

PSO5: Capacity for Application, Problem-Solving, and Analytical Reasoning: Graduates will possess the capacity to apply learned concepts in practical settings, solve complex problems, and analyze data effectively. This requires critical thinking, creativity, adaptability, and a readiness to learn and take calculated risks.

PSO6: Communication Skills and Collaboration: Graduates will effectively communicate complex information, both orally and in writing, using appropriate media and language. They will also collaborate effectively in diverse teams, demonstrating leadership qualities and facilitating cooperative efforts toward common goals.

PSO7: Research-related Skills: Graduates will demonstrate observational and inquiry skills, formulate research questions, and utilize appropriate methodologies for data collection and analysis. They will also adhere to research ethics and effectively report research findings.

PSO8: Learning How to Learn Skills: Graduates will acquire new knowledge and skills through self-directed learning, adapt to changing demands, and set and achieve goals independently.

PSO9: Digital and Technological Skills: Graduates will demonstrate proficiency in using ICT, accessing information sources, and analyzing data using appropriate software.

PSO10: Multicultural Competence, Inclusive Spirit, and Empathy: Graduates will engage effectively in multicultural settings, respecting diverse perspectives, leading diverse teams, and demonstrating empathy and understanding of others' perspectives and emotions.

PSO11: Value Inculcation and Environmental Awareness: Graduates will embrace ethical and moral values, practice responsible citizenship, recogaine and address ethical issues, and take appropriate actions to promote sustainability and environmental conservation.

PSO12: Autonomy, Responsibility, and Accountability: Graduates will apply knowledge and skills independently, manage projects effectively, and demonstrate responsibility and Accountability in work and leaming contexts

PSO13: Community Engagement and Service: Graduates will actively participate in community engaged advices and activities, promoting societal well-being

Anekant Education Society's

Tuljaram Chaturchand College,
Of Arts, Science & Commerce, Baramati

(Empowered Autonomous)

Board of Studies (BOS) in Chemistry

From 2025-26 To 2028

Sr. No.	Name	Designation
1.	Dr. Prof. Shrikrushna T. Salunke	Chairman
2.	Mr. Bhimrao R. Torane	Member
3.	Mr. Maharudra A. Dudhe	Member
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17.	Mrs. Kalpana Surnavar	Member
18.	Mrs. Chaitrali A. Bunage	Member
19.	Dr. Dilip Satpute	External Member VC Nominee

20.	Dr. Sidaram Pujari	External Member from other University
21.	Dr. Vijay Vader	External Memberfrom other University
22.	Dr. Nitin Jadhav	Member Representative Alumni
23.	Mr. Dadaso Kare	Member Representative from Industry
24.	Ms. Tanishka Phadatare	UG Student Representative
25.	Ms. Disha Waghmode	PG Student Representative

Credit Distribution Structure for Three/Four Year Honours / Honours with Research Degree Programme
With Multiple Entry and Exit options as per National Education Policy (2024 Pattern as per NEP-2020)

Level/ Difficulty	Sem	Subject - 1	Subject-2	Subject-3	GE/OE	SEC	IKS	AEC	VEC	CC	Total
4.5/100	I	2(T)+2 (P)	2(T)+2(P)	2(T)+2 (P)	2 (T)	2(T/P)	2(T) (Generic)	2(T)	2	--	22
	II	2(T)+2 (P)	2(T)+2(P)	2(T)+2 (P)	2 (P)	2(T/P)	--	2(T)	2	2	22
Exit option: Award of UG Certificate in Major with 44 credits and an additional 4 credit score NSQF course/Internship OR Continue with Major and Minor **Continue option**: Student will select one subject among the (subject 1, subject 2 and subject 3) as major and another as minor and third subject will be dropped.											
Level / Difficulty	**Sem**	**Credits Related to Major**				**Minor**		**GE/OE**	**SEC**	**IKS**	**AEC**	**VEC**	**CC**	**Total**
		Major Core	**Major Elective**	**VSC**	**FP/OJT/CEP**									
5.0/200	III	4(T)+2 (P)	--	2(T/P)	2 (FP)	2(T)+2(P)	--	2 (T)	--	2 (T) (Subject Specific)	2(T)	--	2	22
	IV	4(T)+2 (P)	--	2(T/P)	2 (CEP)	2(T)+2(P)	--	2 (P)	2(T/P)	--	2(T)	--	2	22
Exit option: Award of UG Diploma in Major and Minor with 88 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major and Minor														
5.5/300	V	8(T)+4(P)	2(T)+2 (P)		4 (OJT)	2(T)	--	--	--	--	--	--	--	22
	VI	8(T)+4(P)	2(T)+2 (P)	2(T/P) 2(T/P)	2 (FP)	--	--	--	--	--	--	--	--	22
Total 3 Years		**44**	**8**	**8**	**10**	**18**	**8**	**8**	**6**	**4**	**8**	**4**	**6**	**132**
Exit option: Award of **UG Degree in Major** with132 credits OR Continue with Major and Minor														
6.0/400	VII	6(T)+4 (P)	2(T)+2 (T/P)	--	--	4 (RP)	4(RM)(T)	--	--	--	--	--	--	22
	VIII	6(T)+4 (P)	2(T)+2 (T/P)	--	0	8 (RP)	0		0	0	0	0	0	22
Total 4 Years		**68**	**16**	**8**	**2**	**22**	**22**		**12**	**6**	**8**	**4**	**8**	**176**
FourYear **UG Research Degree** in Major and Minor with 176 credits **OR**														
6.0/400	VII	10(T)+4(P)	2(T)+2 (T/P)	0	0	0	4 (RM)		0	0	0	0	0	22
	VIII	10(T)+4(P)	2(T)+2 (T/P)	0	0	4 (OJT)	0		0	0	0	0	0	22
Total 4 Years		**76**	**16**	**8**	**2**	**14**	**22**		**12**	**6**	**8**	**4**	**8**	**176**
Four Year **UG Honours Degree** in Major and Minor with 176 credits														

Course and Credit Distribution Structure for BSc (Chemistry)-2026-2027

Level / Difficulty	Sem	Credits Related to Major				Minor		GE/OE	SEC	IKS	AEC	VEC	CC	Total
		Major Core	Major Elective	VSC	FP/OJT/CEP									
5.5/300	V	8(T)+4(P)	2(T)+2 (P)		4 (OJT)	2(T)	--	--	--	--	--	--	--	**22**
	VI	8(T)+4(P)	2(T)+2 (P)	2(T/P) 2(T/P)	2 (FP)	--	--	--	--	--	--	--	--	**22**
Total Credits														**44**

*** T = Theory** *** P = Practical** *** DSC = Discipline Specific Course** *** OJT = On Job Training** *** FP = Field Project**

*** OE = Open Elective** *** SEC = Skill Enhancement Course** *** IKS = Indian Knowledge System**

*** AEC = Ability Enhancement Course** *** VEC = Value Education Course** *** CC = Cocurricular Courses**

Course Structure for T.Y.B.Sc. Chemistry (2024 Pattern)

Sem	Course Type	Course Code	Course Title	Theory/ Practical	Credits
V (5.5)	Major Mandatory	CHE-301-MRM	Physical Chemistry -I	Theory	02
		CHE-302-MRM	Inorganic Chemistry -I	Theory	02
		CHE-303-MRM	Organic Chemistry -I	Theory	02
		CHE-304-MRM	Analytical Chemistry -I	Theory	02
	Major Mandatory	CHE-305-MRM	Physical and Analytical Chemistry Practical-I	Practical	02
		CHE-306-MRM	Organic and Inorganic Chemistry Practical–I	Practical	02
	Major Elective (MJE)	CHE-307-MJE(A)	Industrial Chemistry - I	Theory (Any one)	02
		CHE-307-MJE(B)	Environmental & Green Chemistry - I		
	Major Elective (MJE)	CHE-308-MJE(A)	Industrial Chemistry Practical -I	Practical (Any one)	02
		CHE-308-MJE(B)	Environmental & Green Chemistry Practical - I		
	On Job Training(OJT)	CHE-309-OJT	On Job Training	Practical	04
	Minor	CHE-310-MN	Applied Chemistry - I	Theory	02
				Total Credits Semester-V	**22** (T =12, P=10)
VI (5.5)	Major Mandatory	CHE-351-MRM	Physical Chemistry -II	Theory	02
		CHE-352-MRM	Inorganic Chemistry -II	Theory	02
		CHE-353-MRM	Organic Chemistry -II	Theory	02
		CHE-354-MRM	Analytical Chemistry -II	Theory	02
	Major Mandatory	CHE-355-MJM	Physical and Analytical Chemistry Practical -II	Practical	02
		CHE-356-MJM	Organic and Inorganic Chemistry Practical –II	Practical	02
	Major Elective (MJE)	CHE-357-MJE(A)	Industrial Chemistry -II	Theory (Any one)	02
		CHE-357-MJE(B)	Environmental and Green Chemistry - II		
	Major Elective (MJE)	CHE-358-MJE(A)	Industrial Chemistry Practical -II	Practical (Any one)	02
		CHE-358-MJE(B)	Environmental & Green Chemistry Practical- II		
	Vocational Skill Course (VSC)	CHE-359-VSC	Instrumental Methods of Chemical Analysis	Theory	02
	Vocational Skill Course (VSC)	CHE-360-VSC	Instrumental Practicals	Practical	02
	Field Project	CHE-361-FP	Field Project	Practical	02
				Total Credits Semester-VI	**22** (T =12, P=10)
				Total Credits Semester-V+ VI	**44**

CBCS Syllabus as per NEP 2020 for T.Y.B.Sc. (2024 Pattern)

Name of the Programme	: B.Sc. Chemistry
Program Code	: USCH
Class	: T.Y.B.Sc.
Semester	: V
Course Type	: Major Theory
Course Name	: Physical Chemistry-I
Course Code	: CHE-301-MRM
No. of Lectures	: 30
No. of Credits	: 2 credits

Course Objectives:

After completing this course, students will be able to:

1. Understand the fundamental concepts of crystal structure, symmetry, and crystallographic laws governing solid-state materials.
2. Learn the principles and applications of X-ray diffraction techniques for determination of crystal structures.
3. Develop a conceptual understanding of molecular structure through molar refraction and dipole moment studies.
4. Understand the interaction of electromagnetic radiation with matter and the basic principles of molecular spectroscopy.
5. Gain knowledge of microwave and infrared spectroscopy and their use in determining molecular parameters.
6. Understand the principles governing electrolytic conductance and its variation with concentration in electrolyte solutions.
7. Learn the fundamentals of phase equilibria using Gibbs' phase rule and interpret phase diagrams of one-component systems.

Course Outcomes :

On successful completion of the course, students will be able to:

1. Explain the types of solids, laws of crystallography, and unit cell parameters with suitable examples.
2. Apply Bragg's law and X-ray diffraction methods to determine crystal structures and calculate inter planar spacing.
3. Interpret molecular structure using dipole moment and molar refraction concepts.
4. Describe the principles, selection rules, and applications of microwave and infrared spectroscopy.
5. Calculate bond length, moment of inertia, force constants, and vibrational energies from spectral data.

6. Analyze electrolytic conductance data using Kohlrausch's law and apply it to real systems such as weak electrolytes and sparingly soluble salts.
7. Apply Gibbs' phase rule to explain phase equilibria and interpret phase diagrams of one-component systems like water, sulphur, and carbon dioxide.

Topics and Learning points

Unit 1. Crystal structure [08 L]

Types of Solids: Isotropy and Anisotropy, Laws of crystallography: Law of constancy of interfacial angles, Law of rational indices, Law of crystal symmetry, Weiss indices and Miller indices, Crystal Structure: Parameters of the Unit Cells, Cubic Unit Cells: Three Types of Cubic Unit Cells, Calculation of Mass of the Unit Cell, Methods of Crystal structure analysis: The Laue method and Braggs method: Bragg's equation, Determination of crystal structure of NaCl by Bragg's method, X ray analysis of NaCl crystal system, Calculation of d and λ for a crystal system, problems.

Unit 2. Investigation of Molecular structure [12 L]

Introduction: Molar refraction and molecular structure, Dipole moment and molecular structure, electromagnetic spectrum, energy of molecules, Types of molecular spectra.

