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)
Semester VI
(NEP-1.0 2023 Pattern)

Choice Based Credit System Structure and Syllabus (As Per NEP-2020)

To be implemented from Academic Year 2025-2026

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, facilitate seamless academic mobility, and enhance the global competitiveness of Indian students. It fosters a system where educational achievements can be recognized and valued not only within the country but also in the international arena, expanding opportunities and opening doors for students to pursue the 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 sixth 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 Credit System (CBCS), taking into consideration the guidelines set forth by the National Education Policy (NEP) 2020, LOCF(UGC), NCrF, NHEQF, Prof. R. D. Kulkarni's Report, Government of Maharashtra's General Resolution dated 20th April and 16th May 2023, and the Circular issued by SPPU, Pune on 31st May2023.

The CBCS Course curriculum of the discipline of Chemistry is well designed and very promising. A degree in Chemistry subject equips students with the knowledge and skills necessary for a diverse range of fulfilling career paths. The core course would help to enrich the 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. In 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 NEP 2020 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, recognise 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, Baramati

(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
4.	Mr. Ravikiranamrut R. Gandhi	Member
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6.	Dr. Yogesh N. Indulkar	Member
7.	Dr. Deepali S. Pakhare	Member
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16.	Dr. Pravinkumar B. Patil	Member
17.	Mrs. Kalpana Surnavar	Member
18.	Ms. Pratiksha R. Bankar	Member
19.	Mrs. Chaitrali A. Bunage	Member
20.	Dr. Dilip Satpute	External Member VC Nominee

21.	Dr. Sidaram Pujari	External Member from other University
22.	Dr. Vijay Vader	External Member from other University
23.	Dr. Nitin Jadhav	Member Representative Alumni
24.	Mr. Dadaso Kare	Member Representative from Industry
25.	Ms. Tanishka Phadatare	UG Student Representative
26.	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 (2023 Pattern as per NEP-2020)

Level/ Difficulty	Sem	Subject DSC-1	Subject DSC-2	Subject DSC-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(T)	--	22
	II	2(T)+2(P)	2(T)+2(P)	2(T)+2(P)	2(P)	2 (T/P)	--	2(T)	2(T)	2(T	22
Exit option: Award of UG Certificate in Major with 44 credits and an additional 4 credits core 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 other 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/RP									
5.0/200	III	4(T)+2(P)	--	2 (T/P)	2(FP)	2(T)+2(P)	--	2(T)	--	2(T)	2(T)	--	2(T)	22
	IV	4(T)+2(P)	--	2 (T/P)	2(CEP)	2(T)+2(P)	--	2(P)	2 (T/P)	--	2(T)	--	2(T)	22
Exit option: Award of UG Diploma in Major and Minor with 88 credits and an additional 4credits core NSQF course/Internship OR Continue with Major and Minor														
5.5/300	V	8(T)+4(P)	2(T)+2(P)	2 (T/P)	2(FP/CEP)	2(T)	--	--	--	--	--	--	--	22
	VI	8(T)+4(P)	2(T)+2(P)	2 (T/P)	4 (OJT)	--	--	--	--	--	--	--	--	22
Total 3Years		**44**	**8**	**8**	**10**	**18**	**8**	**8**	**6**	**4**	**8**	**4**	**6**	**132**
Exit option: Award of **UG Degree in Major** with 132 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)	--	6(RP)	--	--	--	--	--	--	--	--	22
Total 4Years		**64**	**16**	**8**	**22**	**22**	**8**	8	**6**	**4**	**8**	**4**	**6**	**176**
Four Year **UG Honours with Research Degree** in Major and Minor with 176 credits														
6.0/400	VII	10(T)+4(P)	2(T)+2 (T/P)	--	--	4(RM) (T)	--	--	--	--	--	--	--	22
	VIII	10(T)+4(P)	2(T)+2 (T/P)	--	4 (OJT)	--	--	--	--	--	--	--	--	22
Total 4Years		**72**	**16**	**8**	**14**	**22**	**8**	8	**6**	**4**	**8**	**4**	**6**	**176**
Four Year **UG Honours Degree** in Major and Minor with176 credits														

T = Theory **P** = Practical **DSC** = Discipline Specific Course **OE** = Open Elective **SEC** = Skill Enhancement Course
IKS = Indian Knowledge System **AEC** = Ability Enhancement Course **VEC** = Value Education Course **CC** = Co-curricular Course **VSC**= Vocational Skill Course
OJT= On Job Training **CEP**= Community Engagement Project **FP**= Field Project **RP**= Research Project

Course and Credit Distribution Structure for B.Sc. (Chemistry)-2024-2025

Level	Semester	Sub. DSC-I Languages	Sub. DSC-II Social Science-I	Sub. DSC-III Social Science-II	OE	SEC	IKS	AEC	VEC	CC	Degree/Cum.Cr.
4.5	I	2 T + 2 T / P	2 T + 2 T / P	2 T + 2 T / P	2 T (from other faculty)	2 T / P	2 T (Generic)	2 T (C. Eng.)	2 T	--	**22**
	I	2 T + 2 T / P	2 T + 2 T / P	2 T + 2 T / P	2 T /P (from other faculty)	2 T / P	--	2 T (C. Eng.)	2 T	2 T YOG/PES/ CUL/NSS/ NCC	**22**
										Total Credits	**44**

*** T = Theory** *** P = Practical** *** DSC = Discipline Specific Course**

*** 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 (2023 Pattern)

SEM	Course Type	Course Code	Course Title	Theory / Practical	Credits
V	Major Mandatory	CHE-301-MRM	Physical Chemistry -I	Theory	02
	Major Mandatory	CHE-302-MRM	Inorganic Chemistry -I	Theory	02
	Major Mandatory	CHE-303-MRM	Organic Chemistry -I	Theory	02
	Major Mandatory	CHE-304-MRM	Analytical Chemistry - I	Theory	02
	Field Project (FP)	CHE-305-MRM	Chemistry Practical- V	Practical	02
	Minor Elective (MJE)	CHE-306-MJE(A)	Industrial Chemistry –I	Theory (Any Two)	04
	Minor Elective (MJE)	CHE-306-MJE(B)	Environmental & Green Chemistry - I		
	Minor Elective (MJE)	CHE-306-MJE(C)	Agri. & Dairy Chemistry - I		
	Minor	CHE-311-MN	Applied Chemistry - I	Theory	02
	Minor	CHE-312-MN	Practicals on Applied Chemistry – I	Practical	02
	Vocational Skill Course (VSC)	CHE-321-VSC	Advanced Chemistry Practical	Practical	02
	Field Project (FP)	CHE-355-FP	Field Project	Practical	02
	Total Credit				**22**
VI	Major Mandatory	CHE-351-MRM	Physical Chemistry -II	Theory	02
	Major Mandatory	CHE-352-MRM	Inorganic Chemistry - II	Theory	02
	Major Mandatory	CHE-353-MRM	Organic Chemistry -II	Theory	02
	Major Mandatory	CHE-354-MRM	Analytical Chemistry - II	Theory	02
	Field Project (FP)	CHE-355-MRM	Chemistry Practical- VI	Practical	02
	Minor Elective (MJE)	CHE-356-MJE(A)	Industrial Chemistry – II	Theory (Any Two)	04
	Minor Elective (MJE)	CHE-356-MJE(B)	Environmental & Green Chemistry - II		
	Minor Elective (MJE)	CHE-356-MJE(C)	Agri. & Dairy Chemistry - II		
	Minor	CHE-361-MN	Applied Chemistry - II	Theory	02
	Minor	CHE-362-MN	Practicals on Applied Chemistry – II	Practical	02
	On Job Training (OJT)	CHE-385-OJT	On Job Training	Practical	04
	Total Credit				**22**
Cumulative Credits Semester V + Semester VI					**44**

CBCS Syllabus as per NEP 2020 for T.Y.B.Sc. (2023 Pattern)

Name of the Programme	: B.Sc. Chemistry
Program Code	: USCH
Class	: T.Y.B.Sc.
Semester	: VI
Course Type	: Major Mandatory Theory
Course Name	: Physical Chemistry -II
Course Code	: CHE-351-MJM
No. of Lectures	: 30
No. of Credits	: 2 credits

Course Objectives:

1. Provide an understanding of the principles, construction, and applications of electrochemical cells.
2. Familiarize students with electrode potentials, reference electrodes, and Nernst equation for emf calculations.
3. Introduce the concepts of radioactivity, nuclear structure, types of decay, and kinetics of radioactive transformations.
4. Develop skills in the detection and measurement of radioactivity using different instruments.
5. Explain the concepts of mass defect, nuclear binding energy, and energy release in nuclear reactions.
6. Highlight the applications of isotopes in chemical investigations, structural studies, and age determination.
7. Introduce the fundamentals of surface chemistry, adsorption phenomena, and adsorption isotherms.

Course Outcomes:

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

CO1: Explain the working of electrochemical cells and differentiate between reversible and irreversible cells.

CO2: Identify and use reference electrodes (standard hydrogen electrode, calomel electrode, glass electrode) for pH determination.

CO3: Perform potentiometric titrations (acid–base, redox, precipitation) using emf measurements.

CO4: Operate and interpret results from radioactivity detection instruments (G.M. counter, scintillation counter, cloud chamber, etc.).

CO5: Calculate nuclear binding energy and mass defect and discuss their significance in nuclear stability.

CO6: Explain adsorption processes and apply isotherm equations (Langmuir, Freundlich) to experimental data.

CO7: Apply theoretical knowledge to practical problems in electrochemistry, nuclear chemistry, and surface chemistry relevant to industry, environment, and research.

Topics and Learning points

Unit I: Electrochemical Cells [14 L]

Electrochemical cells, reversible and irreversible cells with examples, e.m.f. of electrochemical cell and its measurement, The Weston standard cell, Reference electrodes: The primary reference electrode and Secondary reference electrodes, The Nernst equation for E.M.F. of a cell. Types of reversible electrodes, the sign convention for electrode potentials, Thermodynamics of reversible cells and reversible electrodes, E.M.F. and equilibrium constant of cell reaction, Electrochemical series, Types of concentration cells, liquid junction potential, salt bridge, Applications of emf measurements: 1. Determination of pH of a solution by using hydrogen electrode, quinhydrone electrode and glass electrodes 2. Potentiometric titrations: i) Acid-base titrations, (ii) Redox titrations. (iii) Precipitation titration,

Unit II: Nuclear Chemistry [10L]

Radioactivity, Types of Radiations, Properties of Radiations, Detection and Measurement of Radioactivity: Cloud chamber, Ionization Chamber, Geiger-Muller Counter, Scintillation Counter and Film Badges, Nuclear structure, Classification of nuclides, Types of Radioactive Decay, The Group Displacement Law, Kinetics of Radioactive Decay, Half-life, average life, Energy released in nuclear reaction, Mass Defect, Nuclear Binding Energy, Some applications of radio-isotopes as tracers: Chemical investigation – Esterification, Friedel -Craft reaction, Structural determination – Phosphorus pentachloride, Age determination – use of tritium and ^{14}C dating, Problems

Unit III: Surface Chemistry [6L]

Introduction to surface chemistry - some basic terms related to surface chemistry adsorption, adsorption materials, factors affecting adsorption, characteristics of adsorption, types of adsorption, classification of adsorption isotherms, Langmuir adsorption isotherm, Freundlich's adsorption isotherm, BET theory (only introduction), application of adsorption, problems.

References:

1. Principles of Physical Chemistry, S. H. Marron and C. F. Pruton, 6thedn.
2. Essentials of Physical Chemistry, Bahl, Tuli, Revised multicolour edn. 2009
3. Physical Chemistry, G. M. Barrow, Tata McGraw-Hill (2007)
4. University Chemistry, B. H. Mahan, 3rd edn. Narosa (1998)
5. Chemical Thermodynamics, R. P. Rastogi and R.P. Misera
6. Atkin's Physical Chemistry, Peter Atkins, Julio De Paula, Oxford publication. 8thed.
7. Essentials of Nuclear Chemistry, Prof. H.J. Arnikar Fourth edn.
8. Nuclear and Radiochemistry, Friedlander and Kennedy.

Choice Based Credit System Syllabus (2023 Pattern)

(As per NEP 2020)

Class : T.Y.B.Sc. (SEM VI) **Subject** : Chemistry

Course Name : Physical Chemistry-II **Course Code** : CHE-351-MJM

Mapping of Course Outcomes with Program Outcomes

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	2	0	2	3	1	0	1	1	0	1	2	0
CO2	3	3	0	2	3	1	2	2	2	0	1	2	0
CO3	2	3	0	3	3	2	1	2	3	0	2	3	0
CO4	2	3	0	3	3	3	2	2	3	0	2	3	0
CO5	3	2	0	2	3	1	3	2	2	0	3	2	1
CO6	2	3	0	3	3	2	3	2	3	1	3	3	2
CO7	3	3	3	3	3	3	3	3	3	2	3	3	3

Justification for the Mapping

PO1: Comprehensive Knowledge and Understanding

CO1. Explain the working principles of electrochemical cells, differentiating between reversible and irreversible cells.

