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 V

(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 their aspirations on a global scale.

In response to the rapid advancements in science and technology and the evolving approaches in various domains of Chemistry and related subjects, the Board of Studies in Chemistry at Tuljaram Chaturchand College, Baramati - Pune, has developed the curriculum for the third 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 21st century. 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 May 2023.

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.

POS4: Specialized Skills and Competencies: Graduates will demonstrate proficiency in technical skills, analytical abilities, problem-solving, effective communication, and leadership. relevant to their field of study. They will also adapt and innovate in response to changing circumstances.

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

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

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

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

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

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

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

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

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

Anekant Education Society's

Tuljaram Chaturchand College, Baramati

(Empowered Autonomous)

Board of Studies (BOS) in Chemistry

From 2025-26 To 2028

Sr. No.	Name	Designation
1.	Dr. Prof. Shrikrushna T. Salunke	Chairman
2.	Mr. Bhimrao R. Torane	Member
3.	Mr. Maharudra A. Dudhe	Member
4.	Mr. Ravikiranamrut R. Gandhi	Member
5.	Dr. Vaibhav P. Landge	Member
6.	Dr. Yogesh N. Indulkar	Member
7.	Dr. Rahul S. Bhondwe	Member
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9.	Mrs. Supriya S. Deokate	Member
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12.	Mrs. Reshma T. Gadadare	Member
13.	Mrs. Swati A. Deokate	Member
14.	Ms. Sakshi S. Nawale	Member
15.	Ms. Pratiksha P. Tak	Member
16.	Ms. Anjali N. Bhong	Member
17.	Mr. Harshad J. Salunkhe	Member
18.	Mrs. Kalpana Sumavar	Member
19.	Dr. Dilip Satpute	External Member VC Nominee
20.	Dr. Sidaram Pujari	External Member from other University
21.	Dr. Vijay Vader	External Member from other University
22.	Dr. Nitin Jadhav	Member Representative Alumni
23.	Mr. Dadaso Kare	Member Representative from Industry
24.	Ms. Tanishka Fadatare	UG Student Representative
25.	Ms. Disha Waghmode	PG Student Representative

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

Level/ Difficulty	Sem	Subject 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/ Difficulty	Sem	Credits Related to Major				Minor	--	GE/OE	SEC	IKS	AEC	VEC	CC	Total
		Major Core	Major Elective	VSC	FP/OJT/CE P/RP									
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 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 Code	Course Title	Course Type	Credits
V	CHE-301-MJM	Physical Chemistry -I	Theory	02
	CHE-302-MJM	Inorganic Chemistry -I	Theory	02
	CHE-303-MJM	Organic Chemistry -I	Theory	02
	CHE-304-MJM	Analytical Chemistry -I	Theory	02
	CHE-305-MJM	Chemistry Practical- V	Practical	02
	CHE-306-MJE(A)	Industrial Chemistry –I	Theory (MJE)	04
	CHE-306-MJE(B)	Environmental & Green Chemistry - I		
	CHE-306-MJE(C)	Agri. & Dairy Chemistry - I		
	CHE-311-MN	Applied Chemistry - I	Theory	02
	CHE-312-MN	Practicals on Applied Chemistry – I	Practical	02
	CHE-321-VSC	Advanced Chemistry Practical	Practical	02
	CHE-355-FP	Field Project	Filed Project (FP)	02
			Total Credit	**22**
VI	CHE-351-MJM	Physical Chemistry -II	Theory	02
	CHE-352MJM	Inorganic Chemistry -II	Theory	02
	CHE-353-MJM	Organic Chemistry - II	Theory	02
	CHE-354-MJM	Analytical Chemistry - II	Theory	02
	CHE-355-MJM	Chemistry Practical- II	Practical	02
	CHE-356MJE(A)	Industrial Chemistry -II	Theory (Any two)	04
	CHE-356-MJE(B)	Environmental and Green Chemistry - II		
	CHE-356-MJE(C)	Agri. & Dairy Chemistry - II		
	CHE-361-MN	Applied Chemistry -II	Theory	02
	CHE-362-MN	Practicals on Applied Chemistry - II	Practical	02
	CHE-385-OJT	On Job Training	Practical	04
			Total Credit	**22**
		Cumulative Credits Semester V+ Semester VI		**44**

CBCS Syllabus as per NEP 2020 (NEP 1.0) for T.Y.B.Sc. Chemistry (2023 Pattern)

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

Course Objectives:

1. To understand the fundamental principles of molecular spectroscopy and its applications in determining molecular properties.
2. To develop knowledge about rotational and vibrational spectroscopy and its role in interpreting molecular structure.
3. To explain the concepts of electrolytic conductance and factors affecting conductance in electrolytic solutions.
4. To familiarize students with various laws of conductance including Kohlrausch's law and its practical applications.
5. To impart knowledge on the interaction of radiation with matter and distinguish between thermal and photochemical processes.
6. To understand the fundamental laws of photochemistry and various excited-state processes like fluorescence and phosphorescence.
7. To develop problem-solving skills through numerical applications in spectroscopy, conductance, and photochemical reactions.

Course Outcomes:

At the end of the course, students will be able to:

CO1. Explain the concepts of molar refraction, polarization, and dipole moments of molecules.
CO2. Analyze and interpret rotational and vibrational spectra of diatomic molecules for structure elucidation.
CO3. Demonstrate the knowledge of specific and equivalent conductance and their variation with concentration.
CO4. Apply Kohlrausch's Law for calculating equivalent conductance at infinite dilution for weak electrolytes.
CO5. Evaluate the principles of photochemistry and differentiate between various radiative and non-radiative processes.
CO6. Interpret the Jablonski diagram and describe the phenomena of fluorescence, phosphorescence, and photosensitization.

CO7. Solve numerical problems based on molecular spectroscopy, electrolytic conductance, and photochemical kinetics.

Topics and Learning Points:

Unit 1: Molecular Spectroscopy (12 L)

Molar refraction, molar polarization, Electrical polarization of polar and non-polar molecules, Permanent dipole moment, Determination of dipole moment

Rotational spectroscopy: Rotational spectra of diatomic molecules, intensities of spectral lines, rigid rotor, moment of inertia, energy levels, conditions for obtaining pure rotational spectrum, selection rule, nature of spectrum, determination of internuclear distance, isotopic shift.

Vibrational spectroscopy: Vibrational motion, degrees of freedom, modes of vibration, vibrational spectrum of a diatomic molecule, simple harmonic oscillator, energy levels, zero-point energy, conditions for obtaining vibrational spectrum, selection rule, nature of spectrum.

Unit 2: Electrolytic Conductance (10 L)

Recapitulation of Electrolytic conductance, Specific and equivalent conductance, Variation of equivalent conductance with concentration, Kohlrausch's law and its applications to determine Equivalent conductance at infinite dilution of a weak electrolyte, The ionic product of water, Solubility of sparingly soluble salts, Migration of ions and ionic mobilities, absolute velocity of ions, Transport number determination by Hittorf's method and moving boundary method, Relation between ionic mobility, ionic conductance and transport number, Ionic theory of conductance, Debye-Hückel-Onsager equation and its validity, Activity insolation, fugacity and activity coefficient of strong electrolyte, Conductometric titrations, Numerical.

Unit 3: Photochemistry (08 L)

Interaction of radiation with matter, difference between thermal and photochemical processes, Laws of photochemistry: Grotthuss – Draper law, Stark – Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non- radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions – energy transfer processes (simple examples), Kinetics of Photo chemical reaction, Numerical

References:

1. Essential of Physical Chemistry, Bahl and Tuli (S. Chand).
2. Principles of Physical Chemistry by Puri, Sharma, Pathania
3. Physical Chemistry, Singh, N.B., et al. Volume 2, New Age International Ltd, 2000
4. Physical Chemistry by G. M. Barrow, International student Edition, McGraw Hill.
5. University General Chemistry by C.N.R. Rao, Macmillan.
6. Physical Chemistry by, R. A. Alberty, Wiley Eastern Ltd.
7. The Elements of Physical Chemistry by P. W. Atkins, Oxford.
8. Principles of Physical Chemistry by S. H. Maron, C. H. Prutton, 4th Edition.

Choice Based Credit System Syllabus (2023 Pattern)

(As per NEP 2020)

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

Course: Physical Chemistry-I **Course Code**: CHE-301-MJM

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

	Programme Outcomes (POs)												
Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO13**
CO1	3	2											
CO2	3	2		2	2								
CO3	3	3											
CO4	3	2										2	
CO5	3	2		2									
CO6	3	2		2									
CO7	3	3		3	2				2			2	

Justification of mapping

PO1: Comprehensive Knowledge and Understanding

CO1: Students will explain the concepts of molar refraction, polarization, and dipole moments of molecules.

CO2: Students will analyze rotational and vibrational spectra of molecules and apply these concepts in structural analysis.

CO3: Students will demonstrate knowledge of conductance concepts with respect to strong and weak electrolytes.

CO4: Students will apply Kohlrausch's Law to determine equivalent conductance at infinite dilution.

CO5: Students will evaluate photochemical principles and classify types of radiative and non-radiative processes.

CO6: Students will interpret the Jablonski diagram to explain various photophysical processes.

CO7: Students will solve numerical problems related to spectroscopy, conductance, and photochemical kinetics.