Microwave Spectroscopy: Introduction, Classification of molecules on the basis of moment of Inertia, Rotational spectra of rigid diatomic molecules, relative intensities of spectral lines, effect of isotopic substitution on the rotational spectra, Determination of bond length and moment of inertia from rotational spectra, Problems

Infrared Spectroscopy: Introduction, Simple Harmonic oscillator, Modes of vibration, force constant, Vibrational spectrum of a diatomic molecule: Vibrational Energy expression, Allowed vibrational energies, zero-point energy, Selection rule, Vibrational energy level diagram with transitions, spectrum depiction, Vibration-rotation Spectra: Born-Oppenheimer approximation, Energy expression for vibrational rotor, Selection rules, Problems

Unit 3. Electrolytic Conductance [05 L]

Recapitulation: Electrolytes, Ohm's law and Electrical units, electrolytic conductance, resistance and specific resistance Electrolytic Conductance, Specific and equivalent conductance, Variation of equivalent conductance with concentration. Kohlrausch's law and its applications to determine: Equivalent conductance at infinite dilution of a weak electrolyte, the ionic product of water, Solubility of sparingly soluble salts. Interionic attraction theory of conductance. Problems

Unit 4: Phase Equilibrium [05 L]

Introduction, Phase, Components and Degree of Freedom of a system, Stability of Phases, Criteria of Phase equilibrium, Gibb's Phase rule and its thermodynamic derivation, Phase Diagrams of One Component system: Water, Carbon Dioxide and Sulphur system.

References

1. Principles of Physical Chemistry, S. H. Marron and C. F. Pruton, 6th edn.
2. Essentials of Physical Chemistry, Bahl, Tuli, Revised multicolour edn. 2009
3. Physical Chemistry, G. M. Barrow, Tata McGraw-Hill (2007)
4. Principles of Physical Chemistry by Puri, Sharma, Pathania
5. University Chemistry, B. H. Mahan, 3rd edn. Narosa (1998)
6. Atkin's Physical Chemistry, Peter Atkins, Julio De Paula, Oxford publication. 8th ed.
7. Fundamentals of molecular spectroscopy by C.N. Banwell and E. M. McCash
8. Physical Chemistry, Singh, N.B., et al. Volume 2, New Age International Ltd, 2000

Mapping of Program Out comes with Course Outcomes

Class: T.Y.B.Sc. (Sem V) Subject: Chemistry

Course: Physical Chemistry I Course Code: CHE-301-MRM

Weightage: 1=weak or low relation, 2=moderate or partial relation, 3=strong or direct relation

Correlation Level:

3 – High | 2 – Moderate | 1 – Low | "–" No direct correlation

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2	–	2	2	–	–	–	–	–	–	–	–
CO2	3	3	–	3	3	–	2	–	2	–	–	2	–
CO3	3	2	–	2	3	–	2	–	–	–	–	–	–
CO4	3	2	–	3	2	1	2	–	2	–	–	–	–
CO5	3	3	–	3	3	–	2	–	2	–	–	2	–
CO6	3	3	–	3	3	–	2	–	2	–	2	2	–
CO7	3	2	–	2	3	–	2	–					

Justification for the mapping

PO1: Comprehensive Knowledge and Understanding

All course outcomes contribute strongly to PO1 as the course builds foundational and advanced knowledge in solid-state chemistry, spectroscopy, electrochemistry, and phase equilibria. Students gain theoretical understanding of crystallography (CO1), diffraction methods (CO2), molecular structure (CO3), spectroscopy (CO4, CO5), conductance (CO6), and thermodynamics (CO7), ensuring comprehensive subject knowledge.

PO2: Practical, Professional, and Procedural Knowledge

Students apply theoretical concepts to practical systems such as XRD analysis (CO2), spectral interpretation (CO4, CO5), conductance measurements (CO6), and phase diagrams (CO7). The course enhances procedural understanding relevant to laboratory practices and real-world chemical systems.

PO3: Entrepreneurial Mindset and Knowledge

The course primarily focuses on core scientific principles and analytical skills. Direct exposure to entrepreneurship, innovation management, or business strategy is not explicitly included in the stated COs.

PO4: Specialized Skills and Competencies

The course develops technical competency in crystallography, spectroscopy, electrochemistry, and thermodynamics. Analytical skills are strengthened through numerical problem-solving (CO2, CO5, CO6, CO7) and interpretation of scientific data (CO3, CO4). These directly support specialized technical proficiency.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning

CO2, CO5, CO6, and CO7 involve numerical calculations and analytical reasoning. CO3 and CO4 require interpretation of molecular and spectral data. The course strongly enhances critical thinking and analytical problem-solving ability in chemistry.

PO6: Communication Skills and Collaboration
While communication is not explicitly stated in COs, topics like spectroscopy (CO4) may involve presentation and interpretation of spectral data in academic settings. However, collaboration and structured communication outcomes are not directly emphasized.

PO7: Research-related Skills
Students interpret experimental data (XRD, spectroscopy, conductance) and apply scientific laws (Bragg's law, Kohlrausch's law, Gibbs' phase rule). These activities develop research-oriented analytical and investigative skills aligned with scientific inquiry.

PO8: Learning How to Learn Skills
Self-directed learning and independent goal setting are not explicitly addressed in the course outcomes, though analytical learning may indirectly support this.

PO9: Digital and Technological Skills
The course involves understanding and use of modern instruments such as XRD, IR, microwave spectroscopy, and conductivity meters. Interpretation of instrument-generated data enhances technological awareness**.**

PO10: Multicultural Competence, Inclusive Spirit, and Empathy
The course content is technical in nature and does not directly address multicultural or inclusive competencies.

PO11: Value Inculcation and Environmental Awareness
Electrolytic conductance (CO6) and phase equilibria involving CO_2 (CO7) have environmental and sustainability relevance. These topics indirectly support awareness of environmental systems.

PO12: Autonomy, Responsibility, and Accountability
Analytical problem-solving, data interpretation, and application of scientific laws require independent thinking and accountability in arriving at correct conclusions.

PO13: Community Engagement and Service
The course focuses on core physical chemistry concepts and does not explicitly incorporate community-based activities or service learning.

CBCS Syllabus as per NEP 2020 for T.Y.B.Sc. (2024 Pattern)

Name of the Programme	: B.Sc. Chemistry
Program Code	: USCH
Class	: T.Y.B.Sc.
Semester	: V
Course Type	: Major Theory
Course Name	: Inorganic Chemistry–I
Course Code	: CHE-302-MRM
No. of Lectures	: 30
No. of Credits	: 2 credits

Course Objectives:

1. Understand the concept of isomerism in coordination complexes and distinguish between different types of structural and stereoisomerism.

2. Explain Sidgwick's theory of coordination compounds, including EAN rule and its role in predicting stability of complexes.

3. Introduce the principles of Valence Bond Theory (VBT) and the need for hybridization in coordination compounds.

4. Describe bonding, geometry, and magnetic behavior of coordination complexes using VBT.

5. Develop a thorough understanding of Crystal Field Theory (CFT) to explain electronic structure, magnetic properties, and spectra of complexes.

6. Apply crystal field concepts to calculate CFSE, magnetic moments, and ligand field splitting parameters for various geometries.

7. Understand Molecular Orbital Theory (MOT) of coordination complexes and compare it with VBT and CFT for explaining bonding and properties.

Course Outcomes:

CO1: Identify and classify different types of isomerism in coordination complexes and predict possible isomers.

CO2: Apply Sidgwick's EAN rule to coordination compounds and evaluate the stability and limitations of the theory.

CO3: Explain coordination geometries, hybridization, and magnetic behavior of complexes using Valence Bond Theory.

CO4: Distinguish between inner- and outer-orbital complexes and explain multiple bonding in coordination compounds.

CO5: Analyze electronic structures of coordination complexes using Crystal Field Theory and predict magnetic properties.

CO6: Calculate CFSE, ligand field splitting energy (10 Dq), and spin-only magnetic moments for octahedral, tetrahedral, and square planar complexes.

CO7: Interpret bonding and spectral properties of coordination complexes using Molecular Orbital Theory and critically compare VBT, CFT, and MOT.

Topics and Learning points

Unit1: Isomerism in Coordination Complexes (06L)

Definition of isomerism in Complexes-Structural Isomerism and stereoisomerism, Structural isomerism (ionization, hydrate, linkage, ligand, coordination position and polymerization isomers) Stereoisomerism and its Types-Geometrical isomerism and optical isomerism.

Unit2: Sidgwick Theory (04L)

Concept of Sidgwick' s model, Scheme of arrow indication for M-L bond suggested by Sidgwick' s, Effective Atomic Number rule (EAN), Calculations of EAN value for different complexes and stability of complexes, Advantages and Draw backs of Sedgwick's theory.

Unit3: Pauling's Valence Bond Theory (08L)

Introduction of Valence Bond Theory (VBT), Need of concept of hybridization, Aspects of VBT, Assumptions, VB representation of tetrahedral, square planer trigonal Bi-pyramidal and octahedral complexes with examples, Inner and outer orbital complexes, Electro neutrality principle, Multiple bonding (dπ-pπ and dπ-dπ), Limitations of VBT.

Unit4: Crystal Field Theory (08 L)

Introduction and need of Crystal Field Theory(CFT),Assumptions, Shapes and degeneracy of d orbital, Splitting of d-orbital's, Application of CFT to octahedral complexes, pairing energy(P) and distribution of electrons in eg and t2g level, calculation of magnetic moment using spin-only formula, Crystal Field Stabilization Energy (CFSE), calculation of CFSE in weak oh field and strong oh field complexes, Evidence for CFSE, Interpretation of spectra of complexes, calculation of 10Dq and factors affecting magnitude of 10Dq,d-dtransitions and color of the complexes, John-Teller distortion theorem for octahedral complexes and its illustration, CFT of tetrahedral and square planar complexes, calculations of CFSE, Spectrochemical series, Nephelauxatic effect and Nephelauxatic series, Limitations of CFT, modified CFT

(LFT), Problems related to calculation of 10 Dq, CFSE and spin only magnetic moment for octahedral, tetrahedral & square planar complexes.(i.e. for high spin & low spin complexes)

Unit5: Molecular Orbital Theory of Coordination Complex (04L)

Introduction, Assumptions, MO treatment to octahedral complexes with sigma bonding, Formation of MO's from metal orbital's and Composite Ligand Orbital's (CLO), MO correlation diagram for octahedral complexes with sigma bonding, effect of π bonding, Charge transfer spectra, Comparison of VBT, CFT, and MOT.

References

1. Introduction to Electrochemistry by Glasstone–2nd edition.
2. Concise Inorganic Chemistry by J.D.Lee–5th edition.
3. Inorganic Chemistry,- D.F. Shiver &P.W. Atkins - C.H. Long ford ELBS 2nd edition.
4. Basic Inorganic Chemistry -F.A. Cotton and G. Wilkinson, Wiley Eastern Ltd 1992.
5. Concept and Model of Inorganic Chemistry by Douglas–McDaniels–3rd edition.
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7. New Guide to Modern Valence Theory by G.I.Brown–3rd edition
8. Co-ordination Compounds by Baselo and Pearson.
9. Theoretical Inorganic Chemistry by Day and Selbin.
10. Inorganic Chemistry by A.G.Sharpe–3rd Edition.
11. Coordination Chemistry by A.K. De.
12. Inorganic Chemistry,- D.F. Shiver &P.W. Atkins - C.H. Long ford ELBS 2nd edition.