CO2. Identify and use various reference electrodes (standard hydrogen, calomel, glass electrode) and apply the Nernst equation.

CO5. Calculate nuclear binding energy and mass defect and explain their role in nuclear stability.

CO6. Explain adsorption phenomena and apply Langmuir and Freundlich isotherms.

CO7. Integrate theoretical knowledge of electrochemistry, nuclear chemistry, and surface chemistry for research and industrial applications.

PO2: Practical, Professional, and Procedural Knowledge

CO2. Identify and use reference electrodes for pH determination and emf measurements.

CO3. Perform potentiometric titrations (acid-base, redox, and precipitation) using emf data.

CO4. Operate radioactivity detection instruments (G.M. counter, scintillation counter, ionization chamber

CO6. Apply adsorption isotherms to experimental data for real material systems.

PO3: Entrepreneurial Mindset and Knowledge

CO6. Apply adsorption and surface chemistry principles to industrial adsorption, catalysis, and pollution control.

CO7. Use electrochemical and nuclear chemistry knowledge in innovation and product development (e.g., batteries, sensors, radiotracers).

PO4: Specialized Skills and Competencies
CO1. Explain and interpret electrochemical cell mechanisms and emf measurement methods.
CO3. Perform and interpret potentiometric titration data.
CO4. Operate radioactivity detection instruments and interpret output data.
CO5. Calculate and analyze nuclear binding energy, decay kinetics, and stability relationships.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning
CO1. Apply electrochemical principles to explain emf and equilibrium constants.
CO3. Analyze titration curves to determine unknown concentrations.
CO5. Interpret radioactive decay data and calculate half-life and binding energy.
CO6. Evaluate adsorption data using isotherm equations.
CO7. Solve real-world chemical problems through theoretical and experimental knowledge.

PO6: Communication Skills and Collaboration
CO1. Present electrochemical and nuclear concepts clearly in written and oral formats.
CO3. Collaborate in group-based practical sessions during titration and instrumentation experiments.

PO7: Research-related Skills
CO4. Operate and interpret data from G.M. counters, scintillation counters, and cloud chambers.
CO7. Apply electrochemistry, nuclear, and surface chemistry in research-oriented experiments.

PO8: Learning How to Learn Skills
CO1. Explore new electrochemical methods through self-study.
CO4. Adapt to technological advancements in radioactivity detection.
CO6. Relate adsorption phenomena to current environmental research trends.

PO9: Digital and Technological Skills
CO2. Use digital potentiometers and pH meters for emf measurements.
CO4. Operate radiation counters and interpret electronic readouts.
CO7. Utilize computational tools for analyzing adsorption and decay data.
PO10: Multicultural Competence, Inclusive Spirit, and Empathy
CO7. Apply electrochemical and surface chemistry principles in environmental sustainability and energy-related industries.

PO11: Value Inculcation and Environmental Awareness
CO4. Handle radioactive substances ethically and safely in laboratory settings.
CO6. Apply adsorption processes for environmental remediation and pollution control.

PO12: Autonomy, Responsibility, and Accountability
CO3. Conduct potentiometric titrations independently with accuracy and precision.
CO4. Manage radioactive measurements with accountability and adherence to safety norms.
CO7. Execute analytical projects responsibly from data collection to result interpretation

PO13: Community Engagement and Service

CO6. Demonstrate applications of adsorption and catalysis in pollution control and clean energy.

CO7. Relate nuclear and electrochemical studies to community welfare, healthcare, and sustainability.

CBCS Syllabus as per NEP 2020 for T.Y.B.Sc. (2023 Pattern)

Name of the Programme	: B.Sc. Chemistry
Program Code	: USCH
Class	: T.Y.B.Sc.
Semester	: VI
Course Type	: Major Mandatory Theory
Course Name	: Inorganic Chemistry-II
Course Code	: CHE-352-MJM
No. of Lectures	: 30
No. of Credits	: 2 credits

Course Objectives:

1. To introduce the students to the chemistry of f-block elements**,** including their position, electronic configuration, oxidation states, separation methods, and applications.
2. To explain the lanthanide contraction and its effect on post-lanthanide chemistry and the comparison between lanthanides and actinides.
3. To develop understanding of nuclear fuels and methods of synthesis of transuranic and super heavy elements**.**
4. To impart knowledge of metallic bonding**,** band theory, and the factors influencing the electrical conductivity of metals.
5. To understand the basic concepts, types, and applications of semiconductors and superconductors**.**
6. To provide knowledge of the principles, types, and examples of homogeneous and heterogeneous catalysisin organic and industrial reactions.
7. To introduce the fundamentals of bioinorganic chemistry and explain the role of metals in enzymatic and non-enzymatic biological processes.
8. To enhance problem-solving and application skills through numerical problems, case studies, and modern applications in catalysis, materials, and bioinorganic systems.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Explain the position, electronic configuration, occurrence, oxidation states, and separation methods of lanthanides and actinides.

CO2: Analyze the concept of lanthanide contraction and its effects on chemical and physical properties of elements.

CO3: Discuss and differentiate between the chemistry of lanthanides and actinides, including nuclear fuel cycles and synthesis of transuranic elements.

CO4: Apply band theory to explain metallic bonding and electrical conductivity in metals, semiconductors, and superconductors.

CO5: Interpret the effect of temperature and impurities on conductivity and classify materials as conductors, semiconductors, or superconductors.
CO6: Illustrate **t**he mechanism and applications of homogeneous catalysis (Wilkinson's, Ziegler–Natta, Monsanto acetic acid synthesis).
CO7: Evaluate heterogeneous catalytic processes (oxidation, reduction, cyclization, biodiesel synthesis) and their industrial importance.
CO8: Explain the role of essential metal ions in biological systems, both enzymatic (Cu, Zn, Fe) and non-enzymatic (Na, K, Ca, Mg).

Topics and Learning points

Unit 1:Chemistryoff-blockelements (08L)

Introduction of f-block elements- on the basis of electronic configurations, occurrence and reactivity, f-block elements as Lanthanide and Actinide series

A) **Lanthanides**

Position in periodic table, Name and electronic configuration of lanthanides, Oxidation States, Occurrence and separation (Group/ Individual) by modern methods (ion exchange and solvent extraction method), Lanthanide contraction & its effect on chemistry of Lanthanides and post lanthanide elements, applications of lanthanides

B) **Actinides**

Position in periodic table, Name and electronic Configuration of actinides, Oxidation States, Occurrence, and general methods of preparation of transuranic elements [viz.,a) Neutron Bombardment, b) Accelerated projectile bombardment and c) Heavy ion bombardment], Nuclear Fuels-Nuclear Fusion fuels& nuclear fission fuels, IUPAC nomenclature system for super heavyelements with atomic no. (z) greater than100, Comparison between Lanthanides and Actinides.
Ref. 2 Pg.859-863, 865-866, 874–875, 879-886, 891-893, 898-900

Unit 2 :Metals, Semiconductors and Superconductors (08L)

Introduction, Metallic bonding, Band theory in metals with respect to Na along with n € and N€ diagrams, Electrical conductivity of metals (Na, Mg, Al), Valence electrons and conductivity of metals, Effect of temperature and impurity on electrical conductivity of metals, Semiconductors – types of Semiconductors: I. Intrinsic II. Extrinsic, effect of temperature and impurity on semi conductivity, N type semiconductors ZnO and NiO, Super conductivity- Discovery, Property, Models structure and super conductivity, Applications of super conductors. Ref.6, Ref.7 Pg.209-221,

Unit 3: Homogeneous Catalysis (04L)

Definition, types of homogeneous catalysts, Essential properties of homogeneous catalysts, Catalytic Reactions such as:

A. Wilkinson's Catalysis

B. Zeigler Natta Catalysis
C. Monsantoacetic acid synthesis

Ref.3, Ref.6, Ref. 13 Pg.650-652 and 656-661

Unit4: Heterogeneous Catalysis (05L)

Definition, types of heterogeneous catalysts-metals, semiconductors, solid acid catalysts and supported catalysts, Essential properties of heterogeneous catalysts, Catalytic Reactions such as:

A. Oxidation-i. Synthesis of terephthalic acid from xylene using ZSM-5 ii) Synthesis of benzoic acid from toluene using $KMnO_4$
B. Reduction-i) Hydrogenation of alkene to alkane using Raney Ni- catalyst. ii) Synthesis of p-aminophenol from nitrobenzene using Pd /C catalyst.
C. Cyclization-i. Benzimidazole synthesis using o-phenene diamine and benzaldehyde by acidic support or clay-solid support, amber list or NH4Cl.
D. Biodiesel Synthesis-using heteropolyacid catalyst- Trans esterification using phosphomolybdic or phosphotungstic acid.

Ref.5, Ref.11, Ref.13

Unit5: BioinorganicChemistry (05L)

Introduction, Role of metals in bioinorganic chemistry-

a. Classification as enzymatic and non-enzymatic metals, Enzymatic redox metals such as Cu(SOD)and enzymatic nonredoxmetals such as Zn(Hydrolase).
b. Role of metal ions in non-enzymatic process- Na, K, Ca, Mg (one example of each and brief discussion).
c. Role of metals in enzymatic Processes-Transition metals- Catalase, peroxidase and nitrogenase (Redox active).
d. Metalloproteinase-Iron Proteins-Introduction of Fe-S proteins, Electron transfer proteins (Fe- S, Fe_2S_2, Fe_3S_4, Fe_4S_4).Transport protein (transferrin) and Storage protein (ferritin)III. Bioinorganic Chemistry of Fe: Hemoglobin and myoglobin, its structure and functions. IV. Bioinorganic Chemistry of Co: Vitamin-B12, its structure and function.

Ref.3 Pg.782-806, Ref.2Pg.353, 775, 779, 796-797, Ref.1 2 Pg.1-13, 24, 285

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. Longford ELBS–2nd edition.
4. Basic Inorganic Chemistry,- F. A. Cottonand G. Wilkinson, Wiley Eastern Ltd 1992.
5. Concepts and Model of Inorganic Chemistry by Douglas–McDaniels–3rd edition.
6. Chemistry by Raymond Chang–5th edition
7. New Guides to Modern Valence Theory by G.I.Brown–3rd edition
8. Co-ordination Compounds by Baselo and Pearson
9. Theoretical Inorganic Chemistry by Dayand Selbin
10. Inorganic Chemistry by A.G.Sharpe–3rdEdition
11. Heterogeneous Catalysis by D.K Chakraborty and B. Vishwanathan, New Age Int. Publishers, 1st edition.
12. Principles of Bioinorganic Chemistry by S. J. Lippardand J. M. Berg, Panima Publishing Corporation, 1st Edn.
13. Inorganic Chemistry by J. E. Huhey, 4th edn, Pearson Education.

Choice Based Credit System Syllabus (2023 Pattern)

(As per NEP 2020)

Class : T.Y.B.Sc.(SEM VI) **Subject** : Chemistry

Course Name : Inorganic Chemistry-II **Course Code** : CHE-352-MJM

Mapping of Course Outcomes with Program Outcomes

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	2	0	2	2	0	0	0	0	0	0	0	0
CO2	3	2	0	2	3	0	0	0	0	0	0	0	0
CO3	3	1	0	2	3	0	2	0	0	0	2	0	0
CO4	2	3	0	3	3	0	0	0	2	0	0	0	0
CO5	3	3	0	2	3	0	0	2	2	0	0	0	0
CO6	3	3	2	3	3	2	0	0	0	0	0	0	0
CO7	3	3	2	3	3	0	2	0	0	1	3	2	3

Justification for the Mapping

PO1: Comprehensive Knowledge and Understanding

CO1. Explainthe position, electronic configuration, occurrence, oxidation states, and separation methods of lanthanides and actinides.

CO2. Analyze the concept of lanthanide contraction and its effects on chemical and physical properties of elements.

CO3. Discuss and differentiate between the chemistry of lanthanides and actinides, including nuclear fuel cycles and synthesis of transuranic elements.

CO4. Apply band theory to explain metallic bonding and electrical conductivity in metals, semiconductors, and superconductors.

CO5. Interpret the effect of temperature and impurities on conductivity and classify materials as conductors, semiconductors, or superconductors.

CO6. Illustrate the mechanism and applications of homogeneous catalysis (Wilkinson's, Ziegler–Natta, Monsanto acetic acid synthesis).

