

Shree Warana Vibhag Shikshan Mandal's

WARANA UNIVERSITY, WARANANAGAR

(A State Public University established under Section 3 (6) of MPUA, 2016)

॥ विद्या सर्वस्य भूषणम् ॥



Established: 2025

**Structure & Syllabus for
Bachelor of Science-B.Sc. in Chemistry
UNDER
Faculty of Science & Technology
B.Sc. Part –I (Semester- I and II)
Structure and Syllabus in Accordance With
National Education Policy - 2020
Having Choice Based Credit System
With Multiple Entry and Multiple Exit Options
To Be Implemented from Academic Year 2025-26
Onwards**

(Subject to the modifications to be made from time to time)

Sr. No.	CONTENT	Page No
1	Preamble	2
2	General Objectives of the Program	3
3	Program Learning Outcomes(PoS)	3
4	Program Specific Outcomes (PSOs)	3
5	Eligibility	4
6	Duration	4
7	Medium of Language	4
8	Multiple Entry Multiple Exit Instructions	4
9	Scheme of Teaching and Examination	5
10	Structure of Program	11
11	Note on OE Courses	16
12	Syllabus	17
13	Question Paper Nature	

1. Preamble:

The National Education Policy 2020 for higher education aims to transform the existing higher education system in India. This policy emphasizes on promoting interdisciplinary studies, introducing new subjects, and providing flexibility in courses and fresh opportunities for students. It aims to increase the Gross Enrolment Ratio (GER) in higher education, provide multiple entry and exit options, and allow students to choose courses according to their interests and aptitude. The policy envisions setting up of a National Research Foundation, a National Education Technology Forum, and setting up of more Higher Education Institutions in the country. The policy is aimed at creating a holistic and flexible education system that is adaptive to the needs of the 21st century.

The B.Sc. Chemistry syllabi are designed to provide a comprehensive and in-depth understanding of the fascinating world of chemistry. We aim to nurture the intellectual curiosity, sharpen their scientific temper, preparing them for successful careers in various sectors of the chemical sciences so that, students to keep updated on recent developments in the field. The Program exposes students to significant advances in chemical sciences as well as related fields through learning; innovative pedagogies and assessment strategies; multidisciplinary and Interdisciplinary education; creative and critical thinking; student centric participatory

learning; imaginative abilities and flexible curricular structures to enable creative combination of disciplines for the study.

2. General Objectives of the Program:

Chemistry is a pervasive subject. All the branches of science need chemistry. It is an experimental science and students need to trend in practicals to get expertise in doing fine experiments and handle sophisticated instruments. Along with the data obtained its statistical analysis is also required to establish authenticity in the fields like environmental science, space chemistry and biotechnology. There is an immense potentiality for chemistry to undertake advanced research or in Industries as skilled chemists.

3. Program Outcomes of the Program (POs):

PO-1:- Students will gain fundamental knowledge of chemistry which will help them with PG Studies and Research

PO-2:- Students will be able to know good laboratory practices and lab safety. PO-3:- To make the learner proficient in analyzing the various observations and chemical phenomena presented to him during the course.

PO-4:- Students will be able to apply the fundamental knowledge to address crosscutting issues such as sustainable development

PO-5:- Students will be able to solve various problems by identifying the essential parts of a problem, formulating a strategy for solving the problem, applying appropriate techniques to arrive at a solution, testing the precision and accuracy of the solution and interpreting the results.

PO-6:- Students will be able to communicate effectively, i.e., articulate, comprehend and write effective reports, make effective presentations and documentation and express the subject through technical writing and oral presentation.

4. Program Specific Outcomes of the Program (PSOs):

PSO-1:- Students will be able to explain fundamental concepts of inorganic, physical, organic, industrial and analytical chemistry.

PSO-2. Identify chemical formulae and solve numerical problems.

PSO-3. Students can use modern chemical tools, Models, Charts and Equipment.

PSO-4. Students will be able to prepare and qualify for competitive examinations.

PSO-5. Students will understand good laboratory practices and safety.

PSO-6. Students will develop research-oriented skills.

5. Eligibility: Eligibility requirements for admission to B.Sc. Part-I (Level 4.5). As per guidelines obtained from Warana University Warananagar by following rules regarding reservation Government of Maharashtra

: The students passing the Higher Secondary School Certificate Examination with Science stream or Vocational subjects with science Stream

conducted by the Maharashtra State Board of Higher Secondary Education shall be allowed to enter upon the B. Sc. Part-I (or Undergraduate Certificate in Science).

OR

An Examination of any other Statutory Board or an examining Body recognized as equivalent there to.

OR

Completed 2nd year of the 3-year diploma after 10th

6. Duration: The course shall be fulltime. One year, semester I and II

7. Medium of Language: The medium of language shall be English.

8. Multiple Entry Multiple Exit Instructions: The eligibility of students taking admission at B. Sc. Part-I [Level 4.5](initial entry) and the eligibility of students making lateral entry (Multiple entry-ME) admission at Level 5.0/ Level 5.5/ Level 6.0 are required to be scrutinized (with stipulated procedure) on the basis of following criteria:

Rules for Multiple Exits:

- a) If a student wishes to exit after completion of Level 4. 5, he/she has to complete additional four credit skill course/ internship.
- b) If a student wishes to exit after completion of Level 5.0, he/she has to complete additional four credit skill course/ internship.
- c) If a student wishes to exit after completion of Level 5.5, he/she need not require completing any additional skill course/ internship.

9. Scheme of Teaching and Examination:

[The scheme of teaching and examination should be given as applicable to the course/paper concerned.]