Mapping of Program Out comes with Course Outcomes
(2024 NEP 2.0 Pattern)

Class: T.Y.B.Sc. (Sem. V) **Subject:** Chemistry
Course: Inorganic Chemistry-I **Course Code:** CHE-302-MRM

Weightage: 1=weak or low relation, 2=moderate or partial relation, 3=strong or direct relation

Mapping of COs with Pos

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	1	0	1	2	1	0	1	0	0	1	1	0
CO2	3	2	0	2	2	1	1	1	0	0	1	1	0
CO3	3	2	0	2	2	1	1	1	0	0	1	1	0
CO4	3	2	0	2	2	1	1	1	0	0	1	1	0
CO5	3	2	0	3	3	1	1	1	1	0	1	1	0
CO6	3	3	0	3	3	1	1	1	1	0	1	2	0
CO7	3	2	1	3	3	1	2	2	1	0	1	2	0

Justification for the mapping

PO1: Comprehensive Knowledge and Understanding
Strong disciplinary foundation in coordination chemistry.
CO1: Identify and classify different types of isomerism in coordination complexes
CO2: Apply Sidgwick's EAN rule to assess stability of coordination compounds
CO3: Explain bonding, geometry, and magnetism using Valence Bond Theory
CO4: Distinguish inner- and outer-orbital complexes and multiple bonding
CO5: Analyze electronic structure and spectra using Crystal Field Theory
CO6: Calculate CFSE, 10Dq, and spin-only magnetic moments
CO7: Interpret bonding and spectra using Molecular Orbital Theory

PO2: Practical, Professional, and Procedural Knowledge
Application of theory to problem solving and professional practice.
CO2: Evaluate stability of coordination complexes using EAN concepts
CO5: Interpret spectra and magnetic properties of complexes
CO6: Perform accurate numerical calculations related to coordination chemistry
CO7: Apply bonding theories to explain experimental observations

PO3: Entrepreneurial Mindset and Knowledge
Innovation awareness and application-oriented thinking.
CO7: Compare bonding theories relevant to catalysis, materials, and industrial chemistry

PO4: Specialized Skills and Competencies
Analytical, technical, and reasoning skills.
CO3: Apply hybridization and bonding principles using VBT
CO4: Analyze orbital involvement and bonding modes

CO5: Use CFT to explain electronic transitions and magnetic behavior
CO6: Solve complex numerical and conceptual problems

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning
Critical thinking and adaptability.
CO1: Predict possible isomers of coordination complexes
CO3: Determine geometry and magnetic nature of unknown complexes
CO6: Apply CFSE and spin-only formulas to new complexes
CO7: Analyze and compare bonding models

PO6: Communication Skills and Collaboration
Scientific communication and explanation.
CO5: Explain spectral features using appropriate scientific terminology
CO7: Communicate comparative analysis of VBT, CFT, and MOT

PO7: Research-related Skills
Inquiry, observation, and ethical analysis.
CO5: Analyze electronic spectra and magnetic data
CO6: Interpret calculated parameters scientifically
CO7: Critically evaluate theoretical models in coordination chemistry

PO8: Learning How to Learn Skills
Self-directed and lifelong learning.
CO2: Independent understanding of coordination theories
CO6: Autonomous numerical problem solving
CO7: Self-learning of advanced bonding models

PO9: Digital and Technological Skills
Use of digital tools and data handling.
CO6: Use digital calculators/software for CFSE and magnetic moment calculations

PO10: Multicultural Competence, Inclusive Spirit, and Empathy
— (Indirectly addressed; minimal linkage in a theory-focused chemistry course)

PO11: Value Inculcation and Environmental Awareness
Ethical scientific practice and sustainability awareness.
CO5: Responsible interpretation of spectra and magnetic data
CO7: Use of appropriate bonding models avoiding misrepresentation

PO12: Autonomy, Responsibility, and Accountability
Independent and responsible academic practice.
CO6: Perform accurate calculations with accountability
CO7: Independently interpret and justify theoretical conclusions

PO13: Community Engagement and Service

— *(Not directly addressed in this theory-oriented course)*

CBCS Syllabus as per NEP 2020 for T.Y.B.Sc. (2024 Pattern)

Name of the Programme : B.Sc. Chemistry
Program Code : USCH
Class : T.Y.B.Sc
Semester : V
Course Type : Theory
Course Name : Organic Chemistry-I
Course Code : CHE-303-MRM
No. of Lectures : 30
No. of Credits : 2 credits

Course Objectives:

After successful completion of this course, students will be able to:

1. Understand and classify reagents in organic synthesis by explaining their reactivity, and applications in common organic reactions.
2. Explain the fundamental principles of nucleophilic substitution reactions at aliphatic carbon, including SN1, SN2, mechanisms, with importance on stereochemistry and reaction kinetics.
3. Analyze elimination reactions (E1, E2, and E1cb) by correlating reaction conditions, substrate structure, and product distribution using mechanistic reasoning.
4. Apply mechanistic concepts to predict outcomes of substitution and elimination reactions under different experimental conditions.
5. Describe aromatic electrophilic substitution reactions by explaining the mechanism, orientation effects, activating and deactivating substituents.
6. Understand aromatic nucleophilic substitution reactions, including addition–elimination and benzyne mechanisms, with respect to electronic and steric effects.
7. Develop problem-solving skills in organic reaction mechanisms by predicting major products and proposing feasible reaction pathways.
8. Relate reaction mechanisms to synthetic strategy, enabling selection of appropriate reagents and conditions for targeted organic synthesis.

Course Outcomes:

After successful completion of this course, the students will be able to:

1. Identify and classify important reagents used in organic synthesis and explain their role in specific functional group transformations.
2. Explain the mechanisms of nucleophilic substitution reactions at aliphatic carbon (SN1, SN2) with respect to kinetics, stereochemistry, and substrate structure.
3. Distinguish between substitution and elimination reactions and predict reaction pathways based on reaction conditions.
4. Analyze elimination reactions (E1, E2, E1cb) and predict major products using Saytzeff and Hofmann rules.
5. Describe the mechanism of aromatic electrophilic substitution reactions and explain the effect of substituents on reactivity and orientation.
6. Explain aromatic nucleophilic substitution reactions, including addition–elimination and benzyne mechanisms, with emphasis on electronic effects.

7. Predict the products of substitution and elimination reactions using mechanistic reasoning and stereochemical principles.

Topics and Learning

Unit 1: Reagents in organic synthesis [8 Hrs]

Oxidizing Reagents: Jones oxidation, Potassium permanganate, m-CPBA, Osmium tetroxide, Criegee Oxidation, O_3, Selenium dioxide, Reducing Reagents: Catalytic hydrogenation, LAH, SBH, DIBAL, Reduction of alkynes by Lindlar's catalyst and Na/NH_3, Clemmensen reduction and Wolff-Kishner reduction.

Ref. 7

Unit 2.Nucleophilic Substitution at Aliphatic Carbon [7 Hrs]

Introduction, nucleophiles and leaving groups, mechanism of nucleophilic substitution. The S_N1 reaction: Kinetic, mechanism and stereochemistry, stability of carbocation. The S_N2 reaction: Kinetic, mechanism and stereochemistry. How to know whether a given reaction will follow S_N1 or S_N2 mechanism, S_Ni reaction and mechanism.

Ref.1

Unit 3.Elimination Reaction [5 Hrs]

Introduction,1,1;1,2-elimination,E1,E2andE1cBmechanismwithevidences,Hoffmann and Saytzeff's elimination, reactivity, effect of structure, attacking and leaving groups.

Ref.1

Unit 4 .Aromatic Electrophilic and Nucleophilic substitution reactions [10Hrs]

Introduction, arrenium ion mechanism, effect of substituent groups (orientation, o/p directing and meta directing groups), classification of substituent groups (activating and deactivating group). Mechanism of nitration, sulphonation, halogenations, Friedel-Craftreactions, diazo-coupling reactions, Ipso substitution. Addition –elimination (S_NAr), S_N1, Elimination-addition (benzyne) S_NR1 reactions, reactivity.

Ref.1, 4 and 5

References:

1. Organic Chemistry by Morrison and Boyd 6th Edn.
2. Organic Chemistry by Cram and Hammond.
3. Stereochemistry of Organic compounds by Eliel, Tata MCGrow Hill 1989.
4. Organic Chemistry by Clayden, Greeves, Warren and Wothers (Oxford press)
5. A guide book of reaction mechanism by Peter Sykes 5th Edn.
6. New Trends in Green Chemistry-V. K. Ahluwalia and M. Kidwai.
7. Rearrangements, reactions and reagents- S.N. Sanyal

Mapping of Program Out comes with Course Outcomes
(2024 NEP 1.0 Pattern)

Class: T.Y.B.Sc. (Sem.V) **Subject:** Chemistry
Course: Organic Chemistry-I **Course Code:** CHE-303-MRM

Weightage: 1 = weak or low relation, 2 = moderate or partial relation, 3 = strong or direct relation

Mapping of Course Outcomes with Program Outcome

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13
CO 1	3	2	1	2	2	1	1	2	1	1	1	1	1
CO 2	3	2	1	3	3	1	2	2	1	1	1	1	1
CO 3	3	2	1	2	3	1	2	2	1	1	1	1	1
CO 4	3	2	1	3	3	1	2	2	1	1	1	1	1
CO 5	3	2	1	3	3	1	2	2	1	2	1	1	1
CO 6	3	2	1	3	3	1	2	2	1	2	1	1	1
CO 7	3	3	1	3	3	2	2	2	1	1	1	2	1

Justification:

PO1: **Comprehensive Knowledge and Understanding**
All COs focus on fundamental and advanced concepts of organic reaction mechanisms, making PO1 strongly mapped across all COs.

PO2: **Practical, Professional and Procedural Knowledge**
Understanding reagents, mechanisms, and product prediction develops procedural knowledge applicable in laboratory and industrial settings.

PO3: **Entrepreneurial Mindset**
Theoretical mechanism study has limited direct linkage to entrepreneurship, though knowledge of reagents and reaction pathways may indirectly support chemical industry ventures.

PO4: Specialized Skills and Competencies
Mechanistic interpretation and stereochemical reasoning develop core subject-specific competencies in organic chemistry.

PO5: **Application, Problem Solving and Analytical Reasoning**
Reaction pathway prediction, mechanistic differentiation, and product analysis strongly enhance analytical skills.

PO6: **Communication Skills and Collaboration**
Explaining mechanisms and defending predicted products improves scientific communication skills, though not the primary focus.

PO7: **Research Related Skills**
Mechanistic understanding forms the foundation for research in synthetic organic chemistry and reaction development.

PO8: **Learning How to Learn Skills**
Understanding reaction patterns promotes self-directed learning and conceptual linking between reactions.

PO9: **Digital and Technological Skills**
Indirect linkage through use of digital molecular modeling tools or reaction databases.

PO10: **Multicultural Competence & Empathy**
Scientific knowledge is universal; exposure to global research developments contributes moderately.

PO11: **Value Inculcation & Environmental Awareness**
Some indirect relevance in selecting environmentally safer reagents and understanding green chemistry implications.
PO12: **Autonomy, Responsibility & Accountability**
Independent problem solving and justification of reaction pathways promote academic responsibility.
PO13: **Community Engagement & Service**
Limited direct connection at theory level; indirect contribution through chemical literacy.

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CBCS Syllabus as per NEP 2020 for T.Y.B.Sc. (2024 Pattern)

Name of the Programme	: B.Sc. Chemistry
Program Code	: USCH
Class	: T.Y.B.Sc.
Semester	: V
Course Type	: Major Theory
Course Name	: Analytical Chemistry- I
Course Code	: CHE-304-MRM
No. of Lectures	: 30
No. of Credits	: 2 credits

Course Objectives:

After completing this course, students will be able to:

1. Understand the principles of gravimetric analysis including solubility product, common ion effect, and precipitation conditions.
2. Explain factors affecting precipitation, co-precipitation, post-precipitation, washing, drying, and ignition of precipitates.
3. Describe methods of filtration and preparation of pure precipitates in quantitative analysis.
4. Understand the basic principles and classification of thermal analytical techniques.
5. Explain instrumentation, working, and applications of TGA and DTA along with factors affecting thermal analysis.
6. Understand the interaction of electromagnetic radiation with matter and the theory of spectrophotometry.
7. Derive and apply Beer–Lambert law for quantitative chemical analysis.
8. Describe instrumentation of colorimeter and single/double beam spectrophotometer and their analytical applications.
9. Develop skills in numerical problem solving, simultaneous determination, spectrophotometric titration, and structural interpretation of compoundsStudent aware to all analytical techniques.