CO7. Evaluate heterogeneous catalytic processes (oxidation, reduction, cyclization, biodiesel synthesis) and their industrial importance.

PO2: Practical, Professional, and Procedural Knowledge

CO1. Explain the position, electronic configuration, occurrence, oxidation states, and separation methods of lanthanides and actinides.

CO3. Discuss and differentiate between the chemistry of lanthanides and actinides, including nuclear fuel cycles and synthesis of transuranic elements.
CO4. Apply band theory to explain metallic bonding and electrical conductivity in metals, semiconductors, and superconductors.
CO5. Interpret the effect of temperature and impurities on conductivity and classify materials as conductors, semiconductors, or superconductors.
CO6. Illustratethe mechanism and applications of homogeneous catalysis (Wilkinson's, Ziegler–Natta, Monsanto acetic acid synthesis).
CO7. Evaluate heterogeneous catalytic processes (oxidation, reduction, cyclization, biodiesel synthesis) and their industrial importance.

PO3: Entrepreneurial Mindset and Knowledge
CO6. Illustratethe mechanism and applications of homogeneous catalysis (Wilkinson's, Ziegler–Natta, Monsanto acetic acid synthesis).
CO7. Evaluate heterogeneous catalytic processes (oxidation, reduction, cyclization, biodiesel synthesis) and their industrial importance.

PO4: Specialized Skills and Competencies
CO1. Explain the position, electronic configuration, occurrence, oxidation states, and separation methods of lanthanides and actinides.
CO2. Analyze the concept of lanthanide contraction and its effects on chemical and physical properties of elements.
CO3. Discuss and differentiate between the chemistry of lanthanides and actinides, including nuclear fuel cycles and synthesis of transuranic elements.
CO4. Apply band theory to explain metallic bonding and electrical conductivity in metals, semiconductors, and superconductors.
CO5. Interpret the effect of temperature and impurities on conductivity and classify materials as conductors, semiconductors, or superconductors.
CO6. Illustrate the mechanism and applications of homogeneous catalysis (Wilkinson's, Ziegler–Natta, Monsanto acetic acid synthesis).
CO7. Evaluate heterogeneous catalytic processes (oxidation, reduction, cyclization, biodiesel synthesis) and their industrial importance.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning
CO1. Explain the position, electronic configuration, occurrence, oxidation states, and separation methods of lanthanides and actinides.
CO2. Analyze the concept of lanthanide contraction and its effects on chemical and physical properties of elements.
CO3. Discuss and differentiate between the chemistry of lanthanides and actinides, including nuclear fuel cycles and synthesis of transuranic elements.
CO4. Apply band theory to explain metallic bonding and electrical conductivity in metals, semiconductors, and superconductors.
CO5. Interpret the effect of temperature and impurities on conductivity and classify materials as conductors, semiconductors, or superconductors.

CO6. Illustrate the mechanism and applications of homogeneous catalysis (Wilkinson's, Ziegler–Natta, Monsanto acetic acid synthesis).
CO7. Evaluate heterogeneous catalytic processes (oxidation, reduction, cyclization, biodiesel synthesis) and their industrial importance.

PO6: Communication Skills and Collaboration
CO1. Explainthe position, electronic configuration, occurrence, oxidation states, and separation methods of lanthanides and actinides.

PO7: Research-related Skills
CO3. Discuss and differentiate between the chemistry of lanthanides and actinides, including nuclear fuel cycles and synthesis of transuranic elements.
CO7. Evaluate heterogeneous catalytic processes (oxidation, reduction, cyclization, biodiesel synthesis) and their industrial importance.

PO8: Learning How to Learn Skills
CO3. Discuss and differentiate between the chemistry of lanthanides and actinides, including nuclear fuel cycles and synthesis of transuranic elements.
CO4. Apply band theory to explain metallic bonding and electrical conductivity in metals, semiconductors, and superconductors.
CO5. Interpretthe effect of temperature and impurities on conductivity and classify materials as conductors, semiconductors, or superconductors.

PO9: Digital and Technological Skills
CO4. Apply band theory to explain metallic bonding and electrical conductivity in metals, semiconductors, and superconductors.
CO5**.** Interpretthe effect of temperature and impurities on conductivity and classify materials as conductors, semiconductors, or superconductors.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy
CO7. Evaluate heterogeneous catalytic processes (oxidation, reduction, cyclization, biodiesel synthesis) and their industrial importance.

PO11: Value Inculcation and Environmental Awareness
CO3. Discuss and differentiate between the chemistry of lanthanides and actinides, including nuclear fuel cycles and synthesis of transuranic elements.
CO7. Evaluateheterogeneous catalytic processes (oxidation, reduction, cyclization, biodiesel synthesis) and their industrial importance.

PO12: Autonomy, Responsibility, and Accountability
CO3. Discuss and differentiate between the chemistry of lanthanides and actinides, including nuclear fuel cycles and synthesis of transuranic elements.
CO7. Evaluate heterogeneous catalytic processes (oxidation, reduction, cyclization, biodiesel synthesis) and their industrial importance.

PO13: Community Engagement and Service
CO7. Evaluate heterogeneous catalytic processes (oxidation, reduction, cyclization, biodiesel synthesis) and their industrial importance.

CBCS Syllabus as per NEP 2020 for T.Y.B.Sc. (2023 Pattern)

Name of the Programme	: B.Sc. Chemistry
Program Code	: USCH
Class	: T.Y.B.Sc.
Semester	: VI
Course Type	: Major Mandatory Theory
Course Name	: Organic Chemistry -II
Course Code	: CHE-353-MJM
No. of Lectures	: 30
No. of Credits	: 2 credits

Course Objectives:

Understand the concept and principles of retrosynthetic analysis.

1. Apply the principles of disconnection to solve synthetic challenges.
2. Study various types of rearrangement.
3. Understand the mechanisms and the factors influencing rearrangement reactions.
4. Understand the principles of UV spectroscopy and its role in determining the electronic structure of molecules.
5. Identify functional groups that exhibit characteristic UV absorption.
6. Understand the principles and working of IR spectroscopy.
7. Learn to interpret IR spectra and identify functional groups based on characteristic absorption frequencies.
8. Understand the principles of NMR spectroscopy and its application in structure determination.
9. Identify functional groups and their associated NMR signals.

Course Outcomes:

CO1: Understand and explain various types of rearrangement reactions and their mechanisms.

CO2: Apply knowledge of rearrangement reactions to solve synthetic challenges.

CO3: Understand principles and perform retrosynthetic analysis of organic molecules.

CO4: Understand and interpret UV-Visible spectroscopy, including functional groups and conjugation.

CO5: Understand and interpret IR spectroscopy for identification of functional groups.

CO6: Understand and interpret H^1 NMR spectroscopy, including chemical shifts and coupling constants.

CO7: Solve combined problems integrating UV, IR, and NMR spectroscopy for structural elucidation.

Topics and Learning points

Unit-1: **Rearrangement Reactions** **[05 L]**

Introduction, Types of rearrangement, Types of reactive intermediate involved in different rearrangements, Rearrangement – Beckmann, Baeyer-Villiger, Favorskii, Curtius, Lossen, Schmidt and Pinacol-Pinacolone with mechanism. Electrocyclic Rearrangements- Claisen, Cope and Mc-Lafferty rearrangements with mechanism. Ref.4, 5

Unit-2: **Retrosynthetic analysis** **[03 L]**

Introduction, Different terms used – Disconnection, Synthons, Synthetic equivalence, FGI, Tm. One group disconnection, Retrosynthesis and Synthesis of target molecules: Acetophenone, Crotonaldehyde, Cyclohexene, Benzyl benzoate, and Benzyl diethyl malonate. Ref. 1, 2

Unit-3 : Spectroscopy

Introduction to Spectroscopy **[02 L]**

Introduction, meaning of spectroscopy, types of spectroscopy, nature of electromagnetic radiation and regions of electromagnetic spectrum, Terms used in spectroscopy; wavelength, amplitude, frequency, wavenumber, energy and their relations and conversions.
Ref 6

Ultra Violet and Visible Spectroscopy **[05 L]**

Introduction, Electromagnetic radiations, electronic transitions, λ_{max} & ε_{max}, chromophore, auxochrome, bathochromic and hypochromic shifts, Application of visible, ultraviolet spectroscopy in organic molecules. Woodward rules for calculating λ_{max} of conjugated dienes and α, β – unsaturated compounds. Ref. 6

Infra-Red Spectroscopy **[06 L]**

Introduction, Infra red radiation and types of molecular vibrations, functional group and finger print region. Infra-red spectroscopy in organic molecules, IR spectra of alkanes, alkenes and simple alcohols (inter and intramolecular hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on >C=O stretching absorptions). Ref. 6

Nuclear Magnetic Resonance Spectroscopy (NMR) **[05 L]**

Introduction, Principles, Magnetic and non magnetic nuclei, nuclear resonance, chemical shift, shielding, & deshielding effect. Measurement of chemical shift, TMS as reference and its advantages, peak area, integration, spin-spin coupling, coupling constants, J-value , problems based on NMR Ref. 6

Unit 4: Combined Problems **[04 L]**

Based on U.V, I.R. and NMR Spectroscopy

References:

1. Designing Organic Synthesis by Stuart Warren 1983.
2. Organic Chemistry by Clayden, Greeves, Warren and Wothers. Second edition.
3. Organic Chemistry by Morrison and Boyd. VI Edn.
4. S. N. Sanyal: Reactions, Rearrangements and Reagents.
5. Jagdamba Singh, Jaya Singh: Photochemistry and Pericyclic reactions, 3rd edition.
6. Pavia D.L.; Lampman G.M. Kriz G. S.; Vyvyan J.R. Spectroscopy, First Indian Reprint 2008: Brooks/Cole CENGAGE Learning.

Choice Based Credit System Syllabus (2023 Pattern)

(As per NEP 2020)

Class : T.Y.B.Sc.(SEM VI) **Subject** : Chemistry

Course Name : Organic Chemistry-II **Course Code** : CHE-353-MJM

Mapping of Course Outcomes with Program Outcomes

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	3	1	3	3	1	2	2	1	1	2	3	1
CO2	3	3	1	3	3	1	2	2	1	1	2	3	1
CO3	3	3	3	3	3	2	2	2	2	2	2	3	2
CO4	3	3	3	3	3	2	2	2	2	2	2	3	2
CO5	3	3	3	3	3	2	2	2	2	2	2	3	3
CO6	3	3	2	3	3	1	3	2	3	1	2	3	1
CO7	3	3	2	3	3	1	3	2	3	1	2	3	1
CO8	3	3	2	3	3	1	3	2	3	1	2	3	1
CO9	3	3	2	3	3	2	3	3	3	1	2	3	1

Justification of the Mapping

PO1: Comprehensive Knowledge and Understanding

CO1, CO2: Students will understand the concept, types, and mechanisms of rearrangement reactions.

CO3, CO4, CO5: Students will apply retrosynthetic analysis principles to solve synthetic challenges.

CO6, CO7, CO8, CO9: Students will understand the principles of UV, IR, and NMR spectroscopy and their application in molecular structure determination.

PO2: Practical, Professional, and Procedural Knowledge

CO1, CO2: Students will perform analysis of rearrangement reactions and understand reaction pathways.

CO3, CO4, CO5: Students will design synthetic routes using retrosynthetic analysis.

CO6, CO7, CO8, CO9: Students will interpret spectroscopic data for functional group identification and molecular structure analysis.

PO3: Entrepreneurial Mindset and Knowledge

CO3, CO4, CO5: Students will gain skills to design novel synthetic strategies and potential application in chemical industries.

PO4: Specialized Skills and Competencies

CO1, CO2: Students will demonstrate understanding of reaction mechanisms and intermediate behaviour.

CO6, CO7, CO8, CO9: Students will develop analytical and interpretative skills in spectroscopy, enhancing problem-solving and technical competencies.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning
CO1–CO9: Students will apply theoretical knowledge of organic reactions and spectroscopy to solve complex chemical problems and structure determination.

PO6: Communication Skills and Collaboration
CO3, CO4, CO5: Students will communicate synthetic plans, retrosynthetic routes, and analysis results in group discussions or reports.

PO7: Research-related Skills
CO6, CO7, CO8, CO9: Students will collect, analyze, and interpret spectroscopic data, improving research skills and critical analysis.

PO8: Learning How to Learn Skills
CO1–CO9: Students will develop self-directed learning skills in organic synthesis and spectroscopy for independent problem-solving.

PO9: Digital and Technological Skills
CO6, CO7, CO8, CO9: Students will use computational tools and software for spectral analysis, simulation, and visualization.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy
CO3, CO4, CO5: Understanding synthetic strategies and their relevance in global chemical industries promotes multicultural awareness.