B.Sc.Program Structure for Level 4.5 of B.Sc.-I Semester I														
Teaching Scheme						Examination Scheme								
Sr. No.	Theory (TH) & Practical (P)					Semester-end Examination (SEE)			Internal Assessment (IA)			Practical		
	Course Type	No. of Lectures	Practical	Hours	Credits	Paper Hours	Max	Min	Internal	Max	Min	Paper Hours	Max	Min
1.	DSC-I	4	1	4+4	6	1	30	12	Assignment	20	8	2	50	20
2.	DSC-I	4	1	4+4	6	1	30	12		20	8	2	50	20
3.	DSC-I	4	1	4+4	6	1	30	12		20	8	2	50	20
4.	OE -I	-	1	4	2	-	-	-		-	-	2	50	20
5.	VEC	-	-	-	-	-	-	-		-	-	-	-	-
6.	IKS (Generic)	2	-	2	2	2	50	20		-	-	-	-	-
Total					22	[DSC (60 X 3) + IKS 50] Total SEE = 230			DSC (40X3) Total IA = 120			Practical. = 50X4 Total Practical. = 200		
						Total Semester –I = 550								

B.Sc.Program Structure for Level 4.5 of B.Sc.-I Semester II														
Teaching Scheme						Examination Scheme								
Sr. No.	Theory (TH) & Practical (P)					Semester-end Examination (SEE)			Internal Assessment (IA)			Practical		
	Course Type	No. of Lectures	Practical	Hours	Credits	Paper Hours	Max	Min	Internal	Max	Min	Paper Hours	Max	Min
1.	DSC-II	4	1	4 +4	6	1	30	12	Assignment	20	8	2	50	20
2.	DSC-II	4	1	4 +4	6	1	30	12		20	8	2	50	20
3.	DSC-II	4	1	4 +4	6	1	30	12		20	8	2	50	20
4.	OE -II	-	1	4	2	-	-	-		-	-	2	50	20
5.	VEC -I	2	-	2	2	2	50	20		-	-	-	-	-
6.	IKS (Generic)	-	-	-	-	-	-	-		-	-	-	-	-
Total					22	[DSC (60 X 3) + IKS 50] Total SEE = 230			DSC (40X3) Total IA = 120			Practical. = 50X4 Total Practical. = 200		
						Total Semester –I = 550								

SCHEME OF EXAMINATION:

- The examination shall be conducted at the end of each term for semester pattern.
- The theory paper shall carry 30 marks.
- The evaluation of the performance of the students in theory papers shall be on the basis of Semester Examination of 30 marks.
- The internal evaluation for each paper shall carry 10 marks. (Semester I and II: Home assignment, class assignment, unit test a and midterm test)
- Question paper will be set in the view of the /in accordance with the entire syllabus and preferably covering each unit of syllabi.

STANDARD OF PASSING: As prescribed under rules and regulation for each degree.

NATURE OF THEORY QUESTION PAPER AND SCHEME OF MARKING:

Duration of question paper: As per University rule:

- | | | |
|--|-----------|---------|
| i. Duration of Examination for | 60 marks- | 2 Hours |
| ii. Duration of Examination for | 30 marks- | 1 Hours |
| iii. Duration of Practical Examination for | 50 marks- | 2 Hours |

Assessment pattern

For 4 Credits 60:40 (SSE : CIE)

For 2 Credits 30:20 (SSE : CIE)

Credit Distribution Structure for B.Sc. I in Chemistry with Multiple Entry and Exit Options.

COURSE CATEGORY	ABBREVIATION (Only 2 Letters)	DESCRIPTION	Sem. I Credit	Sem. II Credit
DSC	DSC (DS)	Discipline Specific Course	6x3=18	4x3=12
OE	OE(OE)	Open Elective	2x1=02	2x1=02
SEC	SEC (SE)	Skill Enhancement Course	----	-----
AEC/IKS/VEC	AEC(AE)	Ability Enhancement Course	-----	-----
	IKS(IK)	Indian Knowledge System (Generic)	2x1=02	-----
	VEC(VE)	Value Education Course	-----	2x1=02
CC/CEP	CC (CC)	Co-curricular Course		-----
	CEP(CE)	Community Engagement Project	-----	-----
			22	22
			Total = 44	

1. Course Code Table

A-1) B.Sc.-I: SEMESTER-I (TOTAL CREDITS-22): (Note: Put '—' wherever 'Not Applicable')

COURSE CATEGORY		COURSE NAME	COURSE CODE	CREDITS
DSC	DS-I	Inorganic Chemistry	2502USCHMJ101	2
DSC	DS-I	Organic Chemistry	2502USCHMJ102	2
DSC	DS-I	Practical Laboratory	2502USCHMJ103	2
OE	OE-I	Water Analysis	2502USCHOE101	2
SEC	SE-I	-----		--
AEC	AE-I	-----		--
IKS (Generic)	IK	Introduction to Indian Knowledge System	2502USCHIK101	2
CC	CC	-----		
CREDITS FOR B.Sc.-I, SEM-I:				10

A-2) B.Sc.-I: SEMESTER-II (TOTAL CREDITS-22): (Note: Put '—' wherever 'Not Applicable')

COURSE CATEGORY		COURSE NAME	COURSE CODE	CREDITS
DSC	DS-II	Physical Chemistry	2502USCHMJ201	2
DSC	DS-II	Analytical Chemistry	2502USCHMJ202	2
DSC	DS-II	Laboratory Practical	2502USCHMJ203	2
OE	OE-II	Soil Analysis	2502USCHOE201	2
SEC	SE-II	----	-----	---
AEC	AE-II	----	-----	---
VEC	VE	Democracy, Election and Constitution	2502USCHVE201	2
CEP	CE	----		---
CREDITS FOR B. Sc.-I, SEM-II:				10

2. Determination of CGPA, Grading and Declaration of result

University has adopted 10-point Grading System as follows:

- **In each semester, marks obtained in each course (Paper) are converted to grade points:** If the total marks of course are 100 and passing criteria is 40%, then use the following Table for the conversion.

1. Gradation Chart:

Table

Marks Obtained	Numerical Grade (Grade Point)		CGPA	Letter Grade
Absent	0 (zero)		-	Ab: Absent
0–39	0 to 4		0.0–4.99	F: Fail
40–49	5		5.00–5.49	C: Average
50–54	6		5.50–6.49	B: Above Average
55–64	7		6.50–7.49	B+: Good
65–74	8		7.50–8.49	A: Very Good
75–84	9		8.50–9.49	A+: Excellent
85–100	10		9.50–10.0	O: Outstanding

Note:

1. Marks obtained ≥ 0.5 shall be rounded off to next higher digit.
2. The SGPA & CGPA shall be rounded off to 2 decimal points.
3. Marks obtained in 50 marks or 200 marks paper shall be converted to 100 marks.