PO2: Practical, Professional, and Procedural Knowledge

CO1: Students will relate physical properties to experimental observations and practices.

CO2: Students will analyze and interpret spectra to understand molecular structure.

CO3: Students will evaluate conductivity behavior using graphs and equations.

CO4: Students will apply electrochemical principles to determine unknown values through computation.

CO5: Students will distinguish photochemical processes in relation to practical light-based reactions.

CO6: Students will interpret spectroscopic representations of photophysical transitions.

CO7: Students will practice solving structured problems relevant to laboratory and industrial chemistry.

PO4: Specialized Skills and Competencies

CO2: Students will interpret molecular spectra and assess molecular behavior using spectroscopy.

CO5: Students will evaluate processes using reaction schemes in photochemistry.

CO6: Students will describe excited-state phenomena using diagrams and fluorescence/phosphorescence relationships.

CO7: Students will apply analytical skills to solve complex numerical problems in physical chemistry.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning
CO2: Students will apply principles of spectroscopy for determining structural parameters.
CO7: Students will apply theoretical models and calculations to experimental data and problem-based learning.

PO9: Digital and Technological Skills
CO7: Students will use computational tools or digital resources to calculate, simulate, or visualize data in spectroscopy and kinetics.

PO12: Autonomy, Responsibility, and Accountability
CO4: Students will solve numerical problems independently, fostering accountability and accuracy.
CO7: Students will manage tasks individually, analyse results, and report them responsibly.

CBCS Syllabus as per NEP 2020 (NEP 1.0) for T.Y.B.Sc. Chemistry (2023 Pattern)

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

Course Objectives:

1. Students should know meaning of various term involved in coordination chemistry
2. Student able to understand different theories of complex formation and the geometries, isomerism of various types of complexes.
3. Students should know geometry of complexes with CN4 and 6 as well as find out the stability of complexes with EAN rule.
4. Students able to understand merit and demerits of Sidgwick theory.
5. Students able to explain structure and magnetic behavior of complexes.
6. Students should know the assumptions and limitations of VBT and CFT.
7. Students able to compare the different approaches to bonding in coordination compounds.

Course Outcomes:

CO1. Know the various terms involved in coordination chemistry apply to coordination compounds.

CO2. Understanding the different theories of complex and various types of isomerism .

CO3. Use of EAN rule to calculate value of complexes and its stability.

CO4. Know the Sidgwick theory and formation square planner, tetrahedral octahedral complexes.

CO5. Know the structure and magnetic behavior of complexes.

CO6. Know the various assumption and limitations of VBT and CFT.

CO7. Know the different approaches to bonding in coordination compounds.

Topics and Learning Points:

Unit 1: Isomerism in Coordination Complexes (06L)

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

Unit 2: Sidgwick Theory (04L)

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

Unit 3: Pauling's Valence Bond Theory (08L)

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

Unit 4: Crystal Field Theory (08 L)

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

Unit 5: Molecular Orbital Theory of Coordination Complex (04L)

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

References:

1. Introduction to Electrochemistry by Glasstone–2nd edition.
2. Concise Inorganic Chemistry by J. D. Lee–5thedition.

3. Inorganic Chemistry,- D. F. Shiver & P. W. Atkins -C. H. Longford ELBS-2nd edition.
4. Basic Inorganic Chemistry, - F.A. Cotton and G.Wilkinson, WileyEastern Ltd 1992.
5. Concept and Model of Inorganic Chemistry by Douglas – Mc Daniels– 3rd edition.
6. Chemistry by Raymond Chang–5th edition
7. New Guide to Modern Valence Theory by G. I. Brown –3rd edition
8. Co-ordination Compounds by Baselo and Pearson.
9. Theoretical Inorganic Chemistry by Day and Selbin.
10. Inorganic Chemistry by A. G. Sharpe–3rd Edition.
11. Coordination Chemistry by A. K. De.

Choice Based Credit System Syllabus (2023 Pattern)

(As per NEP 2020)

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

Course: Inorganic Chemistry –I **Course Code**: CHE-302-MJM

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

	Programme Outcomes (POs)												
Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO13**
CO 1	3	2											
CO 2	3	2		2									
CO 3	3	2		2									
CO 4	3	2											
CO 5	3	2											
CO 6	3	2		2									
CO 7	3	2		2									

Justification for Mapping

PO1: Comprehensive Knowledge and Understanding

CO1: Students will understand key definitions and terminologies in coordination chemistry.
CO2: Students will comprehend isomerism in coordination compounds and analyze ligand arrangements.
CO3: Students will apply the Effective Atomic Number (EAN) rule to predict the stability of metal complexes.
CO4: Students will explain Sidgwick's theory and distinguish between molecular geometries of complexes.
CO5: Students will study structure and magnetic behavior of metal complexes.
CO6: Students will understand the assumptions and limitations of valence bond theory (VBT) and crystal field theory (CFT).
CO7: Students will evaluate different bonding approaches including molecular orbital theory in coordination chemistry.

PO2: Practical, Professional, and Procedural Knowledge

CO1: Students will apply terminology and formula writing in practical compound identification.
CO2: Students will use theories to interpret laboratory data and chemical behavior of coordination compounds.
CO3: Students will calculate EAN values and assess compound stability relevant to chemical industries.
CO4: Students will use theoretical models to predict shapes of coordination compounds.
CO5: Students will relate structure to observable magnetic properties.
CO6: Students will examine how bonding theories influence spectral and magnetic properties.
CO7: Students will compare bonding theories and apply them to different chemical contexts.

PO4: Specialized Skills and Competencies

CO2: Students will identify geometrical and structural isomers using VBT and CFT.
CO3: Students will use theoretical rules to interpret the bonding and stability of compounds.
CO6: Students will critically analyze limitations of traditional bonding theories.
CO7: Students will develop the ability to compare and contrast theoretical approaches used in bonding analysis.

CBCS Syllabus as per NEP 2020 (NEP 1.0) for T.Y.B.Sc. Chemistry (2023 Pattern)

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

Course Objectives:

1. Understand the concept of stereochemistry and its importance in organic chemistry.
2. Analyse how the stereochemistry of dimethyl cyclohexane influences its physical and chemical properties.
3. Understand the concept of nucleophilic substitution and its significance in organic reactions.
4. Analyse the role of leaving groups and nucleophiles in determining the rate and efficiency of nucleophilic substitution reactions.
5. Study the difference between E1 and E2 mechanisms, including the role of the base, leaving group, and solvent.
6. Understand how electron-donating and electron-withdrawing groups on the aromatic ring affect the reactivity and regioselectivity of EAS reactions.
7. Study the mechanism of nucleophilic aromatic substitution including the role of leaving groups and nucleophiles.

Course Outcomes:

After completion of this course students will be able to..

CO1. Students will be able to analyse and predict the most stable conformations of dimethyl cyclohexane, recognizing the influence of steric interactions and strain on molecular stability.

CO2. Students will apply their knowledge of conformational analysis to explain the physical and chemical properties of cyclohexane derivatives, including stereochemical preferences and substitution patterns.

CO3. Students will compare and contrast the S_N1 and S_N2 mechanisms, explaining how structural features of the substrate, the leaving group, and the nucleophile influence the reaction pathway and rate.

CO4. Students will apply principles of nucleophilic substitution to solve problems related to reaction mechanisms, including identifying the most likely pathway for a given substrate.

CO5. Students will be able to distinguish between the E1 and E2 mechanisms and predict the most likely mechanism based on the structure of the substrate, the strength of the base, and the solvent.
CO6. Students will be able to explain the mechanism of electrophilic aromatic substitution (EAS) reactions, including the formation of the arenium ion and the role of the electrophile.
CO7. Students will understand and describe the mechanism of nucleophilic aromatic substitution, including the role of electron-withdrawing groups.

Topics and Learning Points

Unit 1. Stereochemistry of di-substituted cyclohexane. [04 L]

Introduction,1,1-alkyl substituted cyclohexane,1,2; 1,3; 1,4-di methyl cyclohexane- geometrical isomerism, optical isomerism, Stability of con formation, Energy calculation.
Ref.1

Unit 2. Nucleophilic Substitution at Aliphatic Carbon [07 L]

Introduction, Nucleophiles and leaving groups, Mechanism of nucleophilic substitution, The SN1 reaction: Kinetic, mechanism and stereochemistry, stability of carbocation, The SN2 reaction: Kinetic, mechanism and stereochemistry. How to know whether a given reaction will follow SN1 or SN2 mechanism, SNi reaction and mechanism.
Ref.1

Unit 3. Elimination Reaction. [05L]

Introduction,1,1;1,2-elimination, E1, E2 and E1cB mechanism with evidences, Hoffmann and Saytzeff's elimination, Reactivity, Effect of structure, attacking and leaving groups.
Ref.1

Unit 4. Aromatic Electrophilic and Nucleophilic substitution reactions [08 L]

Introduction, Arenium ion mechanism, Effect of substituent groups (orientation, o/p directing and meta directing groups), Classification of substituent groups (activating and deactivating group). Mechanism of nitration, sulphonation, halogenation, Friedel-Craft reactions, diazo-coupling reactions, Ipso substitution. Addition elimination (SNAr), S_{N1}, Elimination-addition (benzyne) SN R1 reactions, reactivity.
Ref.1,4 and 5

Unit 5. Carbanion and Their Reactions [06L]

Introduction, Formation and stability of carbanion, Reaction involving carbanions and their mechanism-Aldol, Claisen, Dieckman and Perkin condensation; Synthesis and synthetic applications of –Wittig reagent. Ref. 5

References:

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

Choice Based Credit System Syllabus (2023 Pattern)

(As per NEP 2020)

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

Course Name: Organic Chemistry-I **Course Code**: CHE-303-MJM

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

	Programme Outcomes (POs)												
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2		2									
CO2	3	2		2									
CO3	3	2		3									
CO4	3	2		3								2	
CO5	3	2		3									
CO6	3	2		2									
CO7	3	2		2									

Justification of Mappings

PO1: Comprehensive Knowledge and Understanding

CO1: Students will understand the conformational behavior of dimethyl cyclohexane and factors influencing its stability.