PO11: Value Inculcation and Environmental Awareness
CO1, CO2, CO5: Understanding safe chemical practices, reaction hazards, and sustainable synthetic approaches.

PO12: Autonomy, Responsibility, and Accountability
CO1–CO9: Students will independently solve synthetic and spectroscopic problems, demonstrating accountability in analytical and experimental tasks.

PO13: Community Engagement and Service
CO5: Application of knowledge in real-world chemical or industrial problem-solving contributes to societal benefit.

CBCS Syllabus as per NEP 2020 for T.Y.B.Sc. (2023 Pattern)

Name of the Programme	: B.Sc. Chemistry
Program Code	: USCH
Class	: T.Y.B.Sc.
Semester	: VI
Course Type	: Major Mandatory Theory
Course Name	: Analytical Chemistry-II
Course Code	: CHE-354-MJM
No. of Lectures	: 30
No. of Credits	: 2 credits

Course Objectives:

The course intends to:

1. Provide knowledge of the principles and theory underlying modern separation techniques such as solvent extraction, chromatography, gas chromatography, and electrophoresis.
2. Familiarize students with distribution laws, separation factors, and efficiency concepts in solvent extraction.
3. Introduce the classification, theoretical concepts, and applications of various chromatographic methods.
4. Develop understanding of instrumentation and working mechanisms of gas chromatography.
5. Illustrate the separation mechanisms in GSC, GLC, and their qualitative–quantitative analytical importance.
6. Impart knowledge of different electrophoresis techniques and their applications in analytical chemistry.
7. Enable students to solve numerical problems related to distribution ratios, separation efficiency, and chromatographic parameters.
8. Develop the ability to apply separation techniques to real-world analytical, industrial, biological, and pharmaceutical problems.

Course Outcomes:

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

CO1: Explain the principles of solvent extraction, chromatography, gas chromatography, and electrophoresis.

CO2: Calculate distribution coefficients, distribution ratios, and % extraction for solvent extraction systems.

CO3: Differentiate between chromatographic techniques (Column, TLC, Paper, Ion Exchange) and evaluate their applications.

CO4: Describe the concept of theoretical plates and column efficiency in chromatography.

CO5: Interpret chromatograms and carry out qualitative and quantitative analysis using gas chromatography.
CO6: Understand instrumentation and working of GSC and GLC systems.
CO7: Apply electrophoresis techniques (paper, gel, cellulose acetate) in separation of biomolecules.
CO8: Relate separation techniques to industrial, environmental, and pharmaceutical applications, strengthening problem-solving ability in analytical chemistry.

Topics and Learning points

Unit 1: Solvent Extraction (10 L)

Introduction, Principle of solvent extraction, Distribution coefficient, distribution ratio, Relation between Distribution coefficient and distribution ratio, factors affecting solvent extraction, percentage extracted, solvent extraction method, separation factor, batch extraction, counter current extraction, application of solvent extraction, numerical problems.
Ref:3, 4, 7, 9 relevant pages**.**

Unit 2: Introduction to Chromatography (10 L)

Introduction and classification of chromatographic methods, Principle of chromatographic analysis with match box model, Theoretical plates and column efficiency, Theory, Principle, technique and applications of-Column Chromatography, Ion exchange Chromatography, Thin layer Chromatography, Paper Chromatography, Numerical Problems
Ref.1-8 Relevant pages

Unit 3:Gas Chromatography (06L)

Introduction, Theory, Principle, GSC and GLC, Separation mechanism involved in GSC and GLC, Instrumentation of Gas chromatography, Working of gas chromatography, Gas chromatogram and Qualitative-quantitative analysis, Applications of gas chromatography
Ref.1. Pg.167-174, Ref.4. Pg.454-464, Ref.5 Pg.624-640

Unit 4:Electrophoresis (04 L)

Introduction, Principle and theory of electrophoresis, Different types of electrophoresis techniques, Moving Boundary Electrophoresis, Zone electrophoresis-Paper, Cellulose acetate and Gel electrophoresis, of electrophoresis
Ref.3 and Ref.4 relevant pages

References:

1. Text book o f Quantitative Chemical Analysis-3rd Edition, A. I. Vogel
2. Principles of Physical Chemistry 4thedition–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-4th edition Besset Denney, Jaffrey, Mendham
6. Instrumental Methods of Chemical Analysis-6th edition, Willard, Merritt, Dean and Settle
7. Analytical Chemistry by Skoog
8. Introduction to Instrumental Analysis- R. D.Braun Instrumental methods of Chemical Analysis-Willard, Dean & Merrit-6thEdition

Choice Based Credit System Syllabus (2023 Pattern)

(As per NEP 2020)

Class : T.Y.B.Sc.(SEM VI) **Subject** : Chemistry

Course Name : Analytical Chemistry-II **Course Code** : CHE-354-MJM

Mapping of Course Outcomes with Program Outcomes

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	2	1	2	2	1	1	2	1	1	2	2	1
CO2	2	3	1	2	3	1	2	2	2	1	2	2	1
CO3	3	2	1	3	3	2	2	2	1	1	2	2	1
CO4	3	2	1	3	3	2	2	2	2	1	2	2	1
CO5	3	3	1	3	3	2	3	2	3	1	2	2	1
CO6	3	3	1	3	2	1	2	2	3	1	2	2	1
CO7	2	3	1	3	3	2	3	2	2	1	2	2	2
CO8	2	3	2	3	3	3	3	3	3	2	3	3	3

Justification of the mapping

PO1: Comprehensive Knowledge and Understanding

CO1: Explaining the working principles of electrochemical cells and differentiating reversible and irreversible cells enhances conceptual understanding of electrochemistry.

CO2: Identifying and using various reference electrodes and applying the Nernst equation develops in-depth theoretical knowledge of electrochemical measurements.

CO5: Calculating nuclear binding energy and mass defect deepens understanding of nuclear stability and underlying principles.

CO6: Explaining adsorption phenomena and applying Langmuir and Freundlich isotherms strengthens comprehension of surface chemistry theories.

CO7: Integrating electrochemistry, nuclear chemistry, and surface chemistry for research and industrial applications demonstrates multidisciplinary knowledge.

PO2: Practical, Professional, and Procedural Knowledge

CO2: Using reference electrodes for pH determination and emf measurements develops hands-on experimental skills.

CO3: Performing potentiometric titrations (acid-base, redox, precipitation) enhances procedural competency in analytical chemistry.

CO4: Operating radioactivity detection instruments builds practical skills in instrumentation and measurement.

CO6: Applying adsorption isotherms to experimental data demonstrates professional application of theory to real systems.

PO3: Entrepreneurial Mind-set and Knowledge

CO6: Applying adsorption and surface chemistry in industrial adsorption, catalysis, and pollution control fosters innovation and entrepreneurship.

CO7: Using electrochemical and nuclear chemistry knowledge for product development (e.g., batteries, sensors, radiotracers) encourages innovative thinking and commercialization.

PO4: Specialized Skills and Competencies

CO1: Explaining and interpreting electrochemical cell mechanisms and emf measurement methods develops specialized analytical skills.

CO3: Performing and interpreting potentiometric titration data enhances technical proficiency.

CO4: Operating radioactivity detection instruments and interpreting output data demonstrates specialized instrumentation skills.

CO5: Calculating and analyzing nuclear binding energy, decay kinetics, and stability relationships strengthens problem-solving and analytical competence.

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

CO1: Applying electrochemical principles to explain emf and equilibrium constants develops problem-solving ability.

CO3: Analysing titration curves to determine unknown concentrations strengthens analytical reasoning.

CO5: Interpreting radioactive decay data and calculating half-life and binding energy enhances data analysis skills.

CO6: Evaluating adsorption data using isotherm equations builds applied analytical capability.

CO7: Solving real-world chemical problems through integrated theoretical and experimental knowledge demonstrates practical problem-solving.

PO6: Communication Skills and Collaboration

CO1: Presenting electrochemical and nuclear concepts clearly in written and oral formats improves scientific communication.

CO3: Collaborating in group-based practical sessions during titration and instrumentation experiments develops teamwork and cooperative skills.

PO7: Research-related Skills

CO4: Operating and interpreting data from G.M. counters, scintillation counters, and cloud chambers develops research and data analysis skills.

CO7: Applying electrochemistry, nuclear chemistry, and surface chemistry in research-oriented experiments strengthens inquiry and experimental design skills.

PO8: Learning How to Learn Skills

CO1: Exploring new electrochemical methods independently encourages self-directed learning.

CO4: Adapting to technological advancements in radioactivity detection demonstrates learning agility.

CO6: Relating adsorption phenomena to current environmental research trends promotes continuous learning and adaptability.

PO9: Digital and Technological Skills

CO2: Using digital potentiometers and pH meters for emf measurements develops technological proficiency.

CO4: Operating radiation counters and interpreting electronic readouts strengthens digital competency.

CO7: Utilizing computational tools for analyzing adsorption and decay data enhances technological skills.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

CO7: Applying electrochemical and surface chemistry principles in sustainability and energy-related industries fosters environmental empathy and societal responsibility.

PO11: Value Inculcation and Environmental Awareness

CO4: Handling radioactive substances ethically and safely in laboratory settings promotes ethical practice.

CO6: Applying adsorption processes for environmental remediation and pollution control strengthens environmental awareness.

PO12: Autonomy, Responsibility, and Accountability

CO3: Conducting potentiometric titrations independently enhances accountability and precision.

CO4: Managing radioactive measurements responsibly ensures adherence to safety norms.

CO7: Executing analytical projects from data collection to interpretation demonstrates autonomy and responsibility.

PO13: Community Engagement and Service

CO6: Demonstrating applications of adsorption and catalysis in pollution control and clean energy benefits the community.

CO7: Relating nuclear and electrochemical studies to healthcare, energy, and sustainability supports societal welfare and service.

CBCS Syllabus as per NEP 2020 for T.Y.B.Sc. (2023 Pattern)

Name of the Programme	: B.Sc. Chemistry
Program Code	: USCH
Class	: T.Y.B.Sc.
Semester	: VI
Course Type	: Practical Major
Course Name	: Chemistry Practical-VI
Course Code	: CHE-355-MJM
No. of Lectures	: 60
No. of Credits	: 2 credits

Course Objectives:

To develop experimental skills for studying adsorption phenomena and validating adsorption isotherms (Freundlich/Langmuir).

1. To understand the kinetics of chemical reactions by determining the rate constant of hydrogen peroxide decomposition.
2. To study redox reactions through potentiometric measurement of electrode potentials.
3. To apply potentiometry for determination of acid mixtures and ionic concentrations.
4. To gain hands-on experience with electroanalytical techniques such as potentiometric titrations.
5. To introduce the principles and operation of Geiger–Müller (G.M.) counters used in radioactivity measurements.
6. To study the plateau voltage and resolving time of G.M. counter to understand detection efficiency.
7. To identify inorganic cations systematically through qualitative analysis of simple mixtures.
8. To separate cations using column chromatography and understand the principles of adsorption and ion-exchange separation techniques.
9. To develop competency in handling chemical reactions with emphasis on laboratory safety and green chemistry practices.
10. To train students in analytical chemistry skills through quantitative estimation of organic compoundsand evaluation of fundamental properties such as the molecular weight of dibasic acids.

Course Outcomes:

After successful completion of this course, students will be able to:
Demonstrate adsorption of solutes on activated charcoal andverify adsorption isotherms experimentally.

CO1: Determine the first-order rate constant for decomposition of hydrogen peroxide and interpret reaction kinetics data.

CO2: Measure and analyze the formal redox potential of Fe^{2+}/Fe^{3+} systems using potentiometric methods.

CO3: Estimate the concentrations of strong and weak acids in a mixture using potentiometric titration techniques.

CO4: Determine the amount of NaCl present in a given solution by potentiometric titration against $AgNO_3$.

CO5: Operate a Geiger–Müller counter and evaluate its plateau voltage and resolving time.

CO6: Identify the cations present in simple inorganic mixtures by qualitative analysis without phosphate and borate.

CO7: Separate binary cation mixtures using column chromatography and explain the principle of chromatographic separation.

Topics and Learning points

Unit 1: Physical Chemistry Practical (Any 05)

1. To investigate the adsorption of oxalic acid /acetic acid by activated charcoal and test the validity of Freundlich / Langmuir isotherm.
2. To determine the first order velocity constant of the decomposition of hydrogen peroxide by volume determination of oxygen.
3. To determine the formal redox potential of Fe^{2+}/ Fe^{3+} system potentriometrically.
4. To determine the concentrations of strong acid and weak acid present in the mixture by titrating with strong base using potentiometry
5. To determine the amount of NaCl in the given solution by potentiometric titration against silver nitrate.
6. To determine plateau voltage of the given G M counter.
7. To determine the resolving time of GM counter.