Calculation of SGPA & CGPA

1.SemesterGradePointAverage(SGPA)

$$SGPA = \frac{\sum(\text{Course credits} \times \text{Grade points obtained}) \text{ of a semester}}{\sum(\text{Course credits}) \text{ of respective semester}}$$

2.CumulativeGradePointAverage(CGPA)

$$CGPA = \frac{\sum(\text{Total credits of a semester} \times \text{SGPA of respective semester}) \text{ of all semesters}}{\sum(\text{Total course credits}) \text{ of all semesters}}$$

10
Structure of B. Sc. I Chemistry

Sr. No.	Semester	Title of Paper
1	I	2502USCHMJ101Paper-I, Inorganic Chemistry (2 credits, 30 Hours)
2		2502USCHMJ102 Paper -II, Organic Chemistry (2 credits, 30 Hours)
3		2502USCHMJ103 Practical Paper-I (2 credits, 60 Hours)
4	II	2502USCHMJ201Paper -III, Physical Chemistry (2 credits, 30 Hours)
5		2502USCHMJ202 Paper -IV, Analytical Chemistry (2 credits, 30 Hours)
6		2502USCHMJ203 Practical Paper-II (2 credits, 60 Hours)

11
Warana University, Warananagar
Bachelor of Science
Credit Framework
First-Year (B. Sc. I-Chemistry)

Level	Sem.	Subject-1 (Chemistry)	Subject-2	Subject-3	IDC/MDC/OE/GE	SEC	AEC, VEC, IKS			OJT, FP, CEP, CC, RP		Total Credits	
		DSC	DSC	DSC	OE	SEC	AEC	VEC	IKS	CC	FP/OJT	RP/ Dissert.	
4.5	I	2502USCHMJ101Paper-I Inorganic Chemistry (2 Cr)	DSC-I (2 Cr)	DSC-I (2 Cr)	2502USCHOE101Practical Paper-I Water Analysis (2 Cr)	--	--	--	2502USCHIK101 IKS-I (2 Cr) Introducti on to IKS	--	--	--	--
		2502USCHMJ102Paper-II Organic Chemistry (2 Cr)	DSC-II (2 Cr)	DSC-II (2 Cr)									
		2502USCHMJ103Practical Paper-I (2 Cr)	DSC-P-I (2 Cr)	DSC-P-I (2 Cr)									
	Credits	4(T)+2(P) =6	4(T)+2(P) =6	4(T)+2(P) =6	2 (P) =2	--	--	--	2(T)	--	--	--	22
	II	2502USCHMJ201Paper-III Physical Chemistry (2 Cr)	DSC-III (2 Cr)	DSC-I (2 Cr)	2502USCHOE201Practical Paper-II Soil Analysis (2 Cr)	--	--	2502USCHVE201 VEC-I (2 Cr) Democracy, Election and Constitution	--	--	--	--	--
		2502USCHMJ202Paper-IV Analytical Chemistry (2 Cr)	DSC-IV (2 Cr)	DSC-II (2 Cr)									
		2502USCHMJ203Practical Paper-II (2 Cr)	DSC-P-II (2 Cr)	DSC-P-II (2 Cr)									
	Credits	4(T)+2(P)=6	4(T)+2(P) =6	4(T)+2(P) =6	2 (P)=2	--	--	2(T)	--	--	--	--	22
Total Credits		12	12	12	4	--	--	2	2	--	--	--	44
Exit Option: Award of UG Certificate in Major with 44 Credits and an additional 4 credits core NSQF course/ Internship/Skill Courses OR Continue													

Nature of Question paper

e)

13
B.Sc. I Syllabus (NEP-2.0)
To be implemented from June 2025 onwards
Semester I
Nature of Practical Exam

Semester-I Practical Paper-I (50 Marks)

Number of Days: 01

First Session:

Section-I- Inorganic (25 Marks)

Q. 1 Experiment- 15 Marks

Q. 2 Internal- 10 Marks

Second Session:

Section-II Organic (25 Marks)

Q. 1 Experiment- 15 Marks

Q. 2 Internal- 10 Marks

Semester-II Practical Paper-II (50 Marks)

First Session:

Section-I- Physical (25 Marks)

Q. 1 Experiment- 15 Marks

Q. 2 Internal- 10 Marks

Second Session:

Section-II Analytical (25 Marks)

Q. 1 Experiment- 15 Marks

Q. 2 Internal- 10 Marks

B. Sc. I OE CHEMISTRY (NEP-2.0)

To be implemented from June 2025 onwards Semester I&II Nature of Practical Exam.

OE Practical Paper-I/II (50Marks) Number of Days: 01

First Session:

Section-I

Q.1 Experiment-I-15 Marks

Q.2 Internal- 10 Marks

Second Session:

