Estd. 1962
"A++" Accredited by NAAC (2021)
With CGPA 3.52

SHIVAJI UNIVERSITY, KOLHAPUR
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दूरध्वनी - इपीबीएक्स - २०६०९०००, अभ्यासमंडळे विभाग : ०२३१- २६०९०९४. २६०९४८७
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Ref. No./S.U./BOS/Sci.&Tech./ 380 **Date : 21/06/2025**

To,

1. The Principal/Director,
   All Concerned Affiliated Colleges/ Institutions,
   Shivaji University, Kolhapur.

2. The Head,
   Department of Chemistry,
   Shivaji University, Kolhapur.

Subject : Regarding revised Structure & syllabi of M. Sc. Chemistry Part I (sem. I & II) degree programme under the Faculty of Science and Technology as per National Education Policy, 2020 (NEP 2.0)

Sir/Madam,

With reference to the subject mentioned above, I am directed to inform you that the University authorities have accepted and granted approval to the revised Structure & syllabi Nature of Question paper of M. Sc. Chemistry Part I (sem. I & II) under the Faculty of Science and Technology as per National Education Policy, 2020. (NEP 2.0)

This Structure & syllabi shall be implemented from the academic year 2025-26 onwards . A soft copy containing