Unit 2: Inorganic Chemistry Practical

Inorganic Qualitative Analysis. (04 Mixtures)

1. Inorganic qualitative Analysis. (With interfering radicals))

Column Chromatography (02 Mixtures)

2. To separate cations of a given binary mixture by column chromatography using Cellulose

Unit 3: Organic Chemistry Practical

Preparation (any two)

1. Preparation of adipic acid from cyclohexanone
2. Preparation of p-nitro acetanilide from acetanilide
3. Preparation of p-bromo acetanilide from acetanilide
4. Preparation of paracetamol from p-hydroxy aniline

Estimations

1. Estimation of acetamide
2. Determination of molecular weight of dibasic acid

3. Report on industrial visit: To prepare a report on the study physical properties Observed in industries.

References:

1. V. V. Agarwal, K. S. Thakur, and P. N. Kapur, *Experimental Physical Chemistry*, New Age International Publishers.
2. J. B. Yadav**,** *Advanced Practical Physical Chemistry*, Goel Publishing House, Meerut.
3. Gurtu and Gurtu, *Advanced Physical Chemistry Experiments*, Pragati Prakashan, Meerut.
4. C. N. R. Rao, *University General Chemistry Laboratory Manual*, Macmillan India.
5. P. W. Atkins and J. de Paula**,** *Atkins' Physical Chemistry*, Oxford University Press (for theory reference).
6. B. P. Levitt**,** *Findlay's Practical Physical Chemistry*, Longman.
7. R. C. Das and B. Behera, *Experimental Physical Chemistry*, Tata McGraw Hill.
8. G. D. Christian, *Analytical Chemistry*, Wiley India (for potentiometric and pH-metric methods).
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Choice Based Credit System Syllabus (2023 Pattern)

(As per NEP 2020)

Class : T.Y.B.Sc.(SEM VI) **Subject** : Chemistry

Course Name : Chemistry Practical -VI **Course Code** : CHE-355-MJM

Mapping of Course Outcomes with Program Outcomes

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	3	0	3	3	0	2	0	2	0	0	0	0
CO2	3	3	0	3	3	0	2	0	2	0	0	0	0
CO3	3	3	0	3	3	0	0	0	2	0	0	0	0
CO4	3	3	0	3	3	0	0	0	2	0	0	0	0
CO5	3	2	0	3	3	0	2	0	3	0	2	2	0
CO6	3	3	0	3	3	0	2	0	0	0	2	2	3
CO7	3	3	2	3	3	0	2	0	2	0	3	2	3

Justification of the Mapping

PO1: Comprehensive Knowledge and Understanding

CO1.Determine the first-order rate constant for decomposition of hydrogen peroxide and interpret reaction kinetics data.

CO2. Measure and analyze the formal redox potential of Fe^{2+}/Fe^{3+} systems using potentiometric methods.

CO3.Estimate the concentrations of strong and weak acids in a mixture using potentiometric titration techniques.

CO4. Determine the amount of NaCl present in a given solution by potentiometric titration against $AgNO_3$.

CO5.Operate a Geiger–Müller counter and evaluate its plateau voltage and resolving time.

CO6.Identify the cations present in simple inorganic mixtures by qualitative analysis without phosphate and borate.

CO7. Separate binary cation mixtures using column chromatography and explain the principle of chromatographic separation.

PO2: Practical, Professional, and Procedural Knowledge

CO1.Determine the first-order rate constant for decomposition of hydrogen peroxide and interpret reaction kinetics data.

CO2. Measure and analyze the formal redox potential of Fe^{2+}/Fe^{3+} systems using potentiometric methods.

CO3. Estimate the concentrations of strong and weak acids in a mixture using potentiometric titration techniques.

CO4. Determine the amount of NaCl present in a given solution by potentiometric titration against $AgNO_3$.
CO5. Operate a Geiger–Müller counter and evaluate its plateau voltage and resolving time.
CO6. Identify the cations present in simple inorganic mixtures by qualitative analysis without phosphate and borate.
CO7.Separate binary cation mixtures using column chromatography and explain the principle of chromatographic separation.

PO3: Entrepreneurial Mindset and Knowledge

CO1.Determine the first-order rate constant for decomposition of hydrogen peroxide and interpret reaction kinetics data.
CO2.Measure and analyze the formal redox potential of Fe^{2+}/Fe^{3+} systems using potentiometric methods.
CO3.Estimate the concentrations of strong and weak acids in a mixture using potentiometric titration techniques.
CO4.Determine the amount of NaCl present in a given solution by potentiometric titration against $AgNO_3$.
CO5.Operate a Geiger–Müller counter and evaluate its plateau voltage and resolving time.
CO6.Identify the cations present in simple inorganic mixtures by qualitative analysis without phosphate and borate.
CO7.Separate binary cation mixtures using column chromatography and explain the principle of chromatographic separation.

PO4: Specialized Skills and Competencies

CO1.Determine the first-order rate constant for decomposition of hydrogen peroxide and interpret reaction kinetics data.
CO2.Measure and analyze the formal redox potential of Fe^{2+}/Fe^{3+} systems using potentiometric methods.
CO3.Estimate the concentrations of strong and weak acids in a mixture using potentiometric titration techniques.
CO4.Determine the amount of NaCl present in a given solution by potentiometric titration against $AgNO_3$.
CO5.Operate a Geiger–Müller counter and evaluate its plateau voltage and resolving time.
CO6.Identify the cations present in simple inorganic mixtures by qualitative analysis without phosphate and borate.
CO7.Separate binary cation mixtures using column chromatography and explain the principle of chromatographic separation.

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

CO1.Determine the first-order rate constant for decomposition of hydrogen peroxide and interpret reaction kinetics data.
CO2.Measure and analyze the formal redox potential of Fe^{2+}/Fe^{3+} systems using potentiometric methods.
CO3. Estimate the concentrations of strong and weak acids in a mixture using potentiometric titration techniques.

CO4. Determine the amount of NaCl present in a given solution by potentiometric titration against $AgNO_3$.
CO5. Operate a Geiger–Müller counter and evaluate its plateau voltage and resolving time.
CO6.Identify the cations present in simple inorganic mixtures by qualitative analysis without phosphate and borate.
CO7. Separate binary cation mixtures using column chromatography and explain the principle of chromatographic separation.

PO6: Communication Skills and Collaboration

CO1.Determine the first-order rate constant for decomposition of hydrogen peroxide and interpret reaction kinetics data.
CO2. Measure and analyze the formal redox potential of Fe^{2+}/Fe^{3+} systems using potentiometric methods.
CO3.Estimate the concentrations of strong and weak acids in a mixture using potentiometric titration techniques.
CO4.Determine the amount of NaCl present in a given solution by potentiometric titration against AgNO3.
CO5.Operate a Geiger–Müller counter and evaluate its plateau voltage and resolving time.
CO6.Identify the cations present in simple inorganic mixtures by qualitative analysis without phosphate and borate.
CO7.Separate binary cation mixtures using column chromatography and explain the principle of chromatographic separation.

PO7: Research-related Skills

CO1.Determine the first-order rate constant for decomposition of hydrogen peroxide and interpret reaction kinetics data.
CO2.Measure and analyze the formal redox potential of Fe^{2+}/Fe^{3+} systems using potentiometric methods.
CO3.Estimate the concentrations of strong and weak acids in a mixture using potentiometric titration techniques.
CO4.Determine the amount of NaCl present in a given solution by potentiometric titration against $AgNO_3$.
CO5.Operate a Geiger–Müller counter and evaluate its plateau voltage and resolving time.
CO6.Identify the cations present in simple inorganic mixtures by qualitative analysis without phosphate and borate.
CO7.Separate binary cation mixtures using column chromatography and explain the principle of chromatographic separation.

PO8: Learning How to Learn Skills

CO1.Determine the first-order rate constant for decomposition of hydrogen peroxide and interpret reaction kinetics data.
CO2.Measure and analyze the formal redox potential of Fe^{2+}/Fe^{3+} systems using potentiometric methods.
CO3.Estimate the concentrations of strong and weak acids in a mixture using potentiometric titration techniques.

CO4.Determine the amount of NaCl present in a given solution by potentiometric titration against $AgNO_3$.
CO5.Operate a Geiger–Müller counter and evaluate its plateau voltage and resolving time.
CO6.Identify the cations present in simple inorganic mixtures by qualitative analysis without phosphate and borate.
CO7. Separate binary cation mixtures using column chromatography and explain the principle of chromatographic separation.

PO9: Digital and Technological Skills

CO1.Determine the first-order rate constant for decomposition of hydrogen peroxide and interpret reaction kinetics data.
CO2.Measure and analyze the formal redox potential of Fe^{2+}/Fe^{3+} systems using potentiometric methods.
CO3.Estimate the concentrations of strong and weak acids in a mixture using potentiometric titration techniques.
CO4. Determine the amount of NaCl present in a given solution by potentiometric titration against $AgNO_3$.
CO5.Operate a Geiger–Müller counter and evaluate its plateau voltage and resolving time.
CO6.Identify the cations present in simple inorganic mixtures by qualitative analysis without phosphate and borate.
CO7.Separate binary cation mixtures using column chromatography and explain the principle of chromatographic separation.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

CO1.Determine the first-order rate constant for decomposition of hydrogen peroxide and interpret reaction kinetics data.
CO2.Measure and analyze the formal redox potential of Fe^{2+}/Fe^{3+} systems using potentiometric methods.
CO3.Estimate the concentrations of strong and weak acids in a mixture using potentiometric titration techniques.
CO4.Determine the amount of NaCl present in a given solution by potentiometric titration against $AgNO_3$
CO5. Operate a Geiger–Müller counter and evaluate its plateau voltage and resolving time.
CO6.Identify the cations present in simple inorganic mixtures by qualitative analysis without phosphate and borate.
CO7.Separate binary cation mixtures using column chromatography and explain the principle of chromatographic separation.

PO11: Value Inculcation and Environmental Awareness

CO1.Determine the first-order rate constant for decomposition of hydrogen peroxide and interpret reaction kinetics data.
CO2. Measure and analyze the formal redox potential of Fe^{2+}/Fe^{3+} systems using potentiometric methods.
CO3. Estimate the concentrations of strong and weak acids in a mixture using potentiometric titration techniques.

CO4. Determine the amount of NaCl present in a given solution by potentiometric titration against $AgNO_3$.
CO5. Operate a Geiger–Müller counter and evaluate its plateau voltage and resolving time.
CO6. Identify the cations present in simple inorganic mixtures by qualitative analysis without phosphate and borate.
CO7. Separate binary cation mixtures using column chromatography and explain the principle of chromatographic separation.

PO12: Autonomy, Responsibility, and Accountability

CO1.Determine the first-order rate constant for decomposition of hydrogen peroxide and interpret reaction kinetics data.
CO2.Measure and analyze the formal redox potential of Fe^{2+}/Fe^{3+} systems using potentiometric methods.
CO3. Estimate the concentrations of strong and weak acids in a mixture using potentiometric titration techniques.
CO4.Determine the amount of NaCl present in a given solution by potentiometric titration against $AgNO_3$.
CO5.Operate a Geiger–Müller counter and evaluate its plateau voltage and resolving time.
CO6.Identify the cations present in simple inorganic mixtures by qualitative analysis without phosphate and borate.
CO7. Separate binary cation mixtures using column chromatography and explain the principle of chromatographic separation.

PO13: Community Engagement and Service

CO1.Determine the first-order rate constant for decomposition of hydrogen peroxide and interpret reaction kinetics data.
CO2. Measure and analyze the formal redox potential of Fe^{2+}/Fe^{3+} systems using potentiometric methods.
CO3.Estimate the concentrations of strong and weak acids in a mixture using potentiometric titration techniques.
CO4.Determine the amount of NaCl present in a given solution by potentiometric titration against $AgNO_3$.
CO5.Operate a Geiger–Müller counter and evaluate its plateau voltage and resolving time.
CO6.Identify the cations present in simple inorganic mixtures by qualitative analysis without phosphate and borate.
CO7. Separate binary cation mixtures using column chromatography and explain the principle of chromatographic separation.