CO2: Students will apply conformational principles to understand substitution patterns and properties.

CO3: Students will differentiate between SN1 and SN2 mechanisms and understand how reaction parameters affect the pathway.

CO4: Students will interpret nucleophilic substitution reactions based on structure and reactivity.

CO5: Students will distinguish between elimination mechanisms and assess reaction preferences.

CO6: Students will explain the mechanism of electrophilic aromatic substitution, including the formation and stabilization of the uranium ion.

CO7: Students will explain nucleophilic aromatic substitution mechanisms and the role of electron-withdrawing groups.

PO2: Practical, Professional, and Procedural Knowledge

CO1: Students will visualize molecular conformations and relate them to physical and chemical behaviour.

CO2: Students will identify stereo electronic effects in substituted cyclohexanes and apply theory to predict reactivity.

CO3: Students will analyze reaction mechanisms using structural and electronic principles.

CO4: Students will use mechanistic knowledge to solve substitution-related reaction problems.

CO5: Students will predict elimination reactions under varying experimental conditions.

CO6: Students will understand practical aspects of aromatic substitution reactions.

CO7: Students will analyze aromatic substitution patterns based on electronic effects and molecular structure.

PO4: Specialized Skills and Competencies
CO1: Students will develop spatial and structural understanding to assess stability.
CO2: Students will use stereochemical insights to solve complex conformational problems.
CO3: Students will evaluate nucleophilic substitution mechanisms through comparative analysis.
CO4: Students will predict and justify the most suitable reaction mechanism in a given scenario.
CO5: Students will compare elimination pathways and assess competing mechanisms.
CO6: Students will understand regioselectivity and orientation in electrophilic aromatic substitution.
CO7: Students will apply electronic effects to explain the reactivity of aromatic compounds.

PO12: Autonomy, Responsibility, and Accountability
CO4: Students will independently analyze and determine reaction mechanisms using logic and structural input.

CBCS Syllabus as per NEP 2020 (NEP 1.0) for T.Y.B.Sc. Chemistry (2023 Pattern)

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

Course Objectives:

1. To develop an understanding of the common ion effect, solubility product principles, and the conditions necessary for good precipitation in gravimetric analysis.
2. To investigate the impact of various factors like pH, temperature, solvent nature, and super saturation on precipitation formation, and learn methods to minimize co-precipitation and post-precipitation.
3. To familiarize students with the principles of spectrophotometry, including Lambert's and Beer's Laws, and their application in quantitative analysis.
4. To introduce students to the instrumentation of common analytical instruments, such as single and double beam spectrophotometers, colorimeters, and flame emission spectrophotometers.
5. To provide students with knowledge of atomic emission spectroscopy, including the theory, instrumentation, methods of analysis, and the interferences that may arise in FES.
6. To study the theory, instrumentation, and applications of atomic absorption spectroscopy, focusing on both qualitative and quantitative analysis of atomic species.
7. To develop practical skills in applying the learned techniques to analyze organic compounds, inorganic complexes, and other substances, through both theoretical and experimental approaches.

Course Outcomes:

After completion of this course students will be able to..

CO1. Upon completion, students will be able to perform gravimetric analysis, apply principles like solubility products, and ensure the formation of pure precipitates while minimizing errors like co-precipitation.

CO2. Students will be able to apply Beer's Law and Lambert's Law to conduct spectrophotometric analysis, interpret data, and solve related numerical problems for the determination of concentrations.

CO3. Students will gain proficiency in the principles of flame emission spectroscopy, including how to measure atomic emissions, identify interferences, and use methods like calibration curves for accurate analysis.

CO4. Students will be able to use atomic absorption spectroscopy to quantitatively analyze atomic species in various samples and troubleshoot any spectral or chemical interferences encountered.

CO5. Students will be able to operate and interpret results from common analytical instruments such as colorimeters, spectrophotometers, flame emission spectrometers, and atomic absorption spectrometers.

CO6. Students will be able to perform spectrophotometric titrations, using principles like the additivity of absorbance to determine concentrations in complex mixtures.

CO7. Students will develop skills in applying analytical techniques to study organic compounds and inorganic complexes, and handle quantitative analysis through various spectroscopic methods, ensuring accurate results.

Topics and Learning Points:

Unit 1. Gravimetric Analysis (10L)

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

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

Unit 2. Spectrophotometry (10L)

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

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

Unit 3. Flame Emission Spectroscopy (05L)

Introduction and theory of atomic emission spectroscopy, Instrumentation of single beam Flame emission spectrophotometer, Measurement of emission of atomic species, Interferences in emission spectroscopy, Methods of analysis- calibration curve method, Standard addition method, and internal, standard method, Qualitative and Quantitative Applications of FES, Numerical Problems.

Ref.3. Pg. 321-322,336-341,364-370,372-376

Unit 4. Atomic Absorption Spectroscopy (05L)

Introduction and theory of atomic absorption spectroscopy, Instrumentation of single beam Atomic

absorption Spectrophotometer, Measurement of absorbance of atomic species by AAS, Spectral and Chemical Interferences, Qualitative and Quantitative Applications of AAS. Numerical Problems.
Ref.3. Pg.321-342

References:

1. Text book of Quantitative Chemical Analysis- 3rd Edition, A .I. Vogel
2. Principles of Physical Chemistry 4th edition–Prutton and Marron
3. Instrumental Methods of Chemical Analysis-Chatwal and Anand
4. Basic Concept of Analytical Chemistry- 2nd edition S. M. Khopkar
5. Vogel's text book of Quantitative Inorganic Analysis- 4thedition
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
9. Instrumental methods of Chemical Analysis- Willard, Dean & Merrit-6th Edition

Choice Based Credit System Syllabus (2023 Pattern)

(As per NEP 2020)

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

Course: Analytical Chemistry- I **Course Code**: CHE-304 MJM

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

Mapping of Course Outcomes to Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	3		2								2	
CO2	3	3		2								2	
CO3	3	3		2									
CO4	3	3		2									
CO5	3	3		2					2				
CO6	3	3		2								2	
CO7	3	3		3	2				2			2	

Justification for Mapping

PO1: Comprehensive Knowledge and Understanding

CO1: Students will gain foundational understanding of gravimetric analysis, solubility product, and precipitation theory.

CO2: Students will comprehend Beer's and Lambert's Laws and apply them to real-world spectrophotometric data.

CO3: Students will understand atomic emission principles relevant to flame emission spectroscopy.

CO4: Students will grasp theoretical and operational principles of atomic absorption spectroscopy.

CO5: Students will be trained in theoretical foundations of modern analytical instrumentation.

CO6: Students will understand theoretical principles behind spectrophotometric titrations.

CO7: Students will demonstrate comprehensive theoretical knowledge in applying multiple analytical methods to both organic and inorganic compounds.

PO2: Practical, Professional, and Procedural Knowledge

CO1: Students will follow proper gravimetric techniques to avoid co-precipitation and errors.

CO2: Students will apply spectrophotometric procedures and interpret absorbance data effectively.

CO3: Students will develop procedural skills in handling and calibrating flame emission instruments.

CO4: Students will operate AAS instruments for real-time sample analysis and resolve practical challenges.

CO5: Students will perform standard operations using a range of analytical tools.

CO6: Students will perform titrations requiring precision and quantitative analysis.

CO7: Students will practice accurate sampling, dilution, and spectral analysis in analytical chemistry.

PO4: Specialized Skills and Competencies

CO1: Across all outcomes, students develop critical lab competencies including instrumentation, solution preparation, troubleshooting, and data accuracy—vital for specialized roles in industry or academia.
PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning
CO7: Students will apply analytical reasoning to determine results in complex chemical systems using various spectroscopic techniques.

PO9: Digital and Technological Skills
CO5: Students will gain experience using digital readouts, calibration software, and data processing tools.
CO7: Students will use software and analytical instruments that require digital proficiency for accuracy and reporting.

PO12: Autonomy, Responsibility, and Accountability
CO1: Students will work independently in precision-based tasks like gravimetric analysis.
CO2: Students will manage spectrophotometric experiments from setup to data interpretation.
CO6: Students will demonstrate responsibility during titrations involving absorbance readings.
CO7: Students will be accountable for accurate data, error handling, and reporting through multiple techniques.