Course Outcomes:

After successful completion of the course, students will be able to:

1. Apply solubility product and common ion effect concepts to gravimetric estimations.
2. Perform precipitation, filtration, washing, drying, and ignition steps accurately in gravimetric analysis.
3. Evaluate and minimize co-precipitation and post-precipitation errors to obtain reliable analytical results.

4. Explain and interpret thermal decomposition behaviour using TGA and DTA data.
5. Solve numerical problems related to thermal analysis and experimental parameters.
6. Apply Beer–Lambert law to determine concentration of unknown samples using spectrophotometry.
7. Operate colorimeter and spectrophotometer for qualitative and quantitative analysis.
8. Carry out simultaneous determination, spectrophotometric titration, and structural analysis of organic compounds and complexes.
9. Demonstrate analytical accuracy, data interpretation, and problem-solving skills required in chemical and instrumental analysis.

Topics and Learning points

Unit 1.Gravimetric Analysis (10 L)

Common ion effect and solubility product principles, Conditions for good precipitation, Factors affecting precipitation like acid, temperature ,nature of solvent, super saturation and precipitation formation, Precipitation from homogeneous solution and examples, Co- precipitation, post precipitation and remedies for their minimization, washing of precipitate and ignition of precipitate, Brief idea about method of filtration and drying of precipitate,

Ref.1.Pg.22-28,30-33,95,107-114,169-171,403-404,407-415,Ref.3.Pg.527-532

Unit 2.Thermal methods of analysis: (04L)

Principle of thermal analysis, classification of thermal techniques,
Principle, instrumentation and applications of TGA and DTA,
factors affecting the thermal analysis, numerical problem.
Ref.1.Pg.515-527,531-537,Ref.6Pg.732-737

Unit 3.Spectrophotometry (10L)

Introduction, Electromagnetic spectrum, Interaction of electromagnetic radiations with the matter, Mathematical Statement and derivation of Lambert's Law and Beer's Law,Terminology involved in spectrophotometric analysis, Instrumentation of single beam colorimeter, Instrumentation of single and double beam spectrophotometer, Principle of additivity of absorbance and simultaneous determination, Spectrophotometric Titrations, Experimental Applications-Structure of organic compounds, Structure of complexes, Numerical Problems.

Ref.1Pg.693-705,Ref.3Pg.144-153,157-160,170-174

References

1. Textbook of Quantitative Chemical Analysis-3rd Edition,A.I.Vogel
2. Principles of Physical Chemistry 4th edition–Prutton and Marron
3. Instrumental Methods of Chemical Analysis-Chatwal and Anand
4. Basic Concept of Analytical Chemistry-2nd edition S.M.Khopkar
5. Vogel's textbook of Quantitative Inorganic Analysis-4thedition
6. Instrumental Methods of Chemical Analysis-6thedition Willard,Merritt,Deanand Settle
7. Analytical Chemistry by Skoog
8. Introduction to Instrumental Analysis-R.D.Braun
9. Instrumental methods of Chemical Analysis-Willard,Dean&Merrit-6thEdition

Mapping of Program Out comes with Course Outcomes

Class: T.Y.B.Sc.(SEM V) **Subject**: Chemistry
Course: Analytical Chemistry-I **Course Code**: CHE-304 MRM
Weightage:1=weak or low relation , 2= moderate or partial elation, 3=strong or direct relation

CO–PO Mapping Table:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	–	2	3	–	1	1	–	–
CO2	2	3	–	3	3	1	2	1	1	–
CO3	2	3	–	3	3	–	2	1	–	–
CO4	3	2	–	3	3	–	2	1	1	–
CO5	2	2	–	2	3	–	1	2	1	–
CO6	3	3	–	3	3	–	2	1	2	–
CO7	2	3	1	3	3	1	2	1	3	–
CO8	3	3	1	3	3	1	2	1	2	–
CO9	3	3	1	3	3	2	2	2	2	1

Justification of CO–PO Mapping:

PO1: Comprehensive Knowledge and Understanding

All COs involve fundamental theoretical concepts such as solubility product, precipitation chemistry, Beer–Lambert law, and thermal decomposition principles. Hence, strong mapping (3) is justified for most COs.

PO2: Practical, Professional, and Procedural Knowledge

CO2, CO3, CO7, CO8, and CO9 emphasize laboratory procedures, instrument handling, accuracy, and analytical techniques, which directly build professional chemistry skills. Therefore, high mapping (3) is appropriate for experimental-skill-based COs and moderate (2) for theory-focused COs.

PO3: Entrepreneurial Mindset and Knowledge

Only limited indirect exposure occurs through analytical applications in industry, environmental, and pharmaceutical analysis (CO7–CO9). Thus, low mapping (1) is justified.

PO4: Specialized Skills and Competencies

Most COs require instrumental operation, analytical calculations, interpretation of spectra/thermal curves, and technical problem solving. Therefore, strong mapping (3) is justified across major COs.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning

Gravimetric calculations, thermal numerical problems, Beer–Lambert law applications, and simultaneous determinations require quantitative reasoning and analytical thinking. Hence, high correlation (3) for nearly all COs.

PO6: Communication Skills and Collaboration

Communication appears through record writing, reporting of analytical data, and interpretation of results (mainly CO7–CO9). Since this is supportive rather than central, low to moderate mapping (1–2) is justified.

PO7: Research-related Skills

CO3, CO4, CO8, and CO9 involve data interpretation, error minimization, experimental observation, and analytical inference, which align with research methodology.Thus, moderate mapping (2) is appropriate.

PO8: Learning How to Learn (Lifelong Learning)

Problem solving, numerical exercises, and independent instrumental analysis promote self-learning and adaptability across CO5–CO9. Hence, low to moderate mapping (1–2) is justified.

PO9: Digital and Technological Skills

Use of colorimeter, spectrophotometer, and thermal instruments builds technological competence (CO6–CO9). Therefore, moderate to high mapping (2–3) is justified for instrument-based COs.

PO10: Multicultural Competence, Inclusiveness, and Empathy

The course is primarily technical and laboratory-oriented, with only indirect development of teamwork and ethical scientific conduct (mainly CO9). Hence, minimal mapping (1) is justified.

CBCS Syllabus as per NEP 2020 for T.Y.B.Sc. (2024 Pattern)

Name of the Programme	: B.Sc. Chemistry
Program Code	: USCH
Class	: T.Y.B.Sc.
Semester	: V
Course Type	: Major Theory
Course Name	:Physical & Analytical Chemistry Practical-I
Course Code	: CHE-305-MRM
No. of Lectures	: 30
No. of Credits	: 2 credits

Course Objectives:

After successful completion of this course, students will be able to:

1. Develop hands-on skills in physical and analytical chemistry experiments related to kinetics, phase equilibria, polymers, and colloids.
2. Understand and apply principles of chemical kinetics, including reaction order, rate constants, and activation energy.
3. Gain practical exposure to solution chemistry and electrochemistry using conductometric, potentiometric, and pH-metric techniques.
4. Learn the fundamentals of instrumental analytical techniques such as conductometry, potentiometry, polarimetry, colorimetry, and X-ray diffraction.
5. Acquire competency in data collection, calculation, graphical interpretation, and error analysis.
6. Follow laboratory safety, ethical practices, and standard operating procedures while performing experiments.
7. Relate experimental findings to theoretical concepts and real-world chemical applications.

Course Outcomes:

On successful completion of the course, students will be able to:

1. Perform non-instrumental experiments related to phase equilibrium, kinetics, polymers, and colloids with accuracy.
2. Determine order of reaction, rate constants, activation energy, and molecular weight from experimental data.
3. Conduct conductometric, potentiometric, and pH-metric titrations for quantitative chemical analysis.

4. Analyze X-ray diffraction data to identify crystal structure and interpret diffraction patterns.
5. Apply instrumental techniques such as polarimetry, refractometry, and colorimetry for solution analysis.
6. Interpret experimental results using appropriate calculations, graphs, and scientific reasoning.
7. Demonstrate laboratory discipline, teamwork, scientific reporting, and ethical responsibility.

Topics and Learning points

A) Non instrumental Practical:

1. To study the effect of addition of salt on critical solution temperature of phenol- water System.

2. To determine the order of reaction between $K_2S_2O_8$ and KI by half-life method.

3. To determine the energy of activation of the reaction between potassium iodide and potassium persulphate.

4.To determine the energy of activation for reaction between $K_2S_2O_8$ and KI (Using unequal initialconcentration).

5. To determine the molecular weight of a polymer by using solutions of different concentration.

6.To study the kinetics of the decomposition of H2O2 by oxygen liberation method catalysed by KI.

7.X-Ray diffraction pattern analysis.

8. X-Ray Data analysis to identify type of the crystal structure.

9.To compare the relative strength of HCl and H2SO4 by studying the kinetics of Inversion of cane sugar using Polarimeter.

10. To compare the precipitation value of sodium chloride, barium chloride and Aluminum chloride for arsenious sulphide sol.

Group – B: Instrumental Experiments

1. To estimate the amount of lead present in given solution of lead nitrate by Conductometric titration with sodium sulphate.

2. Determination of solubility and solubility product of a sparingly soluble salt BaSO4 by using conductometry.

3.To Find out relative strength between acetic acid and chloroacetic acid by using conductometry.

4. To determine the velocity constant of the hydrolysis of ethyl acetate by sodium hydroxide solution by conductometric method.

5. To determine pKa value of given weak acid by pH-metric titration with strong base.

6. To determine the concentrations of strong acid and weak acid present in the mixture by titrating with strong base using potentiometry.

7.To find out solubility product of sparingly soluble salt by potentiometry

8. To determine the specific refractivity's of the given liquids A and B and their mixture and hence determine the percentage composition their mixture C.

9. To determine the molar refraction of homologues methyl, ethyl and propyl alcohol and show the constancy in contribution to the molar refraction by - CH2 group.

10.To determine the order of reaction for the oxidation of ethanol by potassium dichromate pr potassium permanganate in acidic medium colorimetrically.

References

1. Practical Physical Chemistry, 3rd ed. A. M. James and F. E. Prichard, Longman publication.

2. Experiments in Physical Chemistry, R. C. Das and B. Behera, Tata McGraw Hill.

3. Advanced Practical Physical Chemistry, J. B. Yadav, Goal Publishing House.

4. Advanced Experimental Chemistry, Vol-I, J. N. Gurtu and R. Kapoor, S. Chand and Company.

5. Physical Chemistry Experiments, Raghvan and Vishwanathan.

6. Comprehensive experimental Chemistry, V. K. Ahluwalia and S. Raghav, New Age International Senior Practical Physical Chemistry, Khosla, B. D.; Garg, V. C. & Gulati, A. R.

7. Experiments in Physical Chemistry, Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. 8th ed.; McGraw-Hill: New York (2003).

8. Experimental Physical Chemistry Halpern, A. M. & McBane, G. C. 3rd ed.; W.H. Freeman & Co.: New York (2003). 9. Experimental Physical Chemistry, Athawale V. D. and Mathur P., New Age International (2001)

Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B.Sc. (Sem V) Subject: Chemistry

Course: Physical & Analytical Chemistry Practical-I Course Code: CHE-305-MRM

Weightage: 1=weak or low relation, 2=moderate or partial relation, 3=strong or direct relation

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	3	–	3	3	2	2	1	2	–	1	2	–
CO2	3	3	–	3	3	1	2	1	2	–	–	2	–
CO3	3	3	–	3	3	2	2	1	3	–	1	2	–
CO4	3	3	–	3	3	1	3	1	3	–	–	2	–
CO5	3	3	–	3	3	2	2	1	3	–	–	2	–
CO6	3	2	–	3	3	3	2	2	2	–	1	3	–
CO7	2	3	–	3	2	3	2	1	1	2	3	3	2

Justification of Mapping

PO1: Comprehensive Knowledge and Understanding

Students apply theoretical principles of phase equilibrium, kinetics, polymers, colloids, electrochemistry, and instrumental analysis in laboratory experiments. This strengthens conceptual understanding through practical exposure and experimentation.

PO2: Practical, Professional, and Procedural Knowledge

All laboratory experiments involve procedural accuracy, use of standard protocols, instrument handling (conductometer, potentiometer, colorimeter, XRD), and adherence to professional laboratory practices.