CBCS Syllabus as per NEP 2020 for T.Y.B.Sc. (2023 Pattern)

Name of the Programme	: B.Sc. Chemistry
Program Code	: USCH
Class	: T.Y.B.Sc.
Semester	: VI
Course Type	: Minor Elective Theory
Course Name	: Industrial Chemistry II
Course Code	: CHE-356-MJE (A)
No. of Lectures	: 30
No. of Credits	: 2 credits

Course Objectives :

1. Students should know the expressions used in polymer industries.
2. Students able to understand the different steps in manufacturing of soaps and detergents.
3. Students should know the uses and application of dyes, polymerindustries.
4. Students able to understand the different terminologies in pharmaceutical industries.
5. Student should understand aspects of small scale industries.
6. Students should know modern approach towards synthesis of Aspirin and chloroamphenicol etc.
7. Students should able to understand general terms in pollution prevention and waste management.

Course Outcomes :

CO1: Understanding the principles and concepts related to polymers , soaps and detergents, dyes, industrial organic synthesis, and pharmaceutical industries.

CO2: Gaining knowledge of the synthesis, properties, and applications of polymers, soaps and detergents, dyes, and pharmaceuticals.

CO3: Developing skills in laboratory techniques and experimental methods relevant to these fields.

CO4: Analyzing and evaluating the environmental , economic ,and social impacts of these industries.

CO5: Applying theoretical knowledge to solve practical problem related to polymer synthesis, soap and detergent formulation, dyeing processes, and pharmaceutical production.

CO6: Developing critical thinking and problem-solving abilities in the context of these industries.

CO7: Understanding the regulatory and safety considerations associated with the production and use of polymers, soaps and detergents, dyes, and pharmaceuticals.

Enhancing communication skills through written reports, presentations, and discussions on topics related to these subjects.

Topics and Learning points

Unit 1: Polymers (05L)

Introduction, Classification, based on origin, based on the polymerization process, based on the molecular forces, based on the growth of polymerization, based on structure, based on the polymerization reaction, Methods of preparation and applications of some polymers: Nylon-6,6, Polyethylene, polystyrene, polyvinyl chloride.

Ref.1and2

Unit 2: Industrial Organic Synthesis (05L)

Manufacture of methanol from synthesis gas, Isopropanol from propylene, Acetone by catalytic dehydrogenation of Isopropanol. (With flow sheet diagram) Aromatic hydrocarbon-Preparation of toluene (with flow sheet)

Ref.3:Chapter11, Pg.439to451andChapter14, Pg.493 to 522 (Relevant Points Only)

Unit 3:Soap and Detergents (05L)

Soaps-Introduction, Importance of soap, Raw Materials used in Soap Manufacture, Manufacture of soaps, Cleansing action of Soap and detergents

Detergents- Introduction, Advantages and disadvantages of Detergents, Surfactants and detergent, Emulsion and Emulsifying agents, Wetting and Non-wetting agents, Hydrophobic and Hydrophilic nature, Micelles, Types of surfactants, Detergent's builders and Additives, Manufacture of detergents, Comparison between Soap and Detergent. Ref.4

Unit 4: Chemistry of pharmaceutical industries (05L)

Introduction - Importance, Qualities of good drugs, Classification of drugs, Functional and chemotherapeutic drugs, Meaning of the terms: Prescriptions, Doses, Analgesic, Antipyretics, Diuretics, Anesthetics, Antibiotics, sulpha drugs, Anti-inflammatory, Synthesis and uses of Paracetamol, Sulphanilamide, Manufacture of Aspirin with flow sheet, Chloramphenicol, Penicillin-G, Ref.3:Pg.762-775; Ref.5:Pg.803-804, 818-822, Ref.6:Pg..987-1011

Unit 5: Synthetic dyes (05L)

Introduction - Importance, Qualities of good dye, color and chemical constitution, Classification based on the chemical constitution, Witt's theory. Meaning of terms: chromospheres, auxochrome, bath chromic (red) and hypsochromic (blue) shifts. Synthesis and uses of Methyl orange, Malachite green, phenolphthalein ,crystal violet ,Alizarin ,Indigo.

Ref. 3: Pg.777-814; Ref.7: Pg.863-915; Ref. 8. Ref. 9

Unit 6: Pollution prevention and waste management (05L)

Introduction, importance of waste management, concept of atom economy, Terms involved in waste minimization: source reduction, recycling, product changes, source control, use and reuse, reclamation, assessment procedures, types of wastes, treatment, and disposal of industrial waste. Treatment of wastes or effluents with organic impurities. Treatment of wastes or effluents with inorganic impurities.

Ref. 3:Pg.8-92; Ref.10:Pg.15-30; Ref.www.wikipedia.org/atomeconomy

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Choice Based Credit System Syllabus (2023 Pattern)

(As per NEP 2020)

Class : T.Y.B.Sc.(SEM VI) **Subject** : Chemistry

Course Name : Industrial Practical -VI **Course Code** : CHE-356-MJE (A)

Mapping of Course Outcomes with Program Outcomes

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	3	2	2	3	1	2	3	2	2	2	3	2
CO2	3	3	2	3	3	1	2	3	3	2	3	3	2
CO3	3	3	2	3	3	1	3	2	3	2	3	3	2
CO4	3	2	3	2	3	2	2	2	2	3	3	3	3
CO5	3	3	3	3	3	1	2	3	3	2	3	3	2
CO6	3	3	3	3	3	2	3	3	3	2	3	3	3
CO7	3	3	3	3	3	2	3	3	3	3	3	3	3

Justification of the Mapping

PO1: Comprehensive Knowledge and Understanding

CO1–CO5: Students gain a thorough understanding of polymers, detergents, dyes, organic synthesis, and pharmaceutical industries.

PO2: Practical, Professional, and Procedural Knowledge

CO2–CO5, CO7: Students acquire industrial and laboratory-based procedural knowledge for synthesis, analysis, and product formulation.

PO3: Entrepreneurial Mindset and Knowledge

CO1, CO3, CO4, CO5: The course promotes entrepreneurship in polymer, detergent, dye, and pharmaceutical manufacturing industries.

PO4: Specialized Skills and Competencies

CO2, CO3, CO5: Students develop specialized competencies in industrial synthesis, quality testing, and process optimization.

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

CO1–CO6: Learners apply theoretical knowledge to solve real-world industrial chemistry problems and optimize processes.

PO6: Communication Skills and Collaboration

CO4, CO8: Students communicate effectively through reports, discussions, and presentations related to industrial and pharmaceutical chemistry.

PO7: Research-related Skills
CO3, CO5, CO6: Students gain research insights in process development, waste minimization, and pollution control in industries.

PO8: Learning How to Learn Skills
CO1–CO5: Students develop self-learning through exposure to current industrial practices, modern synthesis, and technological innovations.

PO9: Digital and Technological Skills
CO2, CO3, CO5: Students use analytical instruments, flow sheets, and digital tools for industrial analysis and process control.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy
CO4, CO6: Students understand the global industrial impact, ethical production, and sustainability in pharmaceutical and polymer industries.

PO11: Value Inculcation and Environmental Awareness
CO6, CO7: Students understand environmental responsibility and green practices in pollution prevention and waste management.

PO12: Autonomy, Responsibility, and Accountability
CO1–CO7: Learner's practice responsible handling of industrial materials and chemicals, ensuring safety and accountability.

PO13: Community Engagement and Service
CO6, CO7: Students understand waste management's role in protecting communities and promoting sustainable industrial practices.

CBCS Syllabus as per NEP 2020 for T.Y.B.Sc. (2023 Pattern)

Name of the Programme	: B.Sc. Chemistry
Program Code	: USCH
Class	: T.Y.B.Sc.
Semester	: VI
Course Type	: Minor Elective Theory
Course Name	: Environmental and Green Chemistry- II
Course Code	: CHE-356-MJE (B)
No. of Lectures	: 30
No. of Credits	: 2 credits

Course Objectives:

1. Students should know the water treatment and effluent management for domestic water and wastewater.
2. Students able to understand soil and soil waste management with respect to soil composition, types and exchange capacity.
3. Student should know about water treatment and effluent management for domestic and industrial purposes.
4. Students able to understand green house gases, green house effect, global warming and climate change.
5. Students should know the green solvent, water as a solvent, its properties and the interaction of water with different phases as well as reaction.
6. Students able to understand water as the ultimate green solvent, its properties and its role in chemical reaction.
7. Students should know overall pollutant effect on environment.

Course Outcomes:

CO1: Know the water treatment and effluent management apply for waste water purification.

CO2: Understanding the soil structure, composition, types and exchange capacity for applying in a waste management.

CO3: Understandingtheinstrumentsusedforthedifferenttracepollutant analysis.

CO4: Know the green house gases, green house effect, and global warming, climate change and find the remedial solution for it.

CO5: Know the solvent properties use such type of green solvent instead of hazardous solvents for carryout the chemical reactions.

CO6: Understanding the energy sources and its relation apply for different purposes.

CO7: Know the environmental pollutants, find remedies on it and minimizes the pollution.

Topics and Learning points

Unit 1: Water treatment and effluent management (10L)

Domestic sewage,waste water treatment: primary, secondary and tertiary treatments, aerobic, anaerobic and up flow anaerobic sludge bed treatment processes Industrial waste water treatment i) filtration method ii) ion-exchange method iii) membrane techniques: ultra filtration, reverse osmosis and electro dialysis Treatment of drinking water Ref.1 , Ref. 2, Ref. 3

Unit 2: Soil and solid waste management (04 L)

Composition of soil and types of soil., Organic and inorganic components of soil Acid base and ion exchange reactions in oil and pH of soil Chemistry of disposal of solid waste i) sanity landfill ii) incinerators iii) pyrolysis Ref.1,Ref.2,Ref.3

Unit 3: Green House Effect and Global Warming (04 L)

Introduction, Greenhouse gases, Radioactive forcing, Sources and sinks of CO_2Causes of fluctuations in global temperature, Global warming and climate changes Implications of climate changes Ref. 5

Unit 4. Water the ultimate Green solvent (12 L)

H_2O:Simple formula and complex molecule, Important properties of water The hydrologic cycle, Bodies of water and life in water,Chemical process in water Fizzy water from underground, Oxygen in water, Weak acid from sky, Why natural water contains alkalinity and calcium, Metals in water,Water interactions with other phases
Ref: Green Chemistry by Stanley E Manahan, Chemchar Researching.(2006)-2nd Edn Chapter 7: Pg.16117

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5. Environmental Chemistry–H. Kaur 2nd Edition 2007, Pragati Prakashan, Meerut, India
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Choice Based Credit System Syllabus (2023 Pattern)

(As per NEP 2020)

Class	**:**	T.Y.B.Sc.(SEM VI)	**Subject**	**:**	Chemistry
Course Name	**:**	Environmental and Green Chemistry –II	**Course Code**	**:**	CHE-356-MJE (B)

Mapping of Course Outcomes with Program Outcomes

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

Mapping of POs with COs

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

Justification of the Mapping

PO1: Comprehensive Knowledge and Understanding
CO1–CO5: Students acquire theoretical understanding of water treatment, soil management, pollutant control, greenhouse effect, and green solvents.

PO2: Practical, Professional, and Procedural Knowledge
CO1–CO3, CO5, CO7: Students understand practical procedures of effluent treatment, waste management, pollutant analysis, and solvent applications.

PO3: Entrepreneurial Mindset and Knowledge
CO1, CO4, CO5: Learners can explore sustainable water and waste management technologies and green chemistry innovations as eco-business opportunities.

PO4: Specialized Skills and Competencies
CO2, CO3, CO5, CO7: Students gain specialized laboratory and analytical skills in pollutant detection, soil analysis, and water quality evaluation.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning
CO1–CO7: All outcomes strengthen analytical reasoning and problem-solving in pollution control, resource conservation, and environmental protection.

PO6: Communication Skills and Collaboration
CO4, CO7: Students communicate environmental issues, findings, and solutions effectively through reports and teamwork.

PO7: Research-related Skills
CO3, CO4, CO7: Students use analytical techniques to assess pollutants and research mitigation strategies for environmental problems.

PO8: Learning How to Learn Skills
CO1–CO5: Learners develop independent learning abilities through studying advanced environmental technologies and sustainability models.

PO9: Digital and Technological Skills
CO1, CO3, CO5: Students use digital tools, instrumentation, and software for analysis of water and soil quality parameters.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy
CO4, CO7: Learners recognize the global impact of climate change and environmental degradation on communities, promoting empathy and inclusiveness.

PO11: Value Inculcation and Environmental Awareness
CO1–CO7: The course promotes ethical responsibility toward nature, environmental awareness, and sustainable living practices.

PO12: Autonomy, Responsibility, and Accountability
CO1, CO4, CO7: Students take responsibility for environmental conservation and adopt accountable practices in laboratory and field settings.

PO13: Community Engagement and Service
CO7: Students engage in local environmental and pollution awareness programs, contributing to sustainable community initiatives.