CBCS Syllabus as per NEP 2020 (NEP 1.0) for T.Y.B.Sc. Chemistry (2023 Pattern)

Name of the Programme	: B.Sc. Chemistry
Program Code	: CHE
Class	: T.Y.B.Sc.
Semester	: V
Course Type	: MRM
Course Name	: Chemistry Practical –V
Course Code	: CHE- 305-MJM
No. of Lectures	: 60
No. of Credits	: 2 credits

Course Objective:

1. Understand the fundamental principles of physical, inorganic, and organic chemistry experiments.
2. Develop practical skills for the determination of physicochemical parameters like critical solution temperature, energy of activation, and reaction kinetics.
3. Apply gravimetric and conductometric techniques for quantitative analysis of inorganic substances.
4. Determine molecular and molar refractivity and understand its correlation with molecular structure.
5. Perform qualitative analysis of organic binary mixtures with systematic separation and identification.
6. Enhance skills in synthesizing coordination compounds using standard laboratory procedures.
7. Strengthen data analysis, calculation, result interpretation, and error analysis in practical chemistry.

Course Outcomes:

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

CO1. Perform experiments related to physical chemistry like critical solution temperature, reaction kinetics, energy of activation, and molar refractivity with accuracy.

CO2. Apply conductometric methods for titration of weak and strong acids or for estimation of metal ions.

CO3. Execute gravimetric methods for the quantitative estimation of metals like iron, barium, and nickel from given samples.

CO4. Synthesize and characterize inorganic complexes such as Potassium trioxalatoferrate(III), Tris-acetylacetanatochromium(III), and Tristhiourea Copper(I) sulphate.

CO5. Perform systematic qualitative analysis of binary organic mixtures and identify the components based on chemical tests.

CO6. Analyze experimental data, calculate results, and interpret findings logically with error analysis.

CO7. Develop laboratory safety practices, teamwork abilities, and professional skills in handling chemicals and instruments.

Topics and Learning Points

A) Physical Chemistry Practical

1. To study the effect of addition of salt on critical solution temperature of phenol- water System.
2. To determine the order of reaction between $K_2S_2O_8$ and KI by half-life method.
3. To determine the energy of activation of the reaction between potassium iodide and potassium persulphate.
4. To determine the specific refractivity's of the given liquids A and B and their mixture and hence determine the percentage composition their mixture C.
5. To determine the molecular refractivity of the given liquids A, B, C and D.
6. To determine the molar refraction of homologues methyl, ethyl and propyl alcohol and show the constancy contribution to the molar refraction by $-CH_2$ group.
7. Titration of a mixture of weak acid and strong acid with strong alkali by conductometry.
8. To estimate the amount of lead present in given solution of lead nitrate by conductometric titration with sodium sulphate

B) Inorganic Chemistry Practical (Any Four)

1) To determine the amount of Irongravimetrically as Fe_2O_3
2) To determine the amount of Barium gravimetrically as $BaSO_4$
3) To determine the amount of Nickel gravimetrically as Ni(DMG)
4) Preparation of Potassium trioxalatoferrate(III)
5) Preparation of Tris-acetylacetanatochromium(III)
6) Preparation of Tristhiourea Copper(I) sulphate

C) Organic Chemistry Practical: (5 Mixtures)

1. **Qualitative analysis of Binary mixtures:**
   - Determination of types of mixtures
   - Separation of binary mixture
   - Individual analysis of single compound

   a) Preliminary test
   b) To determine physical constant
   c) To determine elements
   d) To determine functional group

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 V) **Subject**: Chemistry

Course: Chemistry Practical –V **Course Code**: CHE-305-MJM

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

	Program Outcomes (POs)												
Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO13**
CO1	3	2		2	2								
CO2		3		2	2								
CO3		3		2	2								
CO4		2		3	2		2						
CO5		2		2						2	1		
CO6		3		3	2			2	2				
CO7	2	2				3				2	2	3	2

Justification of Mapping

PO1: Comprehensive Knowledge and Understanding

CO1: provide students with solid practical grounding in physical, inorganic, and analytical chemistry principles through experimental implementation.

CO7: fosters understanding of lab protocols and chemical properties that reflect theoretical principles in action.

PO2: Practical, Professional, and Procedural Knowledge

CO1: involve following standard lab procedures and chemical calculations with precision.

CO4–CO6: demonstrate skill in performing complex syntheses and interpreting data.

CO7: involves maintaining lab records, safety standards, and instrument handling as per professional norms.

PO4: Specialized Skills and Competencies

CO1–CO6 require advanced observation, interpretation, accuracy, and reporting skills, which are vital for scientific careers. Students demonstrate the ability to adapt methods, solve problems, and think analytically.

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

CO1–CO6 encourage students to apply classroom theory to lab situations, troubleshoot experiments, and analyze results with logic.CO6, in particular, emphasizes error calculation and analytical thinking.

PO6: Communication Skills and Collaboration

CO7 emphasizes effective communication, coordination in team settings, and clear documentation—critical for lab success and professional environments.

PO7: Research-related Skills

CO4 introduces concepts of synthesis, structural verification, and methodical experimentation,

building a base for future research activities.

PO8: Learning How to Learn Skills
CO6 promotes independent evaluation of lab data, encourages learning from outcomes, and adapting methods as needed.

PO9: Digital and Technological Skills
CO6 involves the use of digital tools (calculators, software, spreadsheets) for data analysis, error computation, and graphical representation.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy
CO5 builds collaborative skills and inclusivity when students work in pairs or groups during complex qualitative analysis.
CO7 further reinforces inclusive teamwork and respect for diverse viewpoints in lab settings.

PO11: Value Inculcation and Environmental Awareness
CO5 and CO7 promote ethical chemical handling, waste disposal, safety practices, and environmental responsibility in a laboratory environment.

PO12: Autonomy, Responsibility, and Accountability
CO7 develops professional ethics, self-monitoring during lab work, handling chemicals responsibly, and completing experiments within timeframes.

PO13: Community Engagement and Service
CO7 encourages a collaborative and community-learning lab environment, building habits beneficial for academic mentoring, peer support, and safety leadership roles.

CBCS Syllabus as per NEP 2020 (NEP 1.0) for T.Y.B.Sc. Chemistry (2023 Pattern)

Name of the Programme	: B.Sc. Chemistry
Program Code	: CHE
Class	: T.Y.B.Sc.
Semester	: V
Course Type	: Theory
Course Name	: Industrial Chemistry -I
Course Code	: CHE-306-MJE (A)
No. of Lectures	: 30
No. of Credits	: 2 credits

Course Objectives:

1. Students should know the terminology used industries.
2. Students able to understand the different steps in manufacturing of heavy chemical
3. Students should know the use sand application of cement, sugar and glass industries.
4. Students able to understand the different constituents and synthesis in fertilizers.
5. Student should understand aspects of small-scale industries.
6. Students should know modern approach towards chemical industry.
7. Students should able to understand general terms like patent, copyright, trademarks.

Course Outcomes:

CO1. Understanding the production processes and technologies used in the sugar, cement, fertilizer, and glass industries.

CO2. Analyzing the economic, environmental, and social impacts of these industries.

CO3. Identifying the key factors influencing the growth and development of these industries.

CO4. Evaluating the challenges and opportunities faced by the sugar, cement, fertilizer, and glass industries.

CO5. Applying relevant theories and concepts to solve problems and make informed decisions in these industries.

CO6. Developing effective communication and teamwork skills necessary for working in these industries.

CO7. Exploring sustainable practices and innovations in the sugar, cement, fertilizer, and glass industries.

Topics and Learning Points

Unit 1. Modern Approach to Chemical Industry (07 L)

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

Ref.1: Chapter 2 Pg. 26, 27, 31 to 36, Ref.4: Chapter 1 and 2, Ref.6: Chapter 1, 2 and 3

Unit 2. Manufacture of Heavy Chemicals (07 L)

Introduction, Manufacture of Ammonia (NH_3)

i. Manufacture by Modified Bosch-Haber's process.
ii. Physico-chemical principles and Its uses.

Manufacture of Sulphuric acid (H_2SO_4)

i. Manufacture by Contact process
ii. Physico-chemical principles and Its uses.

Manufacture of Nitric acid (HNO_3)

i. Manufacture by Ostwald's (Ammonia oxidation process)
ii. Physico-chemical principles. Its uses.

Ref. 7

Unit 3. Fertilizers (07 L)

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

Unit 4. Sugar Industry and Fermentation Industry (06 L)

Introduction, Important of sugar industry, Manufacture of cane sugar from sugarcane in India: Extraction of juice, Clarification, Concentration, crystallization, centrifugation, and other details of industrial process. Utilization of by-products of sugar industries. Testing and estimation of Analysis sugar by polarimetry.

Fermentation Industry: Introduction, importance, Basic requirements of fermentation process, Factors favoring fermentation, Fermentation operations. Manufacture of industrial alcohol from molasses, fruits, food grains, & ethylene, importance Power alcohol.

Ref.2, 3

Unit 5. Small Scale Industries (03 L)

Introduction and Aspects of Small-Scale Industries, Safety Matches, Agartbatties, Naphthalene balls, Wax Candles, Shoe Polishes, Gum Paste, Writing and fountain Pain ink, Plaster of Paris, Silicon Carbide Crucibles, how to Remove Stains and Liquid Phenyl Manufacturing.