Section-II

Q.1 Experiment-II-15 Marks

Q. 2 Internal- 10 Marks

SEM (Level)	COURSES			OE	VSC/SEC	AEC/VEC/IKS	OJT/FP/CEP /CC/RP	Total Credits	Degree/Cum. Cr. MEME
	Course-1	Course-2	Course-3						
SEMI (4.5)	DSC-I(2) DSC-II (2) DSC P-I(2)	DSC-I(2) DSC-II (2) DSC P-I(2)	DSC-I(2) DSC-II (2) DSC P-I(2)	OE-1(2) (T/P)		IKS-I(2)		22	UG Certificate 44
SEMII (4.5)	DSC-III(2) DSC-IV (2) DSC P-II(2)	DSC-III(2) DSC-IV (2) DSC P-II(2)	DSC-III(2) DSC-IV (2) DSC P-II(2)	OE-2(2) (T/P)		VEC-I(2) (Democracy, Election and Constitution)		22	
Credits	8(T)+4(P)=12	8(T)+4(P)=12	8(T)+4(P)=12	2+2=4 (T/P)	--	2+2=4	--	44	Exit Option:4 credits NSQF/Internship/Skill courses
	MAJOR		MINOR						
SEMIII (5.0)	Major V(2) Major VI (2) Major P III (2)	--	Minor V(2) Minor VI (2) Minor P III(2)	OE-3(2) (T/P)	VSC I (2) (P) (Major specific) SEC I(2) (T/P)	AEC I(2) (English)	CC-I (2)	22	UG Diploma 88
SEMIV (5.0)	Major VII(2) Major VIII (2) Major P IV (2)	--	Minor VII(2) Minor VIII (2) Minor P IV (2)	OE-4(2) (T/P)	SEC-II(2) (T/P)	AEC-II(2) (English) VEC-II(2) (Environmental studies)	CEP-I(2)	22	
Credits	8(T)+4(P)=12		8(T)+4(P)=12	2+2=4(T/P)	4(T/P)+2(P)=6	2+4=6	2+2=4	44	Exit Option:4 credits NSQF/Internship/Skill courses
SEMV (5.5)	Major IX(2) Major X (2) Major P V (4)	Major I (ELEC)(2) Major P-I (ELEC) (2)	-	OE-5(2) (T/P)	VSC II (2) (Major specific)(P)	AEC III(2) (English)	OJT (04)	22	UG Degree 132
SEMVI (5.5)	Major XI(2) Major XII (2) Major P VI (4)	Major II (ELEC)(2) Major P-II(2) (ELEC)	-		VSC III (2) (Major specific) (P) SEC III(2) (T/P)	AEC IV(2) (English) IKS 2 (Major specific) (2)	FP-(02)	22	
Credits	8(T)+8(P)=16	4(T)+4(P)=8	-	2(T/P)	2(T/P)+4(P)=6	4+2=6	4+2=6	44	
Total Credits	40+20=60		24	10	12	16	10	132	Exit Option

16
Syllabus

B. Sc. I (NEP-2.0) Semester I, PAPER-I

2502USCHMJ101- Inorganic Chemistry (Theory Credits-02, 30 hours)

Name of the topic	Expected Course outcomes
1. Atomic Structure and Periodicity of Elements.	To learn and understand basic knowledge of inorganic chemistry. To understand size, shape and electronic distribution in shells and sub- shells of an atom.
2. P-block Elements.	To learn and understand the properties and uses of the compounds of Boron, Carbon and Nitrogen from p-block elements.
3. Chemical Bonding and Molecular Structure: Ionic Bonding.	To learn different types of bonds and nature of bonding in inorganic compounds. Calculations of different energies associated with ionic bonding.
4. Acids and Bases.	To Understand the role of acids and bases in chemistry. The study is useful in all chemical areas.

MODULE	SUB-MODULE	TOPICS	LECTURE PERIOD
1	Atomic Structure and Periodicity of Elements	Bohr's theory of hydrogen atom and its limitations, Wave particle duality, Heisenberg uncertainty principle, Quantum numbers and their significance, Shapes of s, p and d atomic orbital's, Electrons filling rules in various orbitals: a) Aufbau's principle b) Hund's rule of maximum multiplicity c) Pauli's exclusion principle. Electronic configuration of elements. Stability of empty, half-filled and completely filled orbitals. Periodicity of the elements: General discussion of the following	10 hours

		properties of the elements with reference to S-block elements: a) Electronic configuration b) Atomic radii c) Ionic radii d) Ionization energy e) Electron affinity f) Electronegativity g) Metallic characters h) Reactivity i) Oxidation state j) Melting and boiling points k) Chemical properties.	
2	P-block Elements	Position of elements in periodic table. Characteristics of group 13 th , 14 th and 15 th elements with special reference to electronic configuration and periodic properties. Compounds of group 13 th , 14 th and 15 th elements. Boron – Diborane (only structure). Allotropes of Carbon and Phosphorus. Oxyacids of Nitrogen (HNO ₂ , HNO ₃).	9 hours
3	Chemical Bonding and Molecular Structure: Ionic Bonding	Types of Chemical Bonds: a) Ionic Bond b) Covalent Bond c) Co-ordinate bond d) Metallic bond e) Hydrogen Bond f) Van-der Waals force. Definition and formation of ionic bond. General characteristics of ionic bonding. Energetics in ionic bond formation. Born-Haber cycle for NaCl and its applications. Fajan's Rule and its applications.	7 hours
4	Acids and Bases	Theories of Acids and Bases – Arrhenius concept, Bronsted –Lowry concept, Lewis concept, Lux-Flood concept. (Definition and examples only). Hard and Soft Acids and Bases (HSAB concept). Classification of Acids and Bases as hard soft and borderline. Pearson's HSAB concept. Applications and limitations of HSAB concept	4 hours

Reference Books:

- 1) Lee, J. D. Concise Inorganic Chemistry ELBS, 1991.
- 2) Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley.
- 3) Douglas, B. E., McDaniel, D. H. & Alexander, J. J. Concepts and Models in Inorganic Chemistry, John Wiley & Sons.

- 4) Huheey, J. E., Keiter, E. A., Keiter, R. L. & Medhi, O. K. Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India, 2006.
- 5) Puri, Sharma, Kalia. Principles of Inorganic Chemistry
- 6) Madan R. L. Chemistry for Degree Students (B. Sc. First year), S. Chand

B.Sc. Part I (NEP-2.0) SEMESTER-I, PAPER-II

0CH-102- Organic Chemistry (Theory Credits: 02, 30 hours)

Name of the topic	Expected Course outcomes
1. Fundamentals of Organic Chemistry	The students are expected to understand the fundamentals and basic principles involved in organic chemistry.
2. Stereochemistry	Understanding the spatial arrangement of atoms of organic molecule and types of stereoisomers.
3. Aromaticity	Knowledge of general properties and fundamental reactions of aromatic compounds.
4. Heterocyclic Compounds	To understand the basic knowledge of heterocyclic compounds. To get knowledge of methods to preparation, physical and chemical properties of some heterocyclic compounds with five and six membered heterocycles containing N as the hetero atom (Pyrrole and Pyridine).