CBCS Syllabus as per NEP 2020 for T.Y.B.Sc. (2023 Pattern)

Name of the Programme	: B.Sc. Chemistry
Program Code	: USCH
Class	: T.Y.B.Sc.
Semester	: VI
Course Type	: Minor Elective Theory
Course Name	: Agri and Dairy Chemistry- II
Course Code	: CHE-356-MJE (C)
No. of Lectures	: 30
No. of Credits	: 2 credits

Course Objectives:

Student should able to know the definition, constituents of milk, physical and chemical properties of milk.

1. Student should able to know details about Milk Products like Cream, Butter, Cheese and Ice-Cream.
2. Student will aware with Milk proteins, Carbohydrates and Vitamins
3. The student needs tounderstand, the role of agriculture chemistry andits potential, basic concept of soil, properties of soil & its classification on the basis of pH
4. The student needs to know the different plant nutrients, their functions and deficiency symptoms, importance of manures as compared to chemical fertilizers, the importance of green manuring, various techniques to protect the plants.
5. The student needs to have the knowledge of various pesticides, insecticides, fungicides and herbicides and able to identify the problematic soil and recommend method for their reclamation.
6. The student needs to know, quality irrigation water, water quality standards and analysis of irrigation water.

CourseOutcomes:

CO1: Student will able to understand the definition, constituents of milk, physical and chemical properties of milk.

CO2: Student will able to understand the Basic principles in Common Dairy Process

CO3: Student will able to know the details about Special Milks, their types and properties of some Vitaminised/irradiated milk, Standardized milk

CO4: Student will able aware with Milk proteins, Carbohydrates and Vitamins.

CO5: Student will able to learn about Preservatives & Adulterants in Milk

CO6: Student will able to know details about Milk Products like Cream, Butter, Cheese and Ice-Cream.

CO7: Student will able to understand the details about Dried Milk Products like

buttermilk powder, whey powder, cream powder, infect milk powder, Shrikand powder, Ice-cream mix powder, cheese powder

Understanding the role of agriculture chemistry and its potential, basic concept, properties & classification of soil on the basis of pH

CO8: Knowing the details of plant nutrients, importance of manures, green manuring, and various techniques to protect the plants.

CO9: Learning about pesticides, insecticides, fungicides and herbicides, problematic soil and reclamation. Knowing details about irrigation water, water quality standards and analysis.

Topics and Learning points

Unit 1. Market Milk (08L)

Introduction, Definition, constituents of milk of different species such as cow, buffalo, goat,etc.,Chemical composition of milk of Indian breed and foreign breeds of cow, factor affecting composition of milk, characteristics of milk of different mammals, physicochemical properties of milk, acidity, pH, density, specific gravity, color and flavor of milk, food and nutritive value of milk. Microbiology of milk, growth of microorganism, stages of growth, product of microbial growth, destruction of microorganism's growth.
Ref1, Ch.1 relevant pages, Ref 2 Pg. 9-26, Ref 6 relevant pages.

Unit 2. Common Dairy Processes (Manufacture, storage and packaging) (07 L)

Cream separation- Basic principles, gravity creaming water dilution and centrifugal creaming method, construction of centrifugal separator, factors affecting percentage of fat, speed of machine, temp. of milk, rate of inflow amount of flushing water formation of milk, flow sheet diagram, process receiving milk, preheating filtration, clarification, cooling and storage raw milk, standardization, pasteurization, homogenization, packing and storage, uses of milk.
Ref 1 .- Relevant pages.

Unit 3. Plant Nutrients (08L)

Need of plant nutrients, forms of nutrients updates nutrient absorption by plants Classification of essential nutrients Primary nutrients (N, P, K), its role and deficiency symptoms in plants Secondary nutrients, (Ca, Mg, S), its role and deficiency symptoms in plants Micronutrients, General functions of micronutrients (Zn, Fe, Mn, Cu, B, Mo, Cl) Effect of environmental condition, nutrient uptake
Ref 3-Pg. 207-241, Ref 4-Pg. 176-195, Ref 7-Pg. 287-300

Unit 4. Fertilizers and Manures Fertilizers (07L)

Introduction Classification & application of fertilizers, Time and methods of fertilizers Factors affecting efficiency of fertilizers, Vermicomposting preparation, effect of vermicomposting on soil fertility Synthetic fertilizers definition, comparison of synthetic fertilizers with organic fertilizers,

Manures:

Introduction, Definition and classification of manures, Effect of bulky organic manures on soil, farmyard manures (FYM), Factors affecting on FY Method of preparation, losses during handling and storage, Biogas plant. Human waste, sewage and sludge, types of sludge, carbon-nitro generation, sewage irrigation and uses, Green manuring, types of green manuring, characteristics, advantages and disadvantages of green manuring, Bio fertilizers: definition, classification, role & advantages

Ref 2-Pg .205-213, Ref 3- Pg. 90-112,137-149

References:

1. Sukumar De-Outlines of dairy technology (Oxford University press)
2. Ekles,Com and Macky –Milk and milk product
3. Yadav D.S- dairy plant management
4. Rangappa,Muddukrishnaiah and Mahadeven –Dairy chemistry and animal nutritions
5. Tyagi and singh – Milk production and management
6. Reddy G.H and YellamandaReddy ,T- Principles of agronomy
7. N.C.Braddy and R.R Well –Principles of soil science
8. R.S Chandel – Agricultural Extentions : Principles and methods

Choice Based Credit System Syllabus (2023 Pattern)

(As per NEP 2020)

Class : T.Y.B.Sc.(SEM VI) **Subject** : Chemistry

Course Name : Agri and Dairy Chemistry-II **Course Code** : CHE-356-MJE (C))

Mapping of Course Outcomes with Program Outcomes

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

Mapping of POs with COs

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

Justification of the Mapping

PO1: Comprehensive Knowledge and Understanding

CO1: Students will understand milk definition, constituents, physicochemical properties, and nutritive value.

CO2: Students will learn basic principles of common dairy processes.

CO3: Students will understand details of special milks, milk proteins, carbohydrates, and vitamins.

CO4: Students will learn about milk products (cream, butter, cheese, ice-cream) and dried milk products.

CO7, CO8: Students will understand soil properties, plant nutrients, fertilizers, and manures.

PO2: Practical, Professional, and Procedural Knowledge

CO1–CO8: Students will develop skills in analyzing milk quality, processing techniques, and applying agricultural chemistry principles for soil fertility, nutrient management, and irrigation water analysis.

PO3: Entrepreneurial Mindset and Knowledge

CO2, CO4, CO6, CO8: Students will gain knowledge of dairy processing, milk products, fertilizers, and manures to explore potential entrepreneurial activities in dairy and agriculture.

PO4: Specialized Skills and Competencies

CO2, CO4, CO6, CO8: Students will acquire technical skills in dairy processes, preparation of milk products, soil management, and fertilizer/manure application.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning
CO1–CO8: Students will apply theoretical concepts to solve problems in milk quality, dairy processing, soil fertility, nutrient deficiency, and plant protection.

PO6: Communication Skills and Collaboration
CO5, CO8: Students will participate in group discussions, project work, and community-oriented agricultural programs.

PO7: Research-related Skills
CO1, CO7, CO8: Students will collect and analyze data on milk quality, soil, and plant nutrients following research ethics.

PO8: Learning How to Learn Skills
CO1–CO8: Students will develop self-directed learning and independent problem-solving skills in dairy and agricultural chemistry.

PO9: Digital and Technological Skills
CO2, CO4, CO7: Students will use instruments and technology for milk testing, dairy processing, and soil/water analysis.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy
CO7, CO8: Students will understand the environmental and social impact of agricultural practices on communities.

PO11: Value Inculcation and Environmental Awareness
CO7, CO8: Students will learn sustainable soil management, green manuring, biofertilizers, and responsible use of fertilizers/pesticides.

PO12: Autonomy, Responsibility, and Accountability

CO1–CO8:Students will independently manage dairy and agricultural chemistry tasks and demonstrate responsibility in quality management and environmental safety.

PO13: Community Engagement and Service
CO8: Students will engage in community service, agricultural extension activities, and awareness programs about sustainable practices.

CBCS Syllabus as per NEP 2020 for T.Y.B.Sc. (2023 Pattern)

Name of the Programme	: B.Sc. Chemistry
Program Code	: USCH
Class	: T.Y B.Sc.
Semester	: VI
Course Type	: Minor Theory
Course Name	: Applied Chemistry-II
Course Code	: CHE-361-MN
No. of Lectures	: 30
No. of Credits	: 2 credits

Course Objectives

1. To introduce the fundamental concepts of rate of chemical reactions and factors affecting them.
2. To develop an understanding of order, molecularity, and methods for determining reaction order.
3. To familiarize students with the temperature dependence of reaction rates and the concept of activation energy.
4. To study the chemistry and bonding of boron compounds and their applications.
5. To understand the trends in chemical reactivity of nitrogen family elements and their oxides.
6. To introduce the structure, properties, and reactions of amines and alcohols.
7. To provide basic knowledge of carbohydrates, their classification, and structural features.
8. To enable students to apply theoretical knowledge to solve numerical problems and predict chemical behavior

Course Outcomes

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

CO1: Explain the concepts of rate, rate constant, order, and molecularity of chemical reactions.

CO2: Apply integrated rate equations to first and second order reactions and solve related numerical problems.

CO3: Determine the order of a reaction using various experimental methods such as integration, graphical, isolation, and half-time methods.

CO4: Interpret the effect of temperature on reaction rate using Arrhenius equation and calculate activation energy.

CO5: Describe the structure, bonding, and preparation of boron compounds such as diborane and tetraborane.

CO6: Discuss the trends and properties of the nitrogen family and explain the structures of important oxides of nitrogen.
CO7: Classify and differentiate amines, alcohols, and carbohydrates based on their structure and functional groups.
CO8: Relate the physical and chemical properties of organic compounds to their molecular structure and reactivity.

Topics and Learning points

Unit 1: Chemical Kinetics [10 L]

Rate of reaction, rate constant, measurement of reaction rates, order and molecularity of reaction, Integrated rate equation of first order and Second order reactions (with equal initial concentration of reactants) Determination of order of reaction by a) Integration method b) Graphical method c) Ostwald's isolation method d) Half time method, Effect of temperature on the rate of reaction, Concept of activation energy and its calculation from Arrhenius equation (derivation not expected). (Numerical problems expected wherever necessary).

Unit-2: P-block elements [10 L]

Chemistry of Boron compounds

Electron deficient compounds, BH_3, BF_3 and BCl_3 with respect to Lewis acidity and applications. Preparations of simple boranes like diborane and tetra borane. Structure and bonding in diborane and tetra borane (2e- - 3C bonds). Synthesis of borax.

Chemistry of Nitrogen family

Trends in chemical reactivity-formation of hydrides, halides, oxides with special reference to oxides of nitrogen. Oxides of nitrogen with respect to preparation and structure of NO, NO_2, N_2O, and N_2O_4.

Unit-3: Chemistry of functional groups. [10L]

Amines-Introduction, nomenclature, physical properties, general methods of preparations, chemical reactions.

Alcohols-Introduction, nomenclature, physical properties, general methods of preparations, chemical reactions.

Introduction to carbohydrates-

Definition, classification and importance of carbohydrates-Monosaccharide, disaccharide, polysaccharides, structure and properties of glucose and fructose.

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. University Chemistry, B. H. Mahan, 3rd edn. Narosa (1998)
5. Atkin's Physical Chemistry, Peter Atkins,Julio De Paula, Oxford publication.8th ed.
6. Elements of Physical Chemistry, Peter Atkins, Julio DePaula, Oxford publication, 5th ed.
7. Organic synthesis using transition metals-Roderick Bates (Wiley)
8. Organic chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford Press)
9. Designing of organic synthesis – S. Warren (Wiley)
10. Some modern methods of organic synthesis – W. Carruthers (Cambridge)
11. Organic synthesis – Michael B. Smith
12. 6. Organometallics in organic synthesis – J. M. Swan and D. C. Black (Chapman and Hall)
13. Advanced organic chemistry, Part B – F. A Carey and R. J. Sundberg, 5th edition (2007)
14. Guidebook to organic synthesis-R. K. Meckie, D. M. Smith and R. A. Atken
15. Organic synthesis- Robert E Ireland
16. Strategic Applications of named reactions in organic synthesis-Laszlo Kurti and Barbara Czako
17. Concise in Inorganic Chemistry J. D. Lee .4th ,5th, 6th, edn

Choice Based Credit System Syllabus (2023 Pattern)

(As per NEP 2020)

Class : T.Y.B.Sc.(SEM VI) **Subject** : Chemistry

Course Name : Applied Chemistry-II **Course Code** : CHE-361-MN

Mapping of Course Outcomes with Program Outcomes

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

Mapping of POs with COs

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

Justification of the Mapping

PO1: Comprehensive Knowledge and Understanding

CO1: Explaining rate, rate constant, order, and molecularity of reactions strengthens conceptual understanding of chemical kinetics.