PO3: Entrepreneurial Mindset and Knowledge

The laboratory course focuses on technical and analytical skills rather than entrepreneurship or business-related competencies.

PO4: Specialized Skills and Competencies

Students develop technical laboratory skills, analytical abilities, problem-solving techniques, data handling, and scientific reasoning. CO7 further strengthens leadership and teamwork competencies.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning

Students determine reaction order, activation energy, molecular weight, interpret diffraction patterns, and analyze titration data. This involves advanced problem-solving and critical analytical reasoning

PO6: Communication Skills and Collaboration

Students prepare laboratory reports, present results graphically, and work collaboratively in lab teams. CO7 explicitly includes teamwork and scientific reporting

PO7: Research-related Skills

Students collect experimental data, formulate observations, apply scientific methods, and interpret results using appropriate calculations and graphs. XRD and instrumental analysis strongly support research competency.

PO8: Learning How to Learn Skills

Experimental work requires self-learning, adaptation to instruments, troubleshooting errors, and improving techniques, promoting independent learning habits.

PO9: Digital and Technological Skills

Students use digital instruments such as conductometers, potentiometers, pH meters, XRD, polarimeters, and colorimeters. Data analysis often involves graphical and computational tools.

PO10: Multicultural Competence and Empathy

Team-based laboratory activities encourage respect, cooperation, and inclusive participation among diverse peers.

PO11: Value Inculcation and Environmental Awareness

Students follow ethical laboratory practices, safe chemical disposal, and responsible handling of reagents. CO7 explicitly includes ethical responsibility and discipline.

PO12: Autonomy, Responsibility, and Accountability

Students independently conduct experiments, record observations accurately, ensure precision, and take responsibility for laboratory safety and correctness of results.

PO13: Community Engagement and Service

Scientific responsibility and ethical conduct developed in laboratory practice indirectly support societal well-being and responsible citizenship.

CBCS Syllabus as per NEP 2020 for T.Y.B.Sc. (2024 Pattern)

Name of the Programme : B.Sc. Chemistry
Program Code : USCH
Class : T.Y.B.Sc
Semester : V
Course Type : Practical
Course Name : Organic and Inorganic Chemistry Practical-I
Course Code : CHE-306-MRM
No. of Lectures : 30
No. of Credits : 2 credits

Course Objectives:

After successful completion of this course, students will be able to:

1. Identify and separate organic compounds in binary mixtures using systematic qualitative analysis, preliminary tests, and suitable separation techniques.
2. Perform quantitative organic estimations by applying volumetric methods for the determination of acids with proper use of indicators, standard solutions, and calculations.
3. Estimate amides accurately using appropriate analytical technique and determine ester content through the quantitative estimation of ethyl benzoate, understanding ester hydrolysis and titrimetric analysis.
4. Evaluate the quality of oils by determining the saponification value, and correlate the result with molecular weight and industrial significance.
5. Analyze pharmaceutical and commercial samples by determining the alkali content in antacids using standard acid–base titration methods.
6. Estimate metal content in alloys gravimetrically, demonstrating precision in precipitation, filtration, drying, and weighing techniques.
7. Synthesize and characterize inorganic complexes, gaining hands-on experience in coordination chemistry, reaction conditions, and yield calculation.
8. Develop laboratory skills such as safe handling of chemicals, proper use of glassware and instruments, accurate data recording, and error analysis.
9. Strengthen analytical thinking and problem-solving skills through interpretation of experimental results and comparison with theoretical values.

Course Outcomes:

After successful completion of this course, students will be able to:

1. Identify the nature of organic compounds and separate components of binary organic mixtures using systematic qualitative analysis and suitable separation techniques.
2. Perform quantitative volumetric estimations to determine the strength of monobasic and dibasic organic acids, standard solutions, and calculations. Estimate amides quantitatively using appropriate analytical methods and interpret the results with reference to stoichiometric principles.
3. Determine the concentration of esters by carrying out the estimation of ethyl benzoate, demonstrating understanding of ester hydrolysis and titrimetric analysis.

4. Evaluate the saponification value of oils and correlate the experimental value with molecular weight, purity, and industrial applications.
5. Analyze pharmaceutical formulations by determining the alkali content of antacids through acid–base titration using standard HCl.
6. Determine the metal content in alloys using gravimetric analysis, demonstrating precision in precipitation, filtration, drying, and weighing techniques.
7. Prepare inorganic coordination complexes and assess their yield, composition, and relevance in coordination chemistry.

Topics and Learning points:

Section I: Organic Chemistry Practical

A. Organic Qualitative Analysis (Five mixtures: solid-solid, solid-liquid and liquid-liquid type)

Determination of type and separation of two components from given binary mixture of organic compounds containing mono-functional group (Ex. - carboxylic acid, phenols, amines, amide, nitro, etc.) and systematic identification of any one component qualitatively.

B. Organic Estimations (any three1.

1. Determination of molecular weight: Determination of molecular weight of Organic acid by titration against standardized NaOH - a) monobasic acid or b) dibasic acid
2. Estimation of amides: Determine the amount of Acetamide in given solution by volumetric method. (Standardization of acid must be performed)
3. Estimation of Ethyl benzoate: To determine the amount of ethyl benzoate in give in solution volumetrically. (Standardization of acid must be performed).
4. Determination of the saponification value of an oil.
5. Determination of the amount of alkali content in antacid using HCl.

Section II: Inorganic Chemistry Practical

A. Gravimetriy (any four)

1. To determine the amount of Aluminium as Al_2O_3 gravimetrically
2. To determine the amount of Chromium as $PbCr_2O_4$ gravimetrically
3. To determine the amount of Zinc as $Zn_2P_2O_7$ or ZnO gravimetrically
4. To determine the amount of Iron as Fe_2O_3 gravimetrically
5. To determine the amount of Barium as $BaSO_4$ gravimetrically
6. To determine the amount of Nickel as Ni-DMG gravimetrically

B. Preparation(any three)

1. Preparation of Potassium trioxalato ferrate (III) trihydrates.
2. Preparation of Manganese (III) acetylacetone (Mac)
3. Preparation of tris acetylacetonato Chromium (III)
4. Preparation of tris thiourea Copper (I) sulphate.

References:

1. Practical Organic Chemistry by – A.I. Vogel, 5th Edition
2. Vogel's Textbook of Quantitative Chemical Analysis by G.H. Jeffery, J. Bassett, J. Mendham, and R.C. Denney, 5th Edition
3. Practical Organic Chemistry by – O.P. Agarwal
4. General chemistry experiment – Anil J Elias (University press).
5. Vogel Textbook of Quantitative Chemical Analysis G.H. Jeffery, J. Basset.
6. Quantitative Chemical Analysis S. Sahay (S. Chand & Co.).
7. Practical Chemistry K.K. Sharma, D. S. Sharma (Vikas Publication).
8. Vogel's Textbook of Quantitative Chemical Analysis.

Mapping of Program Outcomes with Course Outcomes
(2024 NEP 2.0 Pattern)

Class: T.Y.B.Sc. (Sem.V) **Subject:** Chemistry
Course: Organic and Inorganic Chemistry Practical-I **Course Code:** CHE-306-MRM
Weightage: 1=weak or low relation, 2=moderate or partial relation, 3=strong or direct relation

Mapping of Course Outcomes with Program Outcome

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13
CO 1	3	3	1	3	3	2	2	2	1	1	1	2	1
CO 2	3	3	1	3	3	2	2	2	2	1	1	2	1
CO 3	3	3	1	3	3	2	2	2	2	1	1	2	1
CO 4	3	3	2	3	3	2	2	2	1	1	3	2	2
CO 5	3	3	1	3	3	2	2	2	2	1	2	2	2
CO 6	3	3	1	3	3	2	3	2	1	1	1	3	1
CO 7	3	3	1	3	3	2	3	2	1	1	1	2	1

Justification:

PO1: Comprehensive Knowledge and Understanding
All COs involve fundamental and advanced concepts of organic and inorganic chemistry such as qualitative analysis, titration, gravimetric analysis, ester hydrolysis, coordination chemistry, hence strong correlation.

PO2: Practical, Professional and Procedural Knowledge

Each CO is based on laboratory experimentation, standard procedures, handling of apparatus, precision techniques, direct professional skill development.

PO3: Entrepreneurial Mindset and Knowledge
Moderate in CO4 (industrial relevance of oils, saponification value). Low in other COs as entrepreneurship is indirectly linked through analytical applications.

PO4: Specialized Skills and Competencies
All practical experiments develop laboratory competency, titrimetric, gravimetric, synthetic and analytical expertise.

PO5: Application, Problem Solving & Analytical Reasoning
Students perform calculations, interpret results, analyse purity, determine composition strong analytical component across all COs.

PO6: Communication Skills and Collaboration
Laboratory work requires record writing, viva voce, teamwork during experiments — moderate linkage.

PO7: Research Related Skills
Strong in CO6 & CO7 (gravimetric analysis and coordination complex synthesis).
Moderate in other COs as they build experimental and analytical researchfoundations.

PO8: Learning How to Learn Skills
Students develop self-learning ability through observation, error analysis, and interpretation of experimental outcomes.

PO9: Digital and Technological Skills
Moderate where calculations and data analysis are involved (CO2, CO3, CO5).

Low in experiments primarily manual in nature.

PO10: Multicultural Competence, Inclusive Spirit and Empathy

Indirectly related through collaborative laboratory environment.

PO11: Value Inculcation and Environmental Awareness

Strong in CO4 (oil analysis, industrial and environmental relevance).Moderatein CO5 (pharmaceutical analysis).Low in others.

PO12: Autonomy, Responsibility and Accountability

Strong in CO6 (precision gravimetric analysis).Moderate in other COs due to independent lab performance and safety responsibility.

PO13: Community Engagement and Service

Moderate in CO4 & CO5 (industrial and pharmaceutical relevance to society).Low in other laboratory-focused outcomes.

CBCS Syllabus as per NEP 2020 for T.Y.B.Sc. (2024 Pattern)

Name of the Programme	: B.Sc. Chemistry
Program Code	: USCH
Class	: T.Y.B.Sc.
Semester	: V
Course Type	: Theory
Course Name	: Industrial Chemistry I
Course Code	: CHE-307-MJE (A)
No. of Lectures	: 30
No. of Credits	: 2 credits

Course Objectives:

After successful completion of this course, students will be able to:

1 Introduce students to modern trends in chemical industries and their basic requirements.
2 Provide knowledge of unit processes, unit operations, and principles involved in chemical production.
3 Explain industrial manufacture of heavy chemicals such as ammonia, sulphuric acid, and nitric acid.
4 Develop understanding of fertilizer industries, types of fertilizers, and their role in agriculture.
5 Familiarize students with sugar and fermentation industries, including industrial alcohol production.
6 Create awareness about industrial pollution, its types, effects, and control measures.
7 Impart basic knowledge of quality control, safety measures, patents, copyrights, and trademarks in chemical industries

Course Outcomes:

After successful completion of this course, students will be able to

CO1. 1. Understand and explain the structure, requirements, and working of modern chemical industries.
CO2. Differentiate between unit processes and unit operations used in industrial chemical production.
CO3. Describe the manufacturing processes, principles, and uses of major heavy chemicals like NH_3, H_2SO_4, and HNO_3.
CO4. Explain the importance, classification, and manufacture of fertilizers, including nitrogenous and phosphatic fertilizers.
CO5. Outline the manufacturing process of sugar and industrial alcohol through fermentation.

CO6. Identify various types of industrial pollutants and explain pollution evaluation and control methods.
CO7. Apply basic industrial chemistry concepts related to safety, quality assurance, process control, and intellectual property rights.
CO8. Develop awareness of environmental and safety issues associated with chemical industries.