References:

1. Principles of Industrial Chemistry, Chris A Clausen III and Guy Mattson, John Wiley and Sons, Inc. Somerset, 1978, New York.
2. Shreve's Chemical Process Industries, George T. Austin, 5 th Edition, The McGraw-Hill, Industrial Chemistry by B. K. Sharma, 16th Edition, 2011
3. Comprehensive Industrial Chemistry, P.G. More, 1st Edition, Pragati Prakashan, Meerut, Industrial Chemistry by B. K. Sharma, 16th Edition, 2011
4. Handbook of Industrial Chemistry Organic Chemicals, Mohammad Farhat Ali, Bassam M. El Ali, James G. Speight, The McGraw-Hill Companies, 2005, ISBN 0-07-141037-6
5. Industrial Chemistry-B.K. Sharma, Goyal publishing house, Meerut, Shreve's chemical process industries 5th Edition, G.T. Oustin, McGraw Hill
6. Rigel's handbook of Industrial chemistry, 9th Edition, Jems A. Kent Industrial chemistry –R.K. Das, 2nd Edition, 1976.

Choice Based Credit System Syllabus (2023 Pattern)

(As per NEP 2020)

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

Course: Industrial Chemistry -I **Course Code**:CHE-306-MJE(A)

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

	Programme Outcomes (POs)												
Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO13**
CO1	3	2		3	2				2				
CO2	3				3		2	2			3	2	
CO3	3		3		3		2					2	
CO4	3		3		3		2	2				2	
CO5		3		3	3		2	2	2			2	
CO6						3				2		2	2
CO7	3		2	2	2		2	2	2		3	2	2

Justification of Mapping

PO1: Comprehensive Knowledge and Understanding

CO1: Students will demonstrate knowledge of key production technologies used in the sugar, cement, fertilizer, and glass industries.
CO2: Students will understand the broad environmental, social, and economic implications of chemical industries.
CO3: Students will identify development factors that influence industrial chemistry sectors.
CO4: Students will evaluate the challenges and opportunities that arise in large-scale industrial settings.
CO7: Students will explore sustainable technologies applied in industrial production, demonstrating an understanding of evolving industrial knowledge.

PO2: Practical, Professional, and Procedural Knowledge

CO1: Students will gain insight into various standard processes, protocols, and manufacturing techniques used in key chemical industries.
CO5: Students will apply theoretical knowledge to make process improvements and decisions within industrial contexts.

PO3: Entrepreneurial Mindset and Knowledge

CO3: Students will identify factors such as raw material access, market demand, and cost-efficiency that influence industrial growth.
CO4: Students will evaluate business opportunities and market-related challenges faced by industrial sectors.
CO7: Students will explore green technologies and innovations that could foster new industrial ventures.

PO4: Specialized Skills and Competencies

CO1: Students will demonstrate subject-specific technical understanding of industrial operations.
CO5: Students will apply problem-solving skills to case studies related to industry challenges.
CO7: Students will propose sustainable strategies with sound technical justification.

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

CO1: Students will analyze and interpret industrial-scale processes.

CO2: Students will assess impacts and propose modifications.
CO3: Students will identify systemic industrial issues.
CO4: Students will evaluate operational risks and efficiencies.
CO5: Students will formulate solutions based on real industrial data.
CO7: Students will engage in critical thinking regarding sustainability practices.

PO6: Communication Skills and Collaboration

CO6: Students will develop the communication, documentation, and collaborative skills required to function efficiently in industrial environments.

PO7: Research-related Skills

CO2: Students will investigate social, economic, and environmental data related to industrial operations.
CO3: Students will explore data sources to identify development trends.
CO4: Students will use research methods to assess opportunities.
CO5: Students will apply analytical frameworks.
CO7: Students will investigate new and emerging technologies.

PO8: Learning How to Learn Skills

CO2: Students will independently explore impacts and case studies.
CO4: Students will refine their understanding based on complex real-world problems.
CO5: Students will continuously apply new tools and concepts.
CO7: Students will develop a habit of learning through technology and literature.

PO9: Digital and Technological Skills

CO1: Students will use digital models to understand and simulate industrial processes.
CO5: Students will apply technical and software tools to solve problems.
CO7: Students will explore modern technological innovations and digital tracking in industries.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

CO6: Students will demonstrate empathy, inclusivity, and team engagement in diverse industrial setups.

PO11: Value Inculcation and Environmental Awareness

CO2: Students will evaluate environmental responsibilities and ethical concerns in industrial activity.
CO7: Students will explore sustainable production and green chemistry alternatives.

PO13: Community Engagement and Service

CO6: Students will foster cooperative practices through team-based learning.
CO7: Students will relate industrial sustainability to broader social and environmental responsibility.

CBCS Syllabus as per NEP 2020 (NEP 1.0) for T.Y.B.Sc. Chemistry (2023 Pattern)

Name of the Programme	: B.Sc. Chemistry
Program Code	: CHE
Class	: T.Y.B.Sc.
Semester	: V
Course Type	:Major Elective Theory
Course Name	: Environmental and Green Chemistry–I
Course Code	: CHE- 306-MJE(B)
No. of Lectures	: 30
No. of Credits	: 2 credits

Course Objectives:

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

Course Outcomes:

After completing this course, students will be able to:

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

Topics and Learning Points

Unit 1: Concepts and Scope of Environmental Chemistry (02L)

Introduction, Terminologies, Units of concentration, Segments of Environment.

Unit 2: Atmosphere and Air Pollution (16L)

Composition and structure of atmosphere, Chemical and photochemical reactions in atmosphere, Chemistry of O_3, SOx, NOx and chlorides in atmosphere, Primary air pollutants: CO, NOx, SO_X, HC and Particulates as SPM or TSP, Sampling of air, Particulate matter: inorganic and organic, Smog: - reducing and photochemical, Mechanism of ozone Depletion, Stability and reactions of CFCs, Harmful effects of CFCs, CFCs substitutes Bhopal gas tragedy
Ref.1, Ref.3, Ref.5

Unit 3. Introduction to Green Chemistry (12L)

Chemistry is good, the environment and the five environmental spheres, what is environmental Chemistry? Environmental Pollution, what is green Chemistry? Green Chemistry and synthetic chemistry, Reduction of risk: Hazard and exposure the risk and no risks, Waste prevention, Basic principles of green chemistry, Examples based on green technology.
Ref: Green Chemistry by Stanley E Manahan, Chemchar Research Inc. (2006)-2ndEdn.
Ch.1, Pg.1- 17 and Ref. 6 Relevant pages.

References:

1. Environmental Chemistry–A. K. De, 5th Edition (New age international publishers)
2. Environmental Chemistry- J. W. Moore and E. A. Moore (Academic Press, New York)
3. Environmental Chemistry–A. K. Bhagi and C. R. Chatwal (Himalaya Publishing House)
4. Environmental Chemistry– H. Kaur 2nd Edition 2007, Pragati Prakashan Meerut, India
5. Environmental Chemistry with Green Chemistry – A.K. Das, Books and Allied (P) Ltd.
6. Green Chemistry by Stanley E Manahan, Chemchar Research Inc.(2006)-2nd Edn.

Choice Based Credit System Syllabus (2023 Pattern)

(As per NEP 2020)

Class: T.Y.B.Sc. (SEM V) **Subject:** Chemistry
Course: Environmental and Green Chemistry-I **Course Code:** CHE-306 -MJE (B)

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

	Programme Outcomes (Pos)												
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2		3	3				2				
CO2	3				3		2						
CO3	3		3		3		2						
CO4	3		3	3	3		2						
CO5		3		3	3		2		2				
CO6						3				2			
CO7	3		2		2		2						

Justification for Mapping

PO1: Comprehensive Knowledge and Understanding

CO1: Students will explain the production technologies used in sugar, cement, fertilizer, and glass industries, demonstrating foundational technical knowledge.
CO2: Students will analyze industrial impacts in economic, environmental, and social contexts, reflecting multidisciplinary awareness.
CO3: Students will interpret development trends and challenges in various industrial sectors.
CO4: Students will evaluate current sustainability measures and propose improvements based on industrial chemistry principles.
CO7: Students will exhibit a broad understanding of ethical and responsible industrial behavior.

PO2: Practical, Professional, and Procedural Knowledge

CO1: Students will recognize technical workflows, raw material selection, and process control practices used in major industries.
CO5: Students will apply chemistry concepts to real-life scenarios and process optimization challenges.

PO3: Entrepreneurial Mindset and Knowledge

CO3: Students will identify market and process factors affecting industrial growth.
CO4: Students will evaluate potential for innovation and sustainable industrial development.
CO7: Students will exhibit socially responsible innovation awareness for greener and safer industry practices.

PO4: Specialized Skills and Competencies

CO1: Students will understand technical competencies necessary for production process evaluation.
CO4: Students will demonstrate evaluative skills to recommend environmentally improved alternatives.
CO5: Students will apply problem-solving strategies in practical industrial scenarios.

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

CO1: Students will integrate theory and practice to understand industrial operations.
CO2: Students will critically assess multiple dimensions of industrial activity.
CO3: Students will interpret strategic growth factors.
CO4: Students will propose sustainable solutions to industry problems.
CO5: Students will solve real-world chemical and industrial challenges.

PO6: Communication Skills and Collaboration

CO6: Students will develop collaborative and communicative competencies vital for professional teamwork in industry.

PO7: Research-related Skills

CO2: Students will investigate impacts of industrial processes using data and case studies.
CO3: Students will collect and interpret development and sustainability data.
CO4: Students will research and propose innovative green chemistry applications.
CO5: Students will use structured approaches to analyze real-world cases.