CO4: Interpreting temperature effects on reaction rate and calculating activation energy deepens understanding of reaction dynamics.

CO5: Describing the structure, bonding, and preparation of boron compounds develops conceptual knowledge in inorganic chemistry.

CO6: Discussing nitrogen family trends and oxides enhances understanding of periodic and environmental chemistry.

CO7: Classifying amines, alcohols, and carbohydrates builds theoretical knowledge of organic functional groups.

CO8: Relating structure and reactivity of organic compounds demonstrates integration of chemical theory and practical relevance.

PO2: Practical, Professional, and Procedural Knowledge

CO2:Applying integrated rate equations to solve numerical problems develops practical problem-solving skills.

CO3: Determining reaction order using experimental methods enhances laboratory and procedural competence.

CO5: Preparing boron compounds in lab sessions strengthens professional handling of materials.
CO7: Conducting functional group experiments (amines, alcohols) builds procedural skills and lab professionalism.

PO3: Entrepreneurial Mindset and Knowledge
CO5: Applying boron chemistry in industrial contexts, such as borax synthesis, fosters innovation.
CO7 & CO8: Using knowledge of functional groups and structure-reactivity relationships in pharmaceuticals, polymers, or food chemistry encourages product development and entrepreneurial thinking.

PO4: Specialized Skills and Competencies
CO1 & CO2: Calculating rates and applying kinetics equations strengthens analytical and specialized chemical skills.
CO3 & CO4: Performing and interpreting reaction order experiments and temperature effect studies develops technical competence.
CO5 & CO6: Studying boron compounds and nitrogen oxides enhances specialized understanding in inorganic chemistry.
CO7 & CO8: Correlating functional groups with chemical behavior builds problem-solving and analytical competence in organic chemistry.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning
CO2 & CO3: Solving numerical problems and determining reaction order experimentally enhances analytical reasoning.
CO4: Interpreting activation energy and temperature effects strengthens problem-solving abilities.
CO5 & CO6: Understanding boron and nitrogen chemistry supports applied reasoning in industrial and environmental contexts.
CO8: Relating structure to reactivity enables practical problem-solving and prediction of chemical behavior.

PO6: Communication Skills and Collaboration
CO3 & CO7: Presenting experimental results and discussing functional group chemistry promotes teamwork and effective communication.
PO7: Research-related Skills
CO3 & CO4: Performing kinetics experiments and analyzing reaction data develops research methodology skills.
CO5 & CO6: Studying boron and nitrogen compounds enhances experimental design and investigative competence.

PO8: Learning How to Learn Skills
CO1 & CO2: Exploring reaction kinetics methods independently encourages self-directed learning.
CO4: Adapting knowledge of temperature and activation energy promotes continuous learning.

CO7 & CO8: Studying functional groups and structure-reactivity relationships enhances adaptability and learning agility.

PO9: Digital and Technological Skills

CO2 & CO3: Using computational tools or software for kinetics calculations develops digital proficiency.

CO5 & CO7: Applying molecular modeling or digital analysis for boron and functional group chemistry enhances technological skills.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

CO8: Applying organic chemistry knowledge in pharmaceutical, nutritional, or environmental contexts fosters ethical and societal awareness.

PO11: Value Inculcation and Environmental Awareness

CO5 & CO6: Understanding environmental impact of boron compounds and nitrogen oxides promotes ethical, sustainable, and environmentally responsible practices.

CO8: Applying chemical knowledge to safe and eco-friendly applications reinforces environmental consciousness.

PO12: Autonomy, Responsibility, and Accountability

CO3 & CO7: Conducting experiments and functional group analysis independently develops responsibility, accountability, and precision in laboratory work.

CO5: Handling boron compounds responsibly demonstrates autonomy in lab and research contexts.

PO13: Community Engagement and Service

CO6 & CO8: Applying nitrogen chemistry and organic compound knowledge in environmental remediation, energy, or healthcare applications benefits society and community welfare.

CBCS Syllabus as per NEP 2020 for T.Y.B.Sc. (2023 Pattern)

Name of the Programme	: B.Sc. Chemistry
Program Code	: USCH
Class	: T.Y.B.Sc.
Semester	: VI
Course Type	: Minor (MN) Practical
Course Name	: Practicals on Applied Chemistry-II
Course Code	: CHE-362-MN
No. of Lectures	: 60
No. of Credits	: 2 credits

Course Objectives

1. To enable students to understand the basic principles involved in physical, inorganic, and organic chemistry experiments.
2. To determine thermodynamic parameters such as heat of reaction, enthalpy of dissolution, and neutralization.
3. To study the effect of concentration and temperature on the rate of chemical reactions.
4. To introduce electrochemical techniques like potentiometry and pH metry for analytical estimations.
5. To develop quantitative analytical skills through volumetric, gravimetric, and complexometric methods.
6. To determine and analyze the chemical composition of inorganic and organic samples of industrial and biological importance.
7. To develop practical skills for testing food adulteration and quality parameters of consumer products like oils, soaps, and milk.
8. To strengthen the relationship between theoretical concepts and their industrial applications through observation and reporting.

Course Outcomes

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

CO1: Analyze the rate of reaction and understand the influence of concentration on reaction kinetics.

CO2: Determine the heat of neutralization and enthalpy of dissolution experimentally.

CO3: Measure the pH of buffer solutions and perform titrations using pH metric and potentiometric methods.

CO4: Standardize chemical solutions accurately and estimate analytes such as chloride, sulphate, and aluminium using volumetric and titrimetric techniques.

CO5: Determine Vitamin C and chlorine content in samples using redox titration methods.

CO6: Evaluate the quality of organic samples by determining acid value, detecting adulteration, and testing for functional components (e.g., urea, starch, salt).
CO7: Quantify glucose in a given sample using the hypoiodite method and interpret its biochemical relevance.
CO8: Prepare and present a scientific report on industrial visits linking practical chemistry to industrial processes.
CO9: Demonstrate good laboratory practices, data accuracy, safety awareness, and teamwork in experimental work.

Topics and Learning points

Physical Chemistry practicals (Any 05)

1. To study the effect of change in concentration of sodium thiosulphate on the rate of reaction between sodium thiosulphate and hydrochloric acid.
2. Determination of heat of neutralization of strong base & strong acid.
3. Determine enthalpy of dissolution of salt KNO_3/NH_4Cl
4. Determination of pH of given acidic buffer solution by potentiometer.
5. Titration between strong acid and strong base by using pH metry.
6. To determine the transition temperature of given inorganic salt.
7. Determination of heat of ionization of acetic acid.
8. Determine the densities of series of the solution and calculate the partial molar value of the component

Inorganic Chemistry practicals (Any 05)

1. Standardization of $Na_2S_2O_3$ using potassium dichromate($K_2Cr_2O_7$)
2. Determination of Vitamin-C content in fruit juices using iodine solution.
3. Determination of chloride in a sample using Volhard's method.
4. Estimation of sulphate by $BaSO_4$ precipitation titration.
5. Determination of Aluminum using EDTA.
6. Determination of Chlorine in water sample using iodine solution.

Organic Chemistry Practicals: (Any 05)

1. To determine the acid value of an oil.
2. Detection of adulteration in the given sample of edible oil.
3. Detection of chloride content in the given sample of soap.
4. Detection of Urea, Starch, NaCl in given sample of milk.
5. To determine the amount of Glucose in the given solution by Hypoiodite method.
6. Preparation of Osazone from glucose.
7. Preparation of dibenzal acetone from acetone

References

1. Practical Physical Chemistry, A M. Jemes, F.E.Prichard, 3rd edn, Longman.
2. Advanced Practical Physical Chemistry, J. B.Yadav, Goel Publishing house
3. Organic Qualitative Analysis–A. I. Vogel
4. Vogel's Qualitative Inorganic Analysis, Svehla G. Pearson Education, 2012
5. Vogel's Quantitative Inorganic Analysis, Mendham J. 2012

Choice Based Credit System Syllabus (2023 Pattern)

(As per NEP 2020)

Class	**:**	T.Y.B.Sc.(SEM VI)	**Subject**	**:**	Chemistry
Course Name	**:**	Practicals on Applied Chemistry-II	**Course Code**	**:**	CHE-362-MN

Mapping of Course Outcomes with Program Outcomes

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

Mapping of POs with COs

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

Justification of the Mapping

PO1: Comprehensive Knowledge and Understanding

CO1 and CO2: enable students to understand the principles and working mechanisms of electrochemical cells, reference electrodes, and the Nernst equation.

CO5: enhances their understanding of nuclear binding energy, mass defect, and nuclear stability, linking theory with atomic structure and energetics.

CO6: helps students grasp adsorption theories through Langmuir and Freundlich isotherms, connecting surface phenomena to practical applications.

CO7: integrates knowledge from multiple branches of chemistry and applies it to industrial and research contexts, ensuring a comprehensive understanding of chemical science in a multidisciplinary framework.

PO2: Practical, Professional, and Procedural Knowledge

CO2 and CO3: train students in electrochemical measurement and potentiometric titration techniques, enhancing precision and professional handling of laboratory instruments.

CO4: provides hands-on experience with radioactivity detection instruments such as G.M. counters and scintillation counters, ensuring safe and effective operation.

CO6: extends practical learning to real material systems, applying adsorption isotherms to experimental data.

PO3: Entrepreneurial Mindset and Knowledge

CO6: links adsorption and surface chemistry principles to catalysis, pollution control, and environmental technologies, encouraging innovative thinking.

CO7: emphasizes the application of electrochemistry and nuclear chemistry in emerging fields such as sensor technology, batteries, and radiotracer development. These skills cultivate innovation, creativity, and awareness of market-driven applications of chemistry.

PO4: Specialized Skills and Competencies

CO1 and CO3: enhance the ability to interpret electrochemical data and perform potentiometric titrations accurately.

CO4: trains students to handle and interpret radiation detection instruments.

CO5: develops analytical capabilities through nuclear energy and stability calculations.

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

CO1: applies electrochemical principles to equilibrium and emf determination.

CO3 and CO5: strengthen analytical reasoning through titration analysis and nuclear decay data interpretation.

CO6: enhances problem-solving skills by evaluating adsorption data using isotherms.

CO7:integrates knowledge from multiple areas to address industrial and environmental challenges.

PO6: Communication Skills and Collaboration

CO1: helps students express electrochemical and nuclear concepts clearly in written and oral formats.

CO3: fosters collaboration during group-based practicals such as titration and instrumentation experiments, developing leadership, coordination, and effective communication in laboratory environments.

PO7: Research-related Skills

CO4: provides experience in operating and interpreting data from radiation detection instruments, promoting accuracy and observation.

CO7: encourages application of electrochemical, nuclear, and surface chemistry concepts in research-oriented experiments, enhancing scientific inquiry, data analysis, and ethical research practices.

PO8: Learning How to Learn Skills

CO1: encourages self-directed exploration of modern electrochemical techniques.

CO4: helps students adapt to continuous technological advancements in radiation detection methods.

CO6: motivates them to relate adsorption phenomena to emerging environmental research trends. These experiences foster adaptability, curiosity, and continuous learning.

PO9: Digital and Technological Skills

CO2: enhances skills in using digital potentiometers and pH meters for accurate measurements.

CO4: develops familiarity with digital radiation counters and electronic data interpretation.
CO7: enables students to utilize computational tools for adsorption and radioactive decay analysis, promoting the integration of digital tools with scientific experimentation.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

CO7: helps students apply electrochemical and surface chemistry principles to energy and environmental sectors, fostering empathy, inclusiveness, and social responsibility toward sustainable development and global well-being.

PO11: Value Inculcation and Environmental Awareness

CO4: emphasizes safe and ethical handling of radioactive materials, promoting laboratory integrity.
CO6: applies adsorption for environmental remediation and pollution control, developing eco-consciousness and sustainability values among students.

PO12: Autonomy, Responsibility, and Accountability

CO3: ensures students can perform titrations accurately and independently.
CO4: teaches them to handle radioactive materials responsibly with strict adherence to safety norms.
CO7:fosters accountability through complete project execution — from data collection to analysis and interpretation — promoting professionalism and ethical conduct.

PO13: Community Engagement and Service

CO6: demonstrates how adsorption and catalysis contribute to clean energy and pollution control.
CO7:extends chemical knowledge to community welfare by relating nuclear and electrochemical studies to healthcare, environmental sustainability, and societal betterment. These activities encourage community engagement and responsible citizenship through applied chemistry.