MODULE	SUB-MODULE	TOPICS	LECTURE PERIOD
1	Basic Concepts in Organic Chemistry	Introduction, Curved arrow notations, Cleavage of Bonds: Homolysis and Heterolysis. Organic molecular species: Nucleophiles and electrophiles. Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyper conjugation effect, Reactive Intermediates: Generation, Structure, Stability and Reactions of Carbocations, Carbanions, Carbon free radicals, Carbene and Nitrene.	9 hours
2	Stereochemistry	Introduction, Types of Stereoisomerism, Representation of organic molecules using Wedge, Fischer, Sawhorse and Newman formula, Optical Isomerism: Concept of Chirality, Elements of Symmetry, Optical Isomerism in tartaric acid, 2, 3 Dihydroxy butanoic acid, Enantiomerism, Diastereomerism and Meso compounds, Geometrical isomerism in C=C, C=N and alicyclic compounds. Nomenclature of stereoisomers: D and L, Erythro and Threo, R and S, E and Z.	9 hours
3	Aromaticity	Introduction, Characteristics properties of aromatic compounds, Meaning of terms: Aromatic, Non aromatic, Antiaromatic, Pseudoaromatic, Classification of aromatic compounds, Structure of Benzene: Kekule structure, Resonance structure, M.O. picture, Modern theory of Aromaticity, Mechanism of Electrophilic substitution reactions: Nitration, Sulphonation, Halogenation and Friedel - Crafts reaction.	6 hours
4	Heterocyclic Compounds	Introduction, Classification and Nomenclature of heterocyclic compounds. Nitrogen Heterocycles: a) Pyrrole:- Introduction, Synthesis, Physical and chemical properties. b) Pyridine:- Introduction, Synthesis, Physical and chemical properties.	6 hours

Reference Books:

- 1) Graham Solomon, T. W., Fryhle, C. B. & Snyder, S. A. Organic Chemistry, John Wiley & Sons (2014).
- 2) Mc Murry, J. E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Pvt Ltd, Edition, 2013.
- 3) Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
- 4) Eliel, E. L. Stereochemistry of Carbon Compounds, Tata McGraw Hill education, 2000.
- 5) Finar, I. L. Organic Chemistry (Vol. I & II), E.L.B.S.
- 6) Morrison, R. T. & Boyd, R. N. Organic Chemistry, Pearson, 2010.
- 7) Bahl, A. & Bahl, B. S. Advanced Organic Chemistry, S. Chand, 2010.
- 8) Nasipuri, D. Stereochemistry of Organic compounds: Principles and Applications.
- 9) Madan, R. L. Chemistry for Degree Students (B. Sc. First Year), S. Chand Publication.
- 10) Heterocyclic chemistry, J.A. Joule and K. Mills, 4th ed., Blackwell Publishing 2000
- 11) John A. Joule, Keith Mills.; Heterocyclic Chemistry, 5th Edition, April 2010, ©2010, Wiley Blackwell,
- 12) Gilchrist, T. L. Heterocyclic chemistry; 3rd ed.; Addison Wesley Longman: Edinburgh Gate, 1997.
- 13) Joule, J. A.; Mills, K.; Heterocyclic chemistry; 4th ed.; Blackwell Science: Oxford, 2000.

B. Sc. I Semester I, Practical Course**PRCH-103-PRACTICAL PAPER-I (Credits-02, 60 hours)****A] Inorganic Chemistry:**

- 1) To prepare standard 0.1 N KMnO_4 solution and to determine the strength of given oxalic acid solution.
- 2) To determine quantity of Fe (II) ions from the given solutions by titrating it with 0.1N $\text{K}_2\text{Cr}_2\text{O}_7$ solution by using internal indicator
- 3) To estimate amount of Cu (II) ions by iodometric titration by using $\text{Na}_2\text{S}_2\text{O}_3$ solution.
- 4) To standardize supplied EDTA solution by titrating with 0.01 M ZnSO_4 solution and to estimate amount of calcium from given solution by using Eriochrome Black- T as an indicator.
- 5) Quality control -To determine percentage purity of the given sample of soda ash (Na_2CO_3) by titrimetric method.

- 6) Estimation of amount of Acetic acid from the given vinegar sample by titrimetric method
- 7) Chromatography : Separation and identification of cations by Paper Chromatography technique from the following mixtures :
- a) $\text{Ni}^{2+} + \text{Cu}^{2+}$ b) $\text{Ni}^{2+} + \text{Co}^{2+}$ c) $\text{Cu}^{2+} + \text{Co}^{2+}$
- 8) Spot Test : Identify the following metal ions by spot test method
 Cu^{2+} , Ni^{2+} , Co^{2+} , Fe^{3+} , Al^{3+} , Pb^{2+} , Zn^{2+} , Hg^{+2} , Mg^{+2} , Mn^{+2}

References

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009

B) Organic Chemistry

1) Estimations:

- i) Estimation of Aniline. (by Bromination method) ii)

Estimation of Acetamide.

2) Organic Qualitative Analysis: Detection of physical constant, type, elements, functional group, and Confirmatory test. Identification of Organic Compounds (at least eight) (four containing at least one extra element- N, S, Cl)

- a) Acids: Oxalic acid, Benzoic acid, Cinnamic acid
- b) Phenols: Beta-Naphthol, p-Nitrophenol
- c) Base: Aniline, p-Nitroaniline
- d) Neutral: Acetone, Acetanilide, Chloroform, m-Dinitrobenzene, Thiourea, Bromobenzene

3) Purification of organic compounds by crystallization (from water and alcohol) and distillation.

References:

- 1) Vogel's Text Book of Quantitative Chemical Analysis. (Longmann) ELBS Edition.
- 2) Hand book of Organic Qualitative Analysis: Clarke.
- 3) Comprehensive Practical Organic Chemistry – Qualitative Analysis by V. K. Ahluwalia, Sunita Dhingra. University Press. Distributor – Orient Longman Ltd.
- 4) Comprehensive Practical Organic Chemistry preparation and Quantitative

Analysis: V. K. Ahluwalia, Renu Aggarwal. University Press. Distributor – Orient Longman Ltd.

- 5) A Laboratory Hand - Book of Organic Qualitative Analysis and Separation: V. S. Kulkarni. Dastane Ramchandra & Co. Pune

B.Sc.I (NEP-2.0) Semester I, OE PRACTICAL COURSE PAPER-I CHOEPR-101 – OPEN ELECTIVE (OE) CHEMISTRY (Credits-02,60hours)

Water Analysis

Expected Course Outcomes:

To learn and understand basic knowledge of physico-chemical properties of water. To learn about general water quality analysis techniques.

To acquire hands-on skills to perform actual practical analysis in the laboratory.