PO9: Digital and Technological Skills

CO1: Students will identify technologies used in processing and pollution control.
CO5: Students will apply digital tools for evaluating and presenting sustainable solutions.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

CO6: Students will demonstrate interpersonal skills and respect for diversity in team-based industrial projects.

CBCS Syllabus as per NEP 2020 (NEP 1.0) for T.Y.B.Sc. Chemistry (2023 Pattern)

Name of the Programme	: B.Sc. Chemistry
Program Code	: CHE
Class	: T.Y.B.Sc.
Semester	:V
Course Type	: Major Elective Theory
Course Name	: Agri and Dairy Chemistry-I
Course Code	: CHE- 306-MJE (C)
No. of Lectures	: 30
No. of Credits	: 2 credits

Course Objective:

1. Understand the fundamental components and properties of soil relevant to agriculture.
2. Analyse the challenges of problematic soils and explore methods for reclamation and soil testing.
3. Study the basic principles and processes involved in dairy chemistry and milk processing.
4. Examine the manufacture and treatment of various types of milk.
5. Understand practical aspects of dairy operations, including equipment and quality control.
6. Develop skills to assess and improve the sustainability and safety of agricultural and dairy practices.
7. Build communication, teamwork, and ethical awareness related to agricultural and food industries.

Course Outcomes:

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

CO1. Describe the physical and chemical properties of soil and their role in agriculture.

CO2. Identify problematic soils and explain techniques for their reclamation and analysis.

CO3. Demonstrate understanding of dairy chemistry processes like pasteurization and cream separation.

CO4. Explain the production, packaging, and preservation of various milk types.

CO5. Apply principles of soil and dairy chemistry to solve practical problems.

CO6. Communicate scientific and technical information effectively in team settings.

CO7. Recognize ethical, environmental, and societal responsibilities in soil and dairy practices.

Topics and Learning Points:

Unit 1- Soil Chemistry **(08 L)**

Role of agriculture chemistry, Scope and importance of agricultural chemistry, Definition of soil, Soil components-mineral component, organic matter or humus, soil atmosphere, soil water, soil microorganism, Physical properties of soil- soil texture, soil structure, soil colour, soil temp, soil density, porosity of soil, Surface soil and sub-soil, Chemical properties of soil, soil reactions and solutions, Factor controlling soil reaction, buffering capacity, importance of buffer action in agriculture, ion exchange

Unit 2- Problematic Soil and Soil testing **08 L)**

Acid soil-formation of acid soil, effect of soil acidity of soil, reclamation of acidic soil, Alkali Soil-formation of alkali soil, reclamation of alkali soil, Classification of alkali soil- saline soil, saline alkali soil, non-saline alkali soil, Calcareous soils, Introduction to soil testing, Objectives of soil testing, Phases of soil testing- collection of soil sample, analysis in the laboratory and fertilizer applications

Unit 3- Common Dairy Processes **(06 L)**

(Manufacture, storage and packaging)

Introduction to Dairy Chemistry, 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 separator slime Pasteurization of milk, flow sheet diagram, process receiving milk, preheating filtration, clarification, cooling and storage

Unit 4- Special Milks **(08 L)**

Sterilized milk- Definition, method of manufacture in detail, Advantages and disadvantages. Homogenized milk, Definition, merits and demerits factor influencing homogenization, Process of manufacture. Soft curd milk- Definition, characteristics, method of preparation of soft curd milk. Flavored milk- Definition, types, method of manufacture flow sheet diagram. Vitaminised /irradiated milk- Definition, method of manufacture. Fermented milk-Definition, method of manufacture. Standardized milk- Definition, method of manufacture.

References:

1. A text book of soil science (Recise Ed) J.A. Daji, Revised by J.R. Adam, N.D. Patil, Media promoters and publishers, Mumabi, 1996
2. Introduction to Agronomy and soil, water management, V.G. Vaidya, K.R. Sahashtra Buddhe (Continental Prakashan)
3. Principals of soil science, M.M. Rai, Millian complex of India, Bombay, 1977
4. Outline of Dairy Technology- Oxfored University press By- Sukumar De. (Edition-1983)

Choice Based Credit System Syllabus (2023 Pattern)

(As per NEP 2020)

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

Course: Agri and Dairy Chemistry-I **Course Code**: CHE- 306-MJE (C)

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

	Programme Outcomes (POs)												
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2		3									
CO2	3	3	2									2	
CO3	3												
CO4	3						2						
CO5	3	3			3				2				
CO6						3				2			2
CO7	3							2			3		

Justification for Mapping

PO1: Comprehensive Knowledge and Understanding

CO1: Students will demonstrate understanding of soil properties and their agricultural applications.
CO2: Students will describe different soil types and approaches to handle problem soils.
CO3: Students will explain basic dairy processes, such as pasteurization and cream separation.
CO4: Students will describe preservation, packaging, and production of milk and dairy products.
CO7: Students will exhibit broad knowledge of environmental and ethical practices in agriculture and dairy.

PO2: Practical, Professional, and Procedural Knowledge

CO1: Students will link theoretical chemistry to practical farming practices.
CO2: Students will learn and explain procedural techniques for soil testing and reclamation.
CO5: Students will solve real-life problems in soil and dairy management based on scientific knowledge

PO3: Entrepreneurial Mindset and Knowledge

CO2: Students will identify sustainable and innovative practices that can benefit agribusiness or dairy startups.

PO4: Specialized Skills and Competencies

CO1: Students will gain skills in analytical evaluation of soil quality and dairy processes, and apply these in practical situations.

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

CO5: Students will apply chemistry-based solutions to resolve real-life issues in agricultural and dairy settings.

PO6: Communication Skills and Collaboration
CO6: Students will develop skills to communicate scientific concepts clearly and collaborate in group activities.

PO7: Research-related Skills
CO4: Students will carry out structured study and experimentation to understand soil chemistry and dairy processing.

PO8: Learning How to Learn Skills
CO7: Students will adapt their learning to solve problems, develop new practices, and engage in lifelong learning.

PO9: Digital and Technological Skills
CO5: Students will learn about instrumentation, digital controls, and analysis used in dairy and soil chemistry labs.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy
CO6: Students will work in diverse groups, share responsibilities, and respect team dynamics.

PO11: Value Inculcation and Environmental Awareness
CO7: Students will consider the impact of agricultural practices on the environment and act ethically.

PO12: Autonomy, Responsibility, and Accountability
CO2: Students will conduct tasks independently and responsibly in lab and field-based settings.

PO13: Community Engagement and Service
CO6: Students will share agricultural and dairy knowledge to benefit society, promote environmental sustainability, and improve local practices.

CBCS Syllabus as per NEP 2020 (NEP 1.0) for T.Y.B.Sc. Chemistry (2023 Pattern)

Name of the Programme	: B.Sc. Chemistry
Program Code	: CHE
Class	: T.Y.B.Sc.
Semester	:V
Course Type	: Minor Theory
Course Name	: Applied Chemistry–I
Course Code	: CHE-311-MN
No. of Lectures	: 30
No. of Credits	: 2 credits

Course Objective:

1. Learn how to define and calculate the rate of a chemical reaction, including factors that affect reaction rates.
2. Identify and describe how concentration, temperature, surface area, and catalysts influence the rate of a chemical reaction.
3. Understand the various types of chemical bonds—ionic, covalent, and metallic—and how they affect the properties of substances.
4. Learn how electron pairs and atomic orbitals contribute to the formation of bonds and molecular shapes.
5. Understand the concept of orbital hybridization in relation to bonding in molecules and its influence on molecular geometry.
6. Study the common reactions of alcohols, such as oxidation (to aldehydes, ketones, or carboxylic acids), dehydration, and esterification.
7. Understand the structure of carboxyl groups (-COOH) and their corresponding IUPAC nomenclature and the reactions of carboxylic acids, including esterification, decarboxylation, and reduction.

Course Outcomes:

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

CO1. Students will be able to define reaction rates and determine the factors that influence the rate of chemical reactions, including concentration, temperature, and catalysts.
CO2. Students will be able to derive and apply rate laws from experimental data, calculate the order of reactions, and interpret the implications of rate constants.
CO3. Students will be able to identify and explain the different types of chemical bonds (ionic, covalent, metallic) and their respective characteristics.
CO4. Students will be able to predict and analyse molecular shapes, bond angles, and molecular polarity.
CO5. Students will be able to describe orbital hybridization and its role in determining the geometry and bonding of molecules.

CO6. Students will be able to identify the functional group of alcohols, understand their properties (such as polarity, solubility, and boiling points), and describe their chemical reactivity.

CO7. Students will be able to predict and describe the chemical reactions of alcohols, such as oxidation, esterification, and dehydration.