Topics and Learning points

Unit 1 Modern Trends in Chemical Industries (07 L)

Introduction, basic requirements of chemical industries, chemical production, raw materials, unit process and unit operations, Quality control, quality assurance, process control, research and development, safety measures, classification of chemical reactions, batch and continuous process, Conversion, selectivity, and yield, copy right act, patent act, trademarks

Ref.1: Chapter 2 Pg. 26, 27, 31 to 36, Ref.4: Chapter 1 and 2, Ref.6: Chapter 1, 2 and 3
Ref: Websites and Web Pages www.wikipedia.org/wiki/patentact, www.wikipedia.org/wiki/trademarks, www.wikipedia.org/wiki/copyright_act_of1976

Unit 2. Industrial Production of Heavy Chemicals (06 L)

Introduction, Manufacture of Ammonia (NH3) i. Manufacture by Modified Bosch- Haber's process ii Physico-chemical principles and Its uses.
Manufacture of Sulphuric acid (H2SO4) i. Manufacture by Contact process ii. Physico-chemical principles ii.. Its uses.
Manufacture of Nitric acid (HNO3) i .Manufacture by Ostwald's (Ammonia oxidation process)ii. Physico-chemical principles. Its uses., Ref. 7

Unit 3. Industrial Manufacture of Fertilizers (06L)

Introduction, Plant Nutrients, important of fertilizers, Nutrient functions, Fertilizer types, organic manure, Need for fertilizers, Essential requirements, Classification of fertilizers, inorganic fertilizers, Artificial- fertilizers- Nitrogenous fertilizers Ammonium sulphate, Urea (Manufacture of Urea & Ammonium Sulphate), Action of Ammonium Sulphate & Urea as Fertilizer, Phosphatic Fertilizers- Triple Super Phosphate (Manufacturing Process Only.
Ref. 5

Unit 4. Sugar Industry and Fermentation Industry (05 L)

Introduction, Important of sugar industry, Manufacture of cane sugar from sugarcane in India: Extraction of juice, Clarification, Concentration, crystallization, centrifugation, and other details of industrial process.

Fermentation Industry: Introduction, importance, types of alcohol, Basic requirements of fermentation process, Factors favoring fermentation,. Manufacture of industrial alcohol from molasses.,Ref.2, 3

Unit 5: Industrial Pollution (06 L)

Pollutants and their statutory limits, pollution evaluation methods, Air pollution, water pollution , Pesticide pollution , Radiation pollution and Green House Effect

References

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2. Shreve's Chemical Process Industries, George T. Austin, 5 th Edition, The McGraw-Hill,

3. Industrial Chemistry by B. K. Sharma, 16th Edition, 2011

4. Comprehensive Industrial Chemistry, P.G. More, 1st Edition, Pragati Prakashan, Meerut,

5. Industrial Chemistry by B. K. Sharma, 16th Edition, 2011

6. Handbook of Industrial Chemistry Organic Chemicals, Mohammad Farhat Ali, Bassam M. El Ali, James G. Speight, The McGraw-Hill Companies, 2005, ISBN 0-07-141037-6

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8. Shreve's chemical process industries 5th Edition, G.T. Oustin, McGraw Hill

9. Rigel's handbook of Industrial chemistry, 9th Edition, Jems A. Kent

10. Industrial chemistry –R.K. Das, 2nd Edition, 1976.

Mapping of Program Out comes with Course Outcomes
(2024 NEP 2.0 Pattern)

Class: T.Y.B.Sc. (Sem. V) **Subject:** Chemistry
Course: Industrial Chemistry I **Course Code:** CHE-307-MJE (A)

Weightage: 1=weak or low relation, 2=moderate or partial relation, 3=strong or direct relation

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	P13
CO1	3	2	2	3	2	2	0	0	2	3	2	2	2
CO2	3	3	2	3	3	2	0	0	2	3	3	2	3
CO3	3	3	3	3	3	3	0	0	3	3	3	3	3
CO4	3	2	2	3	2	2	0	2	2	3	2	2	2
CO5	3	2	2	3	2	2	0	0	2	3	2	2	0
CO6	0	0	0	0	0	0	0	3	0	0	0	0	0
CO7	3	2	2	3	2	2	0	0	2	3	2	2	0
CO8	0	0	0	0	0	0	0	3	0	0	0	0	0

PO1: Comprehensive Knowledge and Understanding
CO1: Understands structure, requirements, and functioning of chemical industries → builds foundational knowledge.
CO2: Differentiates unit processes and operations → deepens understanding of industrial chemical production principles.
CO3: Knows manufacturing processes of heavy chemicals → enhances theoretical and practical knowledge.
CO4: Knowledge of fertilizers → applies chemical principles to agriculture.
CO5: Sugar and alcohol production → applies chemical knowledge to bioprocesses.
CO7: Safety, quality, IPR → adds professional knowledge.

PO2: Practical, Professional, and Procedural Knowledge :
CO1–CO5: Practical exposure to industrial processes, operations, and chemical production techniques.
CO7: Knowledge of safety, quality control, and process procedures → aligns with professional standards.

PO3: Entrepreneurial Mindset and Knowledge:
Understanding production processes (CO1–CO5) helps identify opportunities for innovation or industrial entrepreneurship.
Knowledge of fertilizers, heavy chemicals, sugar, and fermentation industries encourages awareness of business and market applications.

PO4: Specialized Skills and Competencies:
CO3, CO4, CO5: Hands-on understanding of industrial chemical manufacturing develops technical and analytical skills.

CO7: Safety and quality measures enhance professional competency in industrial environments.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning:
CO1–CO5: Applying knowledge to industrial processes develops problem-solving ability.
CO6: Pollution evaluation → applies concepts to solve real-world environmental problems.
CO7: Safety and quality → analytical decision-making.
CO8: Awareness of environmental and safety issues → encourages practical problem-solving in industrial contexts.

PO6: Communication Skills and Collaboration:
Not explicitly targeted in this course; could be developed indirectly through project work or lab reports.

PO7: Research-related Skill:
This course does not focus on research methodology; only industrial processes are covered.
CO4: Fertilizer production → environmental impact awareness.
CO5: Sugar and alcohol industries → pollution and sustainability awareness.
CO6: Industrial pollution → develops ethical and environmental responsibility.
CO8: Environmental and safety awareness → inculcates sustainability and industrial ethics.

PO9: Learning How to Learn Skills :
Course focuses on industry knowledge; self-directed learning is not a primary outcome.

PO10: Digital and Technological Skills :
CO6: Pollution control may involve modern tools and technology.
CO7: Quality control and safety measures often use industrial technology.
CO8: Environmental monitoring may require data analysis tools.

PO11: Autonomy, Responsibility, and Accountability :
CO7: Application of safety, quality control, and intellectual property knowledge → fosters professional responsibility and accountability.

PO12: Multicultural Competence, InclusiveSpirit, and Empathy :
This course is technical and industrial in focus; multicultural or team dynamics are not explicitly addressed.

PO13: Community Engagement and Service :
The course focuses on industrial chemical knowledge; direct community engagement is not part of the syllabus.

CBCS Syllabus as per NEP 2020 for T.Y.B.Sc. (2024 Pattern)

Name of the Programme	: B.Sc. Chemistry
Program Code	: USCH
Class	: T.Y.B.Sc.
Semester	: V
Course Type	: Major Theory
Course Name	: Environmental and Green Chemistry- I
Course Code	: CHE-307-MJE (B)
No. of Lectures	: 30
No. of Credits	: 2 credits

Course Objectives:

1. Understand the fundamental manufacturing processes involved in the sugar, cement, fertilizer, and glass industries.
2. Explore the raw materials, unit operations, and technologies used in each industrial sector.
3. Analyse the environmental, economic, and societal impacts of these industries.
4. Identify factors affecting the performance and growth of these industries.
5. Examine current trends, innovations, and sustainable practices in these sectors.
6. Enhance problem-solving and decision-making abilities through case studies and practical examples.
7. Develop soft skills including teamwork, communication, and ethical responsibility required in industrial settings.

Course Outcomes:

After completing this course, students will be able to:
CO1. Explain the key production processes and technological components used in sugar, cement, fertilizer, and glass industries.
CO2. Analyse the economic, environmental, and social implications of industrial operations.
CO3. Identify and interpret key growth factors and challenges affecting these industries.
CO4. Evaluate sustainability practices and propose innovative solutions for industrial improvement.
CO5. Apply theoretical and conceptual knowledge to solve real-world problems in these industries.
CO6. Demonstrate effective communication and teamwork skills in industry-related scenarios.
CO7. Exhibit awareness of ethical, environmental, and social responsibilities in industrial decision-making

Topics and Learning points

Unit 1: Concepts and Scope of Environmental Chemistry (02 L)
Introduction, Terminologies, Units of concentration, Segments of Environment

Unit 2: Atmosphere and Air Pollution (16L)
Composition and structure of atmosphere, Chemical and photochemical reactions in atmosphere ChemistryofO3, SOx,NOx and chlorides in atmosphere, Primary air pollutants, Sampling of air Particulate matter: inorganic and organic, Smog: reducing and photochemical, Mechanism of ozone
Depletion, Stability and reactions of CFCs, Harmful effects of CFCs, CFCs substitutes Bhopal gas tragedy
Ref.1, Ref.3, Ref.5

Unit 3.Introduction to Green Chemistry (12L)
Chemistry is good, The environment and the five environmental spheres What is environmental Chemistry? Environmental Pollution, what is green Chemistry? Green Chemistry and synthetic chemistry, Reduction of risk :Hazard and exposure The risk and no risks, Waste prevention, Basic principles of green chemistry Examples based on green technology.
[Ref: Green Chemistry by Stanley E Manahan ,Chemical Research Inc.(2006)-2nd Edn.
Ch.1, Pg. 1-17andRef.6Relevantpages.]

References

1:Environmental Chemistry–A.K.De,5thEdition(New age international publishers)
2:EnvironmentalChemistry–J.W.MooreandE.A.Moore(AcademicPress,NewYork)
3:EnvironmentalChemistry–A.K.BhagiandC.R.Chatwal(HimalayaPublishingHouse)
4:AnalyticalChemistry–G.D.Christian4thEdition(John Wiley and Sons)
5:EnvironmentalChemistry–H.Kaur2ndEdition2007,Pragati Prakashan Meerut, India

Mapping of Program Out comes with Course Outcomes
(2024 NEP 2.0 Pattern)

Class: T.Y.B.Sc. (SEM-V) **Subject:** Chemistry
Course: Environmental and Green Chemistry-I **Course Code:** CHE-307-MJE (B)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	3	–	2	2	–	–	1	1	–	2	1	–
CO2	2	2	1	2	3	1	2	1	1	2	3	2	2
CO3	2	2	2	2	2	–	1	2	1	–	2	2	–
CO4	2	2	2	3	3	–	2	2	2	1	3	2	1
CO5	3	3	2	3	3	1	2	2	2	–	2	3	–
CO6	–	1	–	2	–	3	–	–	–	2	–	1	1
CO7	2	2	1	2	2	2	1	1	–	2	3	3	2

Justification for Mapping

PO1 – Comprehensive Knowledge and Understanding
Strongly mapped to **CO1 and CO5**, as students gain in-depth understanding of industrial processes and apply conceptual knowledge to real-world industrial problems. Moderate alignment with **CO2, CO3, CO4, and CO7** reflects multidisciplinary understanding of industrial, environmental, and ethical aspects.

PO2 – Practical, Professional, and Procedural Knowledge
High correlations with CO1 and CO5, as these outcomes require application of industry practices and operational knowledge. Moderate mapping with **CO2, CO3, CO4, and CO7** supports professional decision-making and awareness of regulations and sustainability.

PO3 – Entrepreneurial Mindset and Knowledge
Mapped moderately with **CO3, CO4, and CO5**, as identifying growth factors, challenges, and proposing innovative solutions nurtures entrepreneurial thinking. Low mapping with **CO2 and CO7** reflects exposure to socio-economic and ethical dimensions of industry.

PO4 – Specialized Skills and Competencies
Strong mapping with **CO4 and CO5**, where students evaluate sustainability practices and solve industry-based problems. Moderate correlation across most COs reflects development of analytical, technical, and adaptive skills.

PO5 – Application, Problem-Solving, and Analytical Reasoning
Highly aligned with **CO2, CO4, and CO5**, as these outcomes emphasize analysis of impacts, evaluation of sustainability, and problem-solving in industrial contexts. Moderate alignment with **CO1, CO3, and CO7** supports analytical reasoning.