अपेक्षितक्षिणपरिणाम:

पाण्याच्याभौतिक-

रासायतिकगुणधर्मांचेरूलभूज्ञािजाणूिघेणे.

सारान्यपाण्याच्यागुणवत्तेचेतवश्लेषणित्रजाणूिघेणे.

प्रयोगशाळेिप्रत्यक्षव्यावहाररकतवश्लेषणकरण्यासाठीकौशल्येआत्मसािकरणे.

Practicals (Credits-02,60hours)

1. Collection of various water samples.
2. Determination of temperature of water.
3. Determination of Ph of various samples using pH meter or pH paper.
4. Determination of electrical conductivity using conductivity meter.
5. Determination of Acidity of water given samples.
6. Determination of Alkalinity of water.
7. Determination of Hardness of water.
8. To measure the dissolved oxygen content in water using a dissolved oxygen test

kit.

9. Determination of Chemical Oxygen Demand (COD).
10. Determination of Biological Oxygen Demand (BOD).
11. Determination of refractive index of given sample using Refractometer.
12. **Water Quality Assessment:** Guiding students through the process of assessing overall water quality based on the results of their tests. They can compare their findings to water quality standards and discuss the implications for human health and the environment.
13. **Field Trips:** Organizing field trips to local water bodies for hands-on observation and testing.

पाणीविश्लेषण(Water Analysis)

प्रात्येक्षिके (Practicals)

(क्रेडिट २, ६० तास)

1. विविध पाण्याचे नमुने गोळा करणे.
2. पाण्याचे तापमान ननश्चत करणे.
3. pH मीटर कर्किंा pH पट्टींापरून विविध नमुन्यांिंचे pH ननश्चत करणे.
4. चालकता मीटर (conductivity meter) िापरून विद्युत चालकता (electrical conductivity) ननश्चत करणे.
5. दिलेल्या पाण्याच्या नमुन्यांिंचे आंबटपणाचे ननधारण करणे (Acidity).
6. पाण्याची क्षारता ननश्चत करणे (Alkalinity).
7. पाण्याच्या कठीणपणाचे ननधारण करणे (Hardness).
8. पाण्यात विरघळलेल्या ऑक्सीजनचे (Dissolved oxygen) प्रमाण चाचणी करणे िापर करून मोजणे.
9. रांियनन कऑक्सीजन मागणीचे ननधारण करणे (COD).
10. जैविक ऑक्सीजन मागणीचे ननधारण करणे (BOD).
11. ररफ्रॅक्टोमीटर िापरून दिलेल्या नमुन्याच्या अपिताकन निशांिकाचे ननधारण करणे.
12. पाण्याच्या गुणितेचे मूल्यांिकन: विद्यार्थ्यांना तयांिंच्या चाचण्यांिंच्या ननकालांिंर आधार रत एकूण पाण्याच्या गुणितेचे मूल्यांिकन करण्याच्या प्रकियेद्िंरे मागांिशान करणे. ते तयांिंच्या ननष्कर्ांांची पाण्याच्या गुणितेच्या मानकांिंशी तुलना करू शकतात

आणमानीआरोग्यआणपयाारिणारिलपरणामांिरिचचाकरूशकतात.

13. फील्ड दिप(क्षेत्र िहल): प्रतयक्ष ननरीक्षण आण चचणीाठी स्थाननकपाणिठयांिरिफील्डदिपआयोशजतकरणे.

Reference Books:

1. Chemical and biological method for water pollution ; R.K. Trivedi and P.K. Geol, Environ. Pub.
2. Methodology of water analysis ;M. S. Kondarkar ,IAAB Publication, Hyderabad.
3. Environmental studies; Dr. K. Mukkanti, S. Chand & Camp Ltd.
4. Standard Methods for Examination of water & wastewater APHA-AWWA- WPCE.
5. Manual of water & waste water analysis, NEERI, Nagpur.
6. Textbook of water and waste water engineering by H.K. Hussien.
7. Water supply & sanitary engineering by Birdie.
8. Practical methods in ecology & Environmental science by R.K. Trivedi, P.K. Goel, C. L. Trisal.

B. Sc. I (NEP-2.0) Semester II, Paper -III

PCH-201-Physical Chemistry Credits: 02, 30 hours

Name of the Topic	Expected Course Outcomes
1. Basic Mathematical Concepts	Learning and coherent understanding of basic concepts and rules of logarithms, graphs, derivative and integrations.
2. Thermodynamics	Knowledge and coherent understanding of basic concepts in thermodynamics will be gained by the student.
3. Chemical Kinetics	Learning and understanding the knowledge about basic concepts in kinetics and first order, second order reactions with characteristics and suitable examples.
4. Physical properties of liquids	Learning and coherent understanding of surface tension, viscosity and refractive index with suitable examples.

5. Electrochemistry	Learning and coherent understanding of basic concepts in electrochemistry, conductors and conductivity cells, measurement of conductance with suitable examples and numerical problems.
---------------------	---

MODULE	SUB-MODULE	TOPICS	LECTURE PERIOD
1	Basic Mathematical Concepts	Logarithm: Basic rules and calculations. Graph - Quadrants, drawing of linear graph, Slopes and Intercept. Derivative and Integration: Basic rules.	3 hours
2	Thermodynamics	Introduction, Basic terms used in thermodynamics, Zero th law of thermodynamics. First law of thermodynamics: Mathematical equation, sign conventions, statements of first law and its limitations. Spontaneous and non-spontaneous processes, Second law of thermodynamics. Heat engine, Carnot's Cycle and efficiency of heat engine. Numerical Problems.	5 hours
3	Chemical Kinetics	Introduction, rate of reaction, definition, and units of rate constant. Factors affecting rate of reaction. Order and Molecularity of reaction. First order reaction: Derivation of rate constant. Characteristics of the first order reaction. Pseudo- first order reactions – i) Hydrolysis of methyl acetate in presence of acid, ii) Inversion of cane sugar. Second order reaction: Derivation of rate constant for equal and unequal concentration of the reactants. Examples of Second order reaction: i) Reaction between $K_2S_2O_8$ and KI and ii) Saponification of ethyl acetate. Characteristics of Second order reactions. Numerical problems.	8 hours