Topics and Learning Points:

Unit-1 Chemical Thermodynamics **[10 L]**

Thermodynamic terms; System, surrounding, boundaries, types of system, Intensive and Extensive properties, State functions and path functions, Thermodynamic processes. First law of thermodynamics: Concept of heat (q), work (w), internal energy (U), enthalpy, heat capacity, relation between heat capacities, sign conventions, calculations of heat, work, internal energy and enthalpy (H). Thermochemistry: Heat of reactions, standard states, enthalpy of formation of molecules, enthalpy of combustion and its applications, calculations of bond energy, bond dissociation energy and resonance energy from thermochemical data, Kirchhoff's equation

(Numerical problems expected wherever necessary)

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

Attainment of stable configuration, type of bonds as ionic, covalent, co-ordinate and metallic. Types of overlap, formation of σ and π bonds, s-s overlap, s-p overlap and p-p overlap with suitable example. Theories of bonding: Valence bond theory a) Heitler-London theory b) Pauling-Slater theory

Unit-3 Stereochemistry **[10 L]**

Concept of isomerism, representation of organic molecules, conformational isomerism in alkane (Ethane, Propane and n-Butane) with energy profile diagram. Geometrical isomerism- Conditions for geometrical isomers, E / Z nomenclature of geometrical isomers. Optical isomers- Chirality, specific rotation, enantiomers, R/S nomenclature of one chiral carbon.

References:

1. Organic Chemistry, Morrison and Boyd, 6th Ed Prentice Hall, New Delhi-2001.
2. Stereochemistry of carbon compounds, E. L. Eliel
3. Inorganic Chemistry by Vogel 6th edition
4. Concise inorganic Chemistry by J. D. Lee 5th edition

Choice Based Credit System Syllabus (2023 Pattern)

(As per NEP 2020)

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

Course: Applied Chemistry–I **Course Code**: CHE-311-MN

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

Mapping of Course Outcomes to Program Outcome

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

Justification for Mapping

PO1: Comprehensive Knowledge and Understanding

CO1: Students will understand fundamental concepts of reaction kinetics including rate and influencing factors.
CO2: Students will apply knowledge of kinetics and rate laws to real-world chemical systems.
CO3: Students will demonstrate understanding of types of chemical bonds and their applications.
CO4: Students will explain molecular geometry and bonding theories.
CO5: Students will understand hybridization and its effect on molecular structure.
CO6: Students will explain the structure, classification, and reactivity of alcohols.

PO2: Practical, Professional, and Procedural Knowledge

CO1: Students will analyze how changes in reaction conditions affect kinetics.
CO6: Students will relate theoretical concepts to practical functional group chemistry.

PO3: Entrepreneurial Mindset and Knowledge

CO6: Students will understand applications of alcohol chemistry in the synthesis of commercial and pharmaceutical compounds.

PO4: Specialized Skills and Competencies

CO2: Students will analyze reaction mechanisms and solve numerical problems in kinetics.
CO4: Students will utilize VSEPR and hybridization models to determine geometry and polarity.

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

CO2: Students will solve problems involving rate laws and reaction order.
CO4: Students will apply bonding and organic chemistry knowledge to reaction prediction and structural analysis.

PO6: Communication Skills and Collaboration

CO7: Students will interpret and explain chemical reactivity and mechanism findings with peers and in reports.

PO7: Research-related Skills
CO2: Students will use kinetic data to deduce mechanisms, supporting scientific inquiry.
CO5: Students will relate bonding theories to physical and chemical data.

PO8: Learning How to Learn Skills
CO5: Students will independently explore and connect bonding, hybridization, and functional group reactivity across disciplines.

PO9: Digital and Technological Skills
CO2: Students will apply graphs, simulations, and software tools to analyze kinetic data.

PO11: Value Inculcation and Environmental Awareness
CO7: Students will recognize the relevance of organic reactions in environmental and health contexts.

PO12: Autonomy, Responsibility, and Accountability
CO2: Students will conduct data-based predictions and chemical analysis with academic integrity and responsibility.

PO13: Community Engagement and Service
CO6: Students will understand applications of alcohol chemistry in public health, pharmaceuticals, and sustainability.

CBCS Syllabus as per NEP 2020 (NEP 1.0) for T.Y.B.Sc. Chemistry (2023 Pattern)

Name of the Programme	: B.Sc. Chemistry
Program Code	: CHE
Class	: T.Y.B.Sc.
Semester	:V
Course Type	: Minor Practical
Course Name	: Practicals on Applied Chemistry
Course Code	: CHE- 312-MN
No. of Lectures	: 60
No. of Credits	: 2 credits

Course Objective:

1. To understand the principles of chemical kinetics and their application in rate law determination.
2. To develop skills for analyzing physical properties such as solubility and enthalpy of solution.
3. To build competency in conducting ester hydrolysis under acid/base catalysis and interpret kinetic data.
4. To perform qualitative analysis of organic compounds and identify unknown substances using classical methods.
5. To synthesize and characterize coordination compounds through inorganic synthetic techniques.
6. To enhance the use of lab instruments (e.g., conductometer, stopwatch, heating setups) with procedural accuracy.
7. To promote laboratory safety, documentation skills, collaborative work, and ethical lab practices

Course Outcomes:

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

CO1. Determine reaction rate constants and deduce reaction order using chemical kinetics experiments.
CO2. Analyse thermodynamic properties such as solubility and enthalpy of solution.
CO3. Differentiate between acid and base catalysis in ester hydrolysis through experimental techniques.
CO4. Identify unknown organic compounds based on systematic qualitative analysis procedures.
CO5. Synthesize, isolate, and characterize various coordination compounds of transition metals.
CO6. Operate laboratory apparatus effectively and interpret experimental data with scientific accuracy.
CO7. Demonstrate lab safety, maintain ethical standards, and collaborate efficiently in a team environment.

Topics and Learning Points

Section I: Physical Chemistry Practical (Any five experiments)

1. Determination of rate constant of a reaction between potassium per sulphate and potassium iodide for equal initial concentration of the reactants.
2. Determination of solubility of Benzoic acid at different temperature and calculate ΔH of solution.
3. To determine the first order rate constant of acid catalysed ester hydrolysis.
4. To determine the rate constant of base catalysed ester hydrolysis.
5. Determination of the relative strength of HCl and H2SO4 by Studying the kinetics of hydrolysis of ester.
6. To study the kinetics of iodination of acetone and hence determine the order of reaction.

Section II: Organic Chemistry Practical

1) Organic Qualitative Analysis (Six Single compounds)
Identification of organic compounds through –

a) Type determination b) preliminary tests c) detection of elements (Sodium fusion tests) Detection of functional groups) melting point/Boiling point

Acid: benzoic, salicylic, phthalic, cinnamic, oxalic, salicylic acid

Phenol: α-naphthol, β-naphthol, resorcinol, o-nitrophenol, p-nitrophenol

Base: Aniline, p-toludine, diphenylamine, N, N-dimethylaniline, o-nitroaniline m-nitroaniline, p-nitroaniline

Neutral : Benzaldehyde, glucose, fructose, acetone, ethylmethyl ketone, acetophenone, methyl acetate, ethyl acetate, naphthalene, Anthracene, Nitrobenzene, m-dinitrobenzene, Acetamide, Urea, Acetanilide, Chloroform, Carbon tetrachloride, Thiourea.

Section III: Inorganic Chemistry Practical

Synthesis of coordination compounds (Any Four)

$[Mn(acac)_3]$	$[Ni(en)_3]Cl_2$	$[Co(NO_2)_3(NH_3)_3]$
$K_3[Fe(OX)_3]$	$[Co(NH_3)_5Cl]Cl_2$	$[Cu(acac)_2]$

References:

1. Senior Practical Physical Chemistry, Khosla, Garg & Gulati, R, Chand & Co
2. Practical Physical Chemistry, A M. Jemes, F. E. Prichard,3rdedn, Longman.
3. Advanced Practical Physical Chemistry, J. B. Yadav, Goel Publishing house
4. Organic Qualitative Analysis–A. I. Vogel
5. Vogel's Qualitative Inorganic Analysis, Svehla G. Pearson Education, 2012
6. 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 V) **Subject**: Chemistry

Course: Practicals on Applied Chemistry **Course Code**: CHE-312-MN

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

Mapping of Course Outcomes to Program Outcome

	Programme Outcomes (POs)												
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	3		2	3		2		2				
CO2	3	3		2	3		2		2		2		
CO3	3	3		2	3		2		2				
CO4	3	3		2	3		2		2				
CO5	3	3		2	3		2		2				
CO6	3	3		2	3	2	2	2	2				
CO7	2	3				3		2		2	2	2	2

Justification for Mapping

PO1: Comprehensive Knowledge and Understanding

CO1: Students will apply foundational principles of chemical kinetics to determine rate constants and reaction orders.
CO2: Students will demonstrate understanding of thermodynamic properties—solubility and enthalpy—in solution studies.
CO3: Students will explain acid- and base-catalysed mechanisms in ester hydrolysis using core catalysis theory.
CO4: Students will leverage organic chemistry fundamentals to systematically identify unknown compounds.
CO5: Students will comprehend coordination chemistry through synthesis, isolation, and characterization of metal complexes.
CO6: Students will exhibit knowledge of laboratory instrumentation and data interpretation techniques.
CO7: Students will recognize safety norms and ethical guidelines underlying all practical work.

PO2: Practical, Professional, and Procedural Knowledge

CO1: Executes standard kinetics experiments with precision in measurement and calculation.
CO2: Conducts solubility and calorimetry protocols accurately, observing procedural rigor.
CO3: Differentiates acid vs. base catalysis via controlled experimental setups.
CO4: Follows systematic qualitative analysis procedures to identify organic compounds.
CO5: Applies standard laboratory methods for synthesis and purification of coordination compounds.
CO6: Operates and calibrates laboratory apparatus, maintaining professional documentation.
CO7: Implements lab safety procedures, ethical standards, and collaborative workflows.