PO6 – Communication Skills and Collaboration
Strongly mapped to **CO6**, as this outcome explicitly focuses on communication and teamwork. Moderate alignment with **CO7** reflects ethical and socially responsible communication in industrial decision-making.

PO7 – Research-related Skills
Moderate mapping with **CO2, CO4, and CO5**, as students analyze industrial data, evaluate practices, and apply inquiry-based approaches. Limited alignment with **CO3 and CO7** supports interpretative and evaluative skills.

PO8 – Learning How to Learn Skills
Moderate correlation with **CO3, CO4, and CO5**, as students adapt to changing industrial challenges and develop self-directed learning habits. Low mapping across other COs reflects supportive but indirect contribution.

PO9 – Digital and Technological Skills
Moderate mapping with **CO4 and CO5**, where technology and data analysis support sustainability evaluation and problem-solving. Limited alignment with **CO1–CO3** reflects basic use of technological resources.

PO10 – Multicultural Competence, Inclusive Spirit, and Empathy
Moderately mapped with **CO2, CO6, and CO7**, as these outcomes involve social implications, teamwork, and ethical decision-making in diverse industrial environments.

PO11 – Value Inculcation and Environmental Awareness
Strongly mapped with **CO2, CO4, and CO7**, as these outcomes emphasize environmental responsibility, sustainability, and ethical industrial practices. Moderate alignment with **CO1, CO3, and CO5** supports value-based learning.

PO12 – Autonomy, Responsibility, and Accountability
High correlation with **CO5 and CO7**, as students independently solve problems and demonstrate ethical responsibility. Moderate mapping with **CO2, CO3, and CO4** reflects accountable decision-making.

PO13 – Community Engagement and Service
Moderately mapped with **CO2 and CO7**, as industrial activities impact society and community well-being. Limited alignment with **CO6** supports collaborative engagement.

CBCS Syllabus as per NEP 2020 for T.Y.B.Sc. (2024 Pattern)

Name of the Programme	: B.Sc. Chemistry
Program Code	: USCH
Class	: T.Y.B.Sc.
Semester	: V
Course Type	: Practical
Course Name	: Industrial Chemistry Practical –I
Course Code	: CHE-308-MJE (A)
No. of Lectures	: 30
No. of Credits	: 2 credits

Course Objectives:

1. To develop practical skills in quantitative and qualitative analysis of fertilizers, soil, and water samples.
2. To train students in titrimetric, colorimetric, and chromatographic techniques.
3. To impart knowledge of environmental and agricultural chemical analysis such as COD, hardness, and nutrient estimation.
4. To enhance analytical accuracy, data recording, and result interpretation skills.
5. To familiarize students with laboratory safety, standard procedures, and ethical practices.
6. To develop problem-solving ability in real sample analysis and quality assessment.
7. To cultivate responsibility toward environmental monitoring and sustainable practices.

Course Outcomes:

After completing this course, students will be able to:

CO1: Perform quantitative analysis of fertilizers for nitrogen, potassium, moisture, and related parameters using titrimetric methods.

CO2: Analyze soil and water quality parameters including hardness, COD, pH, alkalinity, TDS, iron, and manganese.

CO3: Apply volumetric and colorimetric techniques for estimation of chemical species accurately.

CO4: Conduct chromatographic and qualitative analysis of metal ions and carbohydrates.

CO5: Interpret analytical data and evaluate environmental and agricultural sample quality.

CO6: Follow laboratory safety protocols, ethical practices, and standard operating procedures.

CO7: Demonstrate independent laboratory skills, teamwork, documentation, and accountability in practical work

Topics and Learning points

1. Determination of the moisture from sludge fertilizer, compost fertilizer and organic fertilizer.
2. Determination of the nitrogen in a given ammonium chloride fertilizer by titration method
3. Determination of the nitrogen in a given nitro phosphate fertilizer by titration method
4. Determination of the nitrogen in a given NPK fertilizer by titration method
5. Determination of the nitrogen in a given vermi compost fertilizer by titration method
6. Volumetric estimation- fertilizer analysis ($PO4^{3-}$)
7. Volumetric Estimation of NO_2^-using $KMnO_4$
8. Estimation of available potassium in soil.
9. Determination of Sulphide in the given sample by titrimetric method
10. Determination of Hardness of water by EDTA titrimetric method
11. Colorimetric determination of manganese in the given sample of water
12. Colometric determination of iron in the given sample of water
13. Analysis of ground water quality for pH, hardness, TDS, alkanility, acidity.
14. Detection of Ni^{2+}, Co^{2+} and Cu^{2+} in a given mixture by paper chromatography
15. Determination of Chemical Oxygen Demand (COD) in a waste water sample
16. Determination of glucose by Benedict's solution
17. To determine the strength of a given glucose solution using Fehling solution.
18. Determination of strength of sucrose solution by Fehling solution.
19. Qualitative analysis of carbohydrates by osazone test

References

1. Practical Physical Chemistry, 3rdEdn. A. M. James and F. E. Prichard, Longman publication.
2. Experiments in Physical Chemistry, R. C. Das and B. Behra, Tata McGraw Hill.
3. Advanced Practical Physical Chemistry, J. B. Yadav, Goel Publishing House..
5. Physical Chemistry Experiments, Raghvan and Vishwanathan.
6. Practical Organic Chemistry by – A.I. Vogel.
7. Practical Organic Chemistry by – O.P. Agarwal.
8. General chemistry experiment – Anil J Elias (University press).
9. Vogel Textbook of Quantitative Chemical Analysis G.H. Jeffery, J. Basset.

Mapping of Program Out comes with Course Outcomes
(2024 NEP 2.0 Pattern)

Class: T.Y.B.Sc. (SEM-V) **Subject:** Chemistry
Course: Industrial Chemistry Practical –I **Course Code:** CHE-308-MJE (A)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	3	2	3	3	2	2	1	2	1	2	3	1
CO2	3	3	2	3	3	2	2	1	2	1	3	3	2
CO3	3	2	2	3	3	2	2	1	3	1	2	3	1
CO4	2	2	2	3	3	2	2	1	3	1	1	3	1
CO5	3	3	2	3	3	2	2	1	2	1	3	3	2
CO6	2	2	1	2	2	2	2	1	2	1	3	3	1
CO7	2	2	2	3	3	3	2	1	2	2	2	3	3

Justification for Mapping

PO1: Comprehensive Knowledge and Understanding
CO1–CO3: Strongly contribute by developing in-depth practical understanding of fertilizer, soil, and water analysis through titrimetric and colorimetric techniques.
CO4–CO5: Moderately support comprehensive knowledge by applying chromatographic and qualitative analytical methods for real sample evaluation.
CO6–CO7: Limited contribution as focus shifts toward laboratory practice, safety, and documentation rather than theoretical expansion.

PO2: Practical, Professional, and Procedural Knowledge
CO1–CO4: Strongly contribute through hands-on laboratory training in volumetric, colorimetric, and chromatographic techniques aligned with professional laboratory standards.
CO5: Moderately supports procedural understanding through analytical interpretation and quality assessment.
CO6–CO7: Strongly contribute by reinforcing laboratory ethics, SOP adherence, and accountability.

PO3: Entrepreneurial Mindset and Knowledge
CO1–CO2: Moderately contribute by providing skills applicable in fertilizer testing labs and water analysis centers.
CO3–CO5: Moderately support analytical competence useful in consultancy and quality control sectors.
CO6–CO7: Limited contribution as emphasis remains on technical skill development rather than business principles.

PO4: Specialized Skills and Competencies
CO1–CO4: Strongly contribute through development of technical laboratory skills, analytical precision, and problem-solving ability.
CO5: Strongly supports competency through interpretation of environmental and agricultural data.

CO6–CO7: Moderately contribute through development of responsibility and teamwork skills.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning
CO1–CO3: Strongly contribute by applying chemical principles in quantitative analysis and calculations.
CO4–CO5: Strongly support analytical reasoning through qualitative detection and environmental data interpretation.
CO6–CO7: Moderately contribute through practical troubleshooting and independent execution of experiments.

PO6: Communication Skills and Collaboration
CO1–CO4: Moderately contribute through preparation of laboratory records and structured result presentation.
CO5: Moderately supports interpretation-based reporting.
CO6–CO7: Strongly contribute through teamwork, collaborative lab work, and accountable documentation.

PO7: Research-related Skills
CO1–CO3: Moderately contribute through observation, data collection, and quantitative analysis.
CO4–CO5: Strongly support analytical interpretation and evaluation of experimental findings.
CO6–CO7: Moderately contribute by promoting systematic experimentation and adherence to research ethics.

PO8: Learning How to Learn Skills
CO1–CO3: Moderately contribute by encouraging independent practice of analytical techniques.
CO4–CO5: Moderately support development of self-directed analytical reasoning.
CO6–CO7: Strongly contribute by fostering independent laboratory work and accountability.

PO9: Digital and Technological Skills
CO1–CO3: Moderately contribute through data calculations and use of analytical instruments.
CO4–CO5: Moderately support application of instrumental methods in analysis.
CO6–CO7: Limited contribution as digital tools are supplementary.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy
CO1–CO5: Limited contribution as focus is technical and laboratory-based.
CO6–CO7: Moderately contribute through teamwork and cooperative laboratory practices.

PO11: Value Inculcation and Environmental Awareness
CO2, CO5: Strongly contribute by analyzing water quality, COD, and environmental parameters.
CO1–CO3: Moderately support awareness of fertilizer and soil sustainability.
CO6–CO7: Strongly contribute through responsible laboratory practices and environmental sensitivity.

PO12: Autonomy, Responsibility, and Accountability

CO1–CO4: Moderately contribute through independent performance of experiments.

CO5: Strongly supports accountability in data interpretation and result validation.

CO6–CO7: Strongly contribute by reinforcing ethical practices, responsibility, and systematic documentation.

PO13: Community Engagement and Service

CO2, CO5: Strongly contribute through water quality and environmental monitoring relevant to community welfare.

CO1–CO3: Moderately support agricultural and soil health awareness.

CO6–CO7: Moderately contribute through responsible application of analytical skills for societal benefit

CBCS Syllabus as per NEP 2020 for T.Y.B.Sc. (2024 Pattern)

Name of the Programme	:	B.Sc. Chemistry
Program Code	:	USCH
Class	:	T.Y.B.Sc.
Semester	:	V
Course Type	:	Practicals
Course Name	:	Environmental and Green Chemistry Practical-I
Course Code	:	CHE-308-MJE (B)
No. of Lectures	:	30
No. of Credits	:	2 credits

Course Objectives:

After completing this course, students will be able to:

1. To develop practical skills for analyzing the physicochemical quality of water from different environmental sources.
2. To familiarize students with standard methods for determining water quality parameters such as pH, DO, BOD, COD, TDS, TSS, hardness, alkalinity, turbidity, and chlorine.
3. To understand the environmental significance of water pollutants and their impact on water quality.
4. To introduce analytical techniques used in environmental monitoring and pollution assessment.
5. To study the effect of anthropogenic activities, such as detergent usage, on water chemistry.
6. To provide hands-on experience in the estimation and synthesis of environmentally relevant chemical compounds.
7. To promote awareness of green chemistry principles through eco-friendly synthesis methods

Course Outcomes:

After successful completion of the course, students will be able to:

CO1. Measure and interpret pH and basic water quality parameters of various natural and polluted water samples.
CO2. Determine dissolved oxygen, BOD, and COD to assess organic pollution levels in water bodies.
CO3. Analyze physical characteristics of water such as turbidity, total dissolved solids (TDS), and total suspended solids (TSS).
CO4. Estimate chemical parameters like alkalinity, hardness, and residual chlorine using standard analytical methods.

CO5. Evaluate the impact of detergents and human activities on water quality parameters.
CO6. Perform quantitative estimation of environmentally significant compounds such as caffeine from natural sources.
CO7. Apply principles of green chemistry in the synthesis of silver nanoparticles and organic compounds like chalcones.