4	Physical properties of liquids	Introduction to states of matter, qualitative description of intermolecular forces in liquids, structure of liquids, classification of physical properties. Surface tension and its determination using stalagmometer and differential rise method. Viscosity and its determination using Ostwald's viscometer. Refractive index (Snell's law) specific and molecular refractivities and its determination using Abbe's refractometer. Numerical Problems.	6 hours
5	Electrochemistry	Introduction, types of cell, phenomenon of electrolysis, Faradays Laws of electrolysis. Types of conductors. Explanations of Conductance, specific conductance, equivalence and molecular conductance. Variation of specific conductance, equivalence and molecular conductance with dilution, equivalent conductance at infinite dilution. Dipping type of conductivity cell, modifications in the technique used before measurement of conductance w.r.to use of alternating current, use of conductivity water, conductivity cell and temperature control. Measurement of conductance by Wheatstone bridge. Cell constant and its determination. Numerical problems.	8 hours

Reference Books:

1) Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).

- 2) Castellan G.W. Physical Chemistry 4th Ed. Narosa (2004).
- 3) Kotz, J.C. Treichel, P. M. & Townsend, J. R. General Chemistry, Cengage Learning India Pvt Ltd: New Delhi (2009).
- 4) Mahan, B.H. University Chemistry, 3rd Ed. Narosa (1998).
- 5) Petrucci, R.H. General Chemistry, 5th Ed., Macmillan Publishing Co., New York (1985).
- 6) Elements of Physical Chemistry S., Glasstone, D. Lewis. (2010) 7) Principles of physical Chemistry Marron and Prutton. (2007).
- 8) Elements of Physical Chemistry P. W. Atkins (2017-18)
- 9) Essentials of Physical Chemistry Bahl and Tuli. S. Chand, 2010.
- 10) Physical Chemistry Danials and Alberty (2016)
- 11) University General Chemistry C. N. R. Rao (2016)
- 12) Principles of Physical Chemistry, Puri, Sharma and Pathania 47th Edition, Vishal Publishing Co.
- 12) Physical Chemistry, A. J. Mee
- 13) Advanced Physical Chemistry, Guru Deep Raj
- 14) Physical Chemistry, R. A. Alberty
- 15) General Chemistry, 5th Edition, Macmillan Publishing Co., New York (1985)

B. Sc. I Semester II, Paper IV

ACH-202- Analytical Chemistry (Theory Credits:02, Lectures-30 hours)

Expected learning Outcomes:

Name of the topic	Expected Course Outcome
1. Introduction to Analytical Chemistry	Learning various analytical procedures and importance also sampling, accuracy and precision
2. Fundamentals of Industrial Chemistry and IPR	a. Distinguish between classical and industrial chemistry b. Learning and Understanding basic concepts and concentration terms c. Knowledge of IPR

3. Chromatography	Knowledge of chromatographic separation technique and terms involved in it. Learning paper chromatography and thin layer chromatography
4. Theory of titrimetric Analysis	Knowledge of various type of titrations, neutralization curves, indicators used in various titrations

MODULE	SUB-MODULE	TOPICS	LECTURE PERIOD
1	Introduction to Analytical Chemistry	Introduction , Importance of analysis Analytical processes (Qualitative and Quantitative), Methods of analysis (Only classification), Sampling of solids, liquids and gases, Errors, types of errors (determinate and indeterminate), methods of expressing accuracy (Absolute and relative error), Significant figures, mean, median, standard deviation (Numerical problems expected).	7 hours
2	Fundamentals of Industrial Chemistry and IPR	Difference between classical and industrial chemistry, Raw materials for chemical industry, Material safety data sheets (MSDS), Definition and Explanation of terms - Molecular weight, Equivalent weight, Molarity, Normality, Molality, Molarity of mixed solution, Acidity of base, Basicity of acid, ppt, ppm, ppb solutions, Mole Fraction, Weight fraction, Percentage composition by W/W, W/V, V/V, Problems based on Normality, Molarity, mole fraction, mixed solution, etc. IPR- Introduction to IPR and its significance in presence scenario	7 hours
3	Chromatography	Introduction, Basic Principle of Chromatography, Basic terms, Classification of Chromatography, Paper Chromatography- Principle, Methodology-types of papers and	7 hours

		treatment, sample loading, choice of solvent, development-ascending, descending, circular, location of spots, determination of R_f value, Applications, advantages and disadvantages Thin layer chromatography- Principle, Solvent system, stationary phases, preparation of TLC plate, Detecting reagents, methodology-sample loading, development, detection of spot, R_f value, Applications, advantages and disadvantages	
4	Theory of titrimetric Analysis	Introduction, Acid-base indicators Theory of indicators w.r.t. Ostwald's ionization theory, Neutralization curves and choice of indicators for - Strong acid-strong base - Strong acid-weak base - Strong base-weak acid Complexometric titrations - Introduction - Types EDTA titrations - Metallochromic indicators- Eriochrome black- T - Indicator Action of Eriochrome black- T 4.6 Redox Titrations - Introduction - KMnO₄ Vs Oxalic acid titration; theory of KMnO₄ as self indicator. 4.7 Precipitation Titrations - Introduction - Silver nitrate Vs NaCl solution using Potassium chromate indicator	9 hours

References

1. Text Book of Quantitative Inorganic analysis – A. I. Vogel
2. Instrumental methods of Chemical analysis –Willard, Merit & Dean
3. Instrumentals methods of Chemical analysis – Chatwal & Anand

4. Vogel's textbook of qualitative Inorganic analysis – Bassett, Denny etc.
5. Textbook of qualitative Inorganic analysis – Kolthoff and Sandel
6. Fundamentals of analytical chemistry – Skoog and West
7. Basic concepts of analytical chemistry – S. M. Khopkar
8. Text book of qualitative organic analysis – A. I. Vogel
9. Qualitative organic chemistry – A. I. Vogel
10. Instrumental methods of chemical analysis – H. Kaur
11. A text book of Quantitative chemical analysis Vogel's by J. Mendham, R. C. Denney
12. Quantitative Chemical Analysis – Daniel C. Harris
13. Chemical process industries – Shrieve & Brink
14. Industrial Chemistry – B. K. Sharma
15. Industrial Chemistry – R. K. Das
16. Text book of qualitative organic analysis – A. I. Vogel