PO4: Specialized Skills and Competencies
CO1: Develops kinetic modelling and data-analysis skills.
CO2: Gains competence in measuring and interpreting thermodynamic quantities.
CO3: Refines analytical skills in catalysis mechanism investigation.
CO4: Masters classical qualitative tests for organic identification.
CO5: Demonstrates technical ability in synthesis, isolation, and spectral/analytical characterization.
CO6: Builds proficiency in handling specialized glassware, instrumentation, and software tools.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning
CO1: Applies reaction-rate theory to troubleshoot and optimize reactions.
CO2: Uses thermodynamic concepts to address solubility and heat-change problems.
CO3: Solves mechanistic puzzles by comparing catalytic pathways.
CO4: Deduces unknown structures through logical analysis of qualitative data.
CO5: Designs and executes synthesis routes for coordination complexes.
CO6: Interprets experimental data, performs error analysis, and draws valid conclusions.

PO6: Communication Skills and Collaboration
CO6: Clearly documents procedures and results, and presents findings to peers.
CO7: Works effectively in teams, sharing responsibilities and communicating safety and ethical concerns.

PO7: Research-related Skills
CO1: Designs and carries out kinetics experiments to test hypotheses.
CO2: Plans thermodynamic measurements and analyses data critically.
CO3: Investigates catalytic mechanisms through structured experimentation.
CO4: Executes methodical organic analyses to identify unknowns.
CO5: Conducts systematic studies in coordination chemistry synthesis.
CO6: Records and evaluates experimental observations rigorously.

PO8: Learning How to Learn Skills
CO6: Adapts laboratory techniques in response to observed results and feedback.
CO7: Seeks out new safety practices and ethical guidelines to continually improve performance.

PO9: Digital and Technological Skills
CO1: Utilizes digital data-logging devices, graphing software, and instrument interfaces for precise measurement and analysis.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy
CO7: Demonstrates respect for diverse backgrounds in team-based lab activities and peer mentoring.

PO11: Value Inculcation and Environmental Awareness
CO2: Assesses environmental implications of thermodynamic processes.
CO7: Practices ethical disposal of reagents and promotes sustainability in lab work.

PO12: Autonomy, Responsibility, and Accountability
CO7: Shows initiative in following protocols independently and takes responsibility for experimental outcomes.

CBCS Syllabus as per NEP 2020 (NEP 1.0) for T.Y.B.Sc. Chemistry (2023 Pattern)

Name of the Programme	: B.Sc. Chemistry
Program Code	: CHE
Class	: T.Y.B.Sc.
Semester	: V
Course Type	: Practical
Course Name	: Advanced Chemistry Practical
Course Code	: CHE-321-VSC
No. of Lectures	: 60
No. of Credits	: 2 credits

Course Objective:

1. To develop practical understanding of physical chemistry through experiments involving kinetics, equilibrium, and analytical methods.
2. To enable students to analyze and estimate chemical species using titrimetric and colorimetric methods.
3. To familiarize students with preparation and purification techniques in organic chemistry.
4. To promote the application of laboratory techniques in solving real-world chemical problems.
5. To develop the ability to accurately record, analyze, and interpret experimental data.
6. To enhance skills in using instruments like colorimeters, conductometers, and viscometers.
7. To install awareness of laboratory safety, ethics, teamwork, and reporting in a chemistry lab setting.

Course Outcomes:

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

CO1. Perform physical chemistry experiments to determine constants such as reaction rates, molecular weights, and acidity/basicity.

CO2. Accurately conduct titrimetric and colorimetric analysis to estimate metal ions and compounds in inorganic samples.

CO3. Synthesize organic compounds using different reaction techniques and catalysts.

CO4. Apply analytical chemistry techniques to quantify biomolecules and industrial products like oils and antacids.

CO5. Use laboratory instruments such as colorimeter, conductometer, and viscometer with proper calibration and technique.

CO6. Record, interpret, and present experimental results effectively using standard scientific formats.

CO7. Demonstrate responsibility for lab safety, ethical practice, and effective collaboration with peers.

Topics and Learning Points:

Unit-1: Physical Chemistry Practical (Any Five)

1. To determine the indicator constant of methyl red indicator.
2. To determine the concentration of a given solution of Fe (III) using ammonium thiocyanate by colorimetric method.
3. To determine the concentration of given unknown solution of Cobalt solution using R- Nitroso salt at 550 nm by colorimetric method.
4. To determine the order of reaction for the oxidation of ethanol by potassium dichromate or potassium permanganate in acidic medium calorimetrically.
5. To determine the velocity constant of the hydrolysis of ethyl acetate by sodium hydroxide solution by conductometric method.
6. Determination relative strength of acetic acid and monochloroacetic acid
7. To determine the molecular weight of a high polymer using its solution with different concentrations by viscosity measurements.

Unit-2: Inorganic Chemistry Practical

A. Titration (Any Two)

1. Manganese by Volhard's Method
2. Estimation of NO_2^- by using KMnO4
3. Estimation of % purity of given sample of NaCl

B. Colorimetry (Any Two)

1. Colorimetric estimation Iron by using ammonium thiocyanate
2. Colorimetric estimation Cobalt by using R-Nitroso salt
3. Colorimetric estimation Titanium by using H_2O_2

Unit-3: Organic Chemistry Practical

A. Preparation (Any Three)

1. Nitration of phenol and its derivatives using Calcium Nitrate Bromination of acetanilide using Ceric ammonium nitrate in aqueous medium
2. Preparation of 1,4-dihydropyrimidinone from ethyl acetoacetate, benzaldehyde and urea using oxalic acid as a catalyst.
3. To determine the amount of glucose in the given solution by hypoiodite method.
4. Preparation of dibenzal propanone from benzaldehyde and acetone using $LiOH.H_2O/NaOH$

B. Estimation (Any Two)

1. To determine the amount of glycine by formal titration method.
2. To determine the saponification value of an oil.
3. To determine the amount of alkali content in anta acid using HCl.

References:

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

Choice Based Credit System Syllabus (2023 Pattern)

(As per NEP 2020)

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

Course: Advanced Chemistry Practical **Course Code**: CHE-321-VSC

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

	Programme Outcomes (POs)												
Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO13**
CO1	3	3		3	3		2						
CO2	3	3		3	3		2		2				
CO3	3	3	2	3	3		2						
CO4	3	3		3	3		2		2		2		
CO5	3	3	2	3	3		2	2	3				
CO6	3	3		3	3	3	2	2	2	2		2	2
CO7	2	3			2	3		2		2	3	3	2

Justification for Mapping

PO1: Comprehensive Knowledge and Understanding

CO1: Students will perform experiments related to physical chemistry, reinforcing fundamental theories through practical measurement of rates, molecular properties, and acidity.
CO2: Students will demonstrate understanding of classical and instrumental inorganic analysis.
CO3: Students will integrate organic synthesis concepts with reaction mechanisms and catalyst functions.
CO4: Students will apply analytical chemistry for quantifying real-life samples, demonstrating foundational understanding of biomolecular chemistry.
CO5: Students will exhibit understanding of instrumentation principles.
CO6: Students will demonstrate applied knowledge of the scientific method and chemical safety.

PO2: Practical, Professional, and Procedural Knowledge

CO1: Students will perform standard lab protocols, demonstrating analytical accuracy and professional lab conduct.
CO6: Students will effectively report and interpret experimental outcomes using scientific conventions.
CO7: Students will adhere to laboratory procedures and safety regulations.

PO3: Entrepreneurial Mindset and Knowledge

CO5: Students will explore methods applicable in industrial chemistry, product formulation, and quality assurance—key to innovation and entrepreneurship.

PO4: Specialized Skills and Competencies

CO5: Students will develop technical skills in experimental execution, handling of apparatus, and quantitative analysis.

CO6: Students will present scientific findings in formats accepted by the research and industry communities.

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

CO5: Students will troubleshoot reactions, verify results, and interpret complex data, building strong analytical capabilities.
CO6: Students will draw logical conclusions from observed results.

PO6: Communication Skills and Collaboration

CO6: Students will organize and communicate data effectively through reports, charts, and presentations.
CO7: Students will demonstrate collaborative lab skills and respect for diverse working environments.

PO7: Research-related Skills

CO5: Students will plan and carry out experiments methodically, maintain observation logs, and evaluate results critically.
CO6: Students will analyze, document, and summarize experimental findings scientifically.

PO8: Learning How to Learn Skills

CO7: Students will adapt to new laboratory challenges and equipment, developing independent, reflective learning skills.

PO9: Digital and Technological Skills

CO5: Students will use laboratory instruments with precision and understand calibration procedures and data logging methods.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

CO7: Students will participate in inclusive teamwork and develop sensitivity to ethical and social aspects of laboratory work.

PO11: Value Inculcation and Environmental Awareness

CO7: Students will follow safe practices and understand chemical impacts on health and the environment.

PO12: Autonomy, Responsibility, and Accountability

CO6: Students will manage time, tasks, and lab work responsibly and ethically.

PO13: Community Engagement and Service

CO7: Students will foster a culture of safety, peer learning, and knowledge sharing in the academic and professional community.