Topics and Learning points

1. Determination of pH of water sample-measuring the pH of different water sources(river, lake, ground water, sewage)
2. Estimation of Dissolved Oxygen (DO) from given water sample.
3. Analysis of BOD-measuring the oxygen demand for organic matter degradation.
4. Estimation of COD from water sample.
5. Turbidity measurement of water.
6. Chlorine estimation in water-Testing for chlorine content in different water samples.
7. Determination of Total suspended solids (TSS) in water-Assessing the level of particulate matter.
8. Determination of alkalinity measurement from water.
9. Determination of TDS in water.
10. Determination of Hardness of water by EDTA titrimetric method
11. Effect of detergents on water quality-Assessing pH and dissolved oxygen changes.
12. Estimation of Caffine from Tea Leaves.
13. To synthesize silver Nanoparticles by green method using plant extraction.
14. To Synthesize chalcone using benzaldehyde and acetophenone in alkaline medium.

References

1.Principles of Environmental Science-Cunningham and Cunningham
2. Ecology, environment and Resource conservation(2006):Singh J S,Singh S P,Gupta S R,Anamaya Publ,New Delhi
3. Fundamentals of Ecology-W B Saunders Company
4.R S Ramalho,1983 Introduction to waste water treatment process,Academic press,New York
5. Quanag,EAR,Principles of waste water treatmentVol I, Biological Process,National Science Development Board,Manilia,Phillipines.

Mapping of Program Out comes with Course Outcomes

Class: T.Y.B.Sc. (SemV) Subject: Chemistry

Course: Environmental and Green Chemistry Practical-I Course Code: CHE-308-MJE(B)

Weightage: 1=weak or low relation, 2=moderate or partial relation, 3=strong or direct relation

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2	–	2	2	1	–	1	1	–	3	1	–
CO2	3	3	–	2	3	–	2	1	1	–	3	2	–
CO3	2	3	–	2	2	–	–	1	1	–	3	1	–
CO4	2	3	–	2	2	–	–	1	1	–	3	2	–
CO5	2	2	–	2	3	1	1	1	–	1	3	2	2
CO6	2	3	1	2	2	–	2	1	1	–	2	2	–
CO7	2	3	2	3	3	1	2	2	1	–	3	3	1

Justification of Mapping

PO1: Comprehensive Knowledge and Understanding

Mapped strongly to **CO1 and CO2** as students apply foundational chemistry concepts to water quality analysis. Moderate mapping with remaining COs reflects conceptual understanding of analytical and green chemistry experiments.

PO2: Practical, Professional, and Procedural Knowledge

Highly mapped across **CO2, CO3, CO4, CO6, and CO7** due to extensive laboratory work involving standard methods, titrations, estimations, synthesis, and adherence to experimental procedures.

PO3: Entrepreneurial Mindset and Knowledge

Low to moderate mapping with **CO6 and CO7**, as extraction of caffeine and green synthesis of nanoparticles introduce product-oriented thinking, innovation, and potential industrial relevance.

PO4: Specialized Skills and Competencies

Moderate to high mapping across all COs, with **strong alignment to CO7**, as advanced synthesis experiments enhance technical skills, problem-solving ability, and adaptability.

PO5: Application, Problem-Solving, and Analytical Reasoning

Strong correlation with **CO2, CO5, and CO7**, where students analyze pollution parameters, interpret results, and assess environmental impacts using analytical reasoning.

PO6: Communication Skills and Collaboration

Low mapping with **CO1, CO5, and CO7**, as students record observations, prepare lab reports, and occasionally collaborate during experiments.

PO7: Research-related Skills

Moderately mapped to **CO2, CO6, and CO7**, as these involve data collection, quantitative analysis, interpretation, and exposure to research-oriented laboratory practices.

PO8: Learning How to Learn Skills
Low to moderate mapping across COs, with higher alignment in **CO7**, where students independently follow procedures and adapt green chemistry approaches.

PO9: Digital and Technological Skills
Low mapping across most COs due to limited use of digital tools, primarily for calculations, data recording, and result presentation.

PO10: Multicultural Competence and Empathy
Minimal mapping, with slight linkage to **CO5**, as environmental pollution studies promote awareness of societal and community impacts.

PO11: Value Inculcation and Environmental Awareness
Strongly mapped across all COs, especially **CO1–CO5 and CO7**, as the course directly emphasizes environmental protection, sustainability, and responsible chemical practices.

PO12: Autonomy, Responsibility, and Accountability
Moderate to high mapping with **CO2, CO4, CO6, and CO7**, as students independently perform experiments, ensure accuracy, and follow laboratory ethics.

PO13: Community Engagement and Service
Mapped to **CO5 and CO7**, as studies on detergent pollution and green synthesis promote societal awareness and environmentally responsible practices.

CBCS Syllabus as per NEP 2020 for T.Y.B.Sc. (2024 Pattern)

Name of the Programme	: B.Sc. Chemistry
Program Code	: USCH
Class	: T.Y.B.Sc.
Semester	: V
Course Type	: Minor Theory
Course Name	: Applied Chemistry–I
Course Code	: CHE-310-MN
No. of Lectures	: 30
No. of Credits	: 2 credits

Course Objectives:

1. To introduce the fundamental concepts of electromagnetic radiation and spectrophotometric principles.
2. To explain Lambert's Law and Beer's Law with mathematical derivation and analytical applications.
3. To familiarize students with instrumentation of single beam colorimeter and double beam spectrophotometer.
4. To develop understanding of chemical bonding theories including orbital overlap and VSEPR theory.
5. To impart knowledge of structure, classification and reactions of carbohydrates.
6. To explain structure, properties, classification and analytical parameters of lipids and lipoproteins.
7. To develop analytical, numerical problem-solving and application skills in biochemical and instrumental chemistry.

Course Outcomes:

After successful completion of the course, students will be able to:

CO1: Explain the electromagnetic spectrum and interpret interaction of radiation with matter in spectrophotometric analysis.

CO2: Apply Beer–Lambert law for quantitative estimation and solve numerical problems related to absorbance and concentration.

CO3: Describe instrumentation and working of single beam colorimeter and double beam spectrophotometer and explain additive property of absorbance.

CO4: Explain bond formation using orbital overlap concepts and predict molecular geometry using VSEPR theory.

CO5: Illustrate stereochemistry and reactions of carbohydrates including cyclization, anomers, epimers, and glycosidic bonds.

CO6: Evaluate physicochemical constants of lipids (acid number, iodine number, saponification number) and interpret their significance.

CO7: Explain structure and biological importance of complex biomolecules such as polysaccharides, lipoproteins, blood group substances, and prostaglandins.

Topics and Learning points

Unit-1 Spectrophotometry [10 L]

Introduction, Electromagnetic spectrum, Interaction of electromagnetic radiations with the matter, Energy, wavelength, frequency, Absorbance, transmittance, Lambert's Law and Beer's Law, Mathematical Statement and derivation of Lambert's Law and Beer's Law, Terminology involved in spectrophotometric analysis, Instrumentation of single beam colorimeter, Instrumentation of double beam spectrophotometer, Principle of additively of absorbance and simultaneous determination, , Numerical Problems

Unit-2 Chemical Bonding and Structure: [10 L]

Attainment of stable configuration, type of bonds, Types of overlap: formation of σ and π bonds, s-s overlap, s-p overlap and p-p overlap with suitable example.

Valance shell electron pair repulsion (VSEPR) theory.

Unit-3 Carbohydrates and Lipids [10 L]

Intoduction to Biochemistry

Carbohydrates: Definition, Biological significance, Classification with examples: Monosaccharides, Cyclisation of sugars by Fischer and Haworth projection formulas. Anomers, Epimers, reducing and non-reducing sugars, mutarotation, inversion. Reactions of glucose with acid, base, phenylhydrazine, oxidizing agents, reducing agents and its significance, glycosidic bonds. Structure and features of disaccharides, homo and heteropolysaccharides

Lipids: Definition, Biological significance, Classification-Simple, compound, steroids, derived lipids and their structures. Amphipathic lipids and their behaviour in water. Saponification number, acid number, iodine number and their significance. Rancidity. Types of Lipoproteins and their significance.

References

1. Medicinal Chemistry by Ashutosh Kar.
2. Lehninger, Principles of Biochemistry, by Nelson and Cox Macmillan Publisher fourth edition
3. Inorganic Chemistry by Vogel 6th edition
4. Concise inorganic Chemistry by J. D. Lee 5th edition
5. Textbook of Quantitative Chemical Analysis- 3rd Edition, A. I. Vogel
6. Principles of Physical Chemistry 4th edition – Prutton and Marron

Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B.Sc. (SemV) Subject: Chemistry

Course: Applied Chemistry I Course Code: CHE-310-MN

Weightage: 1=weak or low relation, 2=moderate or partial relation, 3=strong or direct relation

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2	1	2	2	1	1	2	2	1	1	2	1
CO2	3	3	1	3	3	1	2	2	3	1	1	2	1
CO3	3	3	1	3	2	2	2	2	3	1	1	2	1
CO4	3	2	1	3	3	1	2	2	2	1	1	2	1
CO5	3	3	2	3	3	1	2	2	2	2	3	2	2
CO6	3	3	2	3	3	1	2	2	2	2	3	2	2
CO7	3	3	3	3	3	2	3	3	3	3	3	3	3

Justification of Mapping

PSO1: Comprehensive Knowledge and Understanding

All COs build strong theoretical foundations in spectrophotometry, chemical bonding, carbohydrates, and lipids. Students gain in-depth conceptual clarity of principles, laws, structures, and reactions, fulfilling comprehensive disciplinary knowledge.

PSO2: Practical, Professional and Procedural Knowledge

CO2 and CO3 develop instrumentation handling and analytical techniques. CO5 and CO6 connect biochemical concepts to pharmaceutical, clinical, and industrial applications. CO7 ensures application of theoretical knowledge in professional contexts.

PSO3: Entrepreneurial Mindset and Knowledge

Knowledge of lipids, lipoproteins, rancidity, and analytical values (CO6) is directly relevant to food, dairy, cosmetic, and pharmaceutical industries. CO7 promotes application-oriented thinking and innovation, encouraging entrepreneurial opportunities.

PSO4: Specialized Skills and Competencies

CO2 and CO3 develop technical competency in spectrophotometric instrumentation. CO4 enhances structural prediction skills using bonding theories. CO7 integrates analytical and technical skills for solving complex chemistry problems.

PSO5: Capacity for Application, Problem-Solving and Analytical Reasoning

Numerical problems in Beer–Lambert law (CO2), molecular geometry prediction (CO4), biochemical reaction analysis (CO5 & CO6), and integrated application (CO7) strengthen analytical reasoning and problem-solving abilities.

PSO6: Communication Skills and Collaboration.
Instrumentation explanation (CO3) and analytical problem discussions (CO7) improve scientific communication skills. Students learn to present experimental data and theoretical interpretations effectively.

PSO7: Research-related Skills
Quantitative analysis (CO2), instrumentation knowledge (CO3), and application-based learning (CO7) develop research aptitude, data interpretation skills, and experimental understanding.

PSO8: Learning How to Learn Skills
Understanding theoretical concepts (CO1 & CO4) encourages independent learning. CO7 promotes integration of concepts and adaptability to new scientific advancements.

PSO9: Digital and Technological Skills
Spectrophotometer operation (CO3), data analysis (CO2), and interpretation of analytical results (CO7) require use of digital instruments and ICT tools.

PSO10: Multicultural Competence, Inclusive Spirit and Empathy
CO5, CO6, CO7 Understanding biochemical importance of carbohydrates and lipids in health and nutrition (CO5 & CO6) promotes awareness of global health issues. CO7 connects chemistry to societal well-being.

PSO11: Value Inculcation and Environmental Awareness
CO5, CO6, CO7 Topics like rancidity, lipid oxidation, and biomolecular health significance encourage environmental responsibility and ethical scientific practices.

PSO12: Autonomy, Responsibility and Accountability
CO2, CO4, CO7 Numerical problem-solving (CO2), structural prediction (CO4), and integrated applications (CO7) require independent thinking, accuracy, and accountability in scientific work.

PSO13: Community Engagement and Service
CO5, CO6, CO7- Knowledge of biomolecules and their impact on nutrition and public health enables students to contribute to community awareness programs related to diet, health, and environmental sustainability.