B. Sc. I Semester II Practical Course

PRCH-203 Practical Paper-II (Credits-02, 60 hours)

A)Physical Chemistry:

- 1)Determination of viscosity of given liquids A and B (Density data of liquids, viscosity of water to be given) [Any two liquids from Acetone, Carbon tetra chloride, Chloroform, Ethyl alcohol, Benzyl alcohol, Ethylene glycol and n- propyl alcohol]
- 2)To study the velocity constant of hydrolysis of methyl acetate in presence HCl.
- 3) To study the velocity constant of hydrolysis of methyl acetate in presence H_2SO_4 .
- 4) To study the reaction between Potassium persulphate and Potassium iodide kinetically (equal concentration).
- 5) Determination of heat of ionization of weak acid by using polythene bottle.
- 6) Determination of Surface tension of the given liquids by Stalagmometer.
- 7) Determination of heat of solution of salt KCl.
- 8) Determination of equivalent weight of Mg by eudiometer.

B)Analytical Chemistry:

- 1) Estimation of amount of Acetic acid from the given vinegar sample by titrimetric method
- 2) Estimation of Aspirin tablet.
- 3) Estimation of Vitamin C from fruit juice.
- 4) Determination of Cell constant of given conductivity cell using KCl solution.
(N/10 and N/50 KCl) (Solutions should be prepared by the students).
- 5) Preparation and standardization of HCl/H₂SO₄ solution from the bulk.
- 6) Separation and identification of amino acids by paper chromatography.
- 7) Estimation of Ca from pharma tablets by complexometric method.

References:

- 1) Practical book of Physical Chemistry: Nadkarni, Kothari & Lawande.
- 2) Experimental Physical Chemistry: A. Findlay.
- 3) Systematic Experimental Physical Chemistry: S. W. Rajbhoj, Chondhekar. (Anjali Publication.)
- 4) Experiments in Physical Chemistry: R. C. Das and B. Behra. (Tata McGraw Hill)
- 5) Advanced Practical Physical Chemistry: J. B. Yadav (Goel Publishing House.)
- 6) Practical Physical Chemistry: B. D. Khosala. (R. Chand & Sons)
- 7) Experiments in Chemistry: D. V. Jahagirdar.
- 8) A Text Book of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis: A.I. Vogel (Third Ed) (ELBS)

**B.Sc.I(NEP-2.0)SemesterII,OE PRACTICAL COURSE PAPER-II CHOEP-201 –
OPEN ELECTIVE (OE) CHEMISTRY (Credits-02,60hours)**

Soil Analysis

Expected Course Outcomes

To learn and understand basic knowledge of physico-chemical properties of soil. To learn about general soil quality analysis techniques.

To acquire hands-on skill to perform actual practical analysis in the laboratory.

अपेक्षित शिक्षण परिणाम:

मातीच्या भौतिक-रासायनिक गुणधर्मांचे रूढ भूविज्ञान जाणवेली.
सामान्य मातीच्या गुणवत्तेचे तक्ते व श्लेषाणित्र जाणवेली.

प्रयोगशाळेप्रत्यक्षव्यावहारिकतवश्लेषणकरण्यासाठी कौशल्ये आत्मसात्करणे.

1. Sampling of soil using various soil sampling methods.
2. Determining the acid-base index of various soil samples using a pH meter or pH paper.
3. Determination of electrical conductivity using conductivity meter.
4. To determine the acidity of the given soil samples. (Acidity)
5. Extraction of coarse sand, fine sand, clay soil etc.
6. Removal of soluble salts from soil
7. Removal of free lime from soil.
8. To check the amount of nutrients such as nitrogen, phosphorus and phosphorus in a given soil sample.
9. Examination of calcium from soil.
10. Soil Quality Assessment: To guide students through the process of assessing overall soil quality based on the results of their tests. They can compare their findings to soil quality standards and discuss the implications for human health and the environment.
11. Field Trips: Conducting field trips to farms for direct observation and testing.

माती विश्लेषण Soil Analysis

(Credits-02, 60 hours)

1. विविध मातीचे नमुने गोळा करण्याच्या पद्धतींना परिचय देणे.
2. pH मीटर किंवा pH पट्टींना परिचय देणे आणि मातीच्या विविध नमुन्यांचे आम्ल-विम्लन निशांकन करणे.
3. चालकता मीटर (conductivity meter) किंवा परिचय देणे आणि विद्युत चालकता (electrical conductivity) नमूद करणे.
4. दिलेल्या मातीच्या नमुन्यांचे अम्लता (Acidity) मोजणे.
5. मातीत अलेल्या जाडरेती, बारीक रेती, चकण माती आणि घटकांचे शेर प्रमाण काढणे.
6. मातीतील विद्राव्य क्षार काढणे.
7. मातीतील मुसत चुना काढणे.
8. नत्र, पालाश, स्फुरिक पोर्कद्रव्यांचा दिलेल्या मातीच्या नमुन्यात कती प्रमाण आहे हे पाहणे.
9. मातीतील कॅल्शियम तपाणी करणे.
10. मातीच्या गुणितेचे मूल्यांकन: विद्यार्थ्यांना तपासण्याच्या चक्राच्या निष्पत्तीवर आधारित तक्ता मातीच्या

गुणित्तेचेमूल्यांिकनकरण्याच्याप्रकियेद्ारेमागांशानकरणे.तेतयां
 ंच्याननष्कर्ाांचीमातीच्या

गुणित्तेच्यामानकांंशीतुलनाकरूशकतातआणणमानीआरोग्यआणणप
 याारिणाारीलपररणामांंरिचचाकरूशकतात.

11. फील्डदिप(िेत्रसहल):प्रतयक्षननरीक्षणआणणचाचणीाठीशेताारि
 फील्डदिपआयोशजतकरणे.

ReferenceBooks:

1. AnalyticalChemistry-AlkaGupta(PragatiPrakashan)
2. SoilchemicalsAnalysis-P.R.Hesse
3. Soiltestingmanualbydepartmentofagricultureandcooperation,India
4. FundamentalsofSoil---V.N.Sahai
5. TextbookofSoilscience—R.K.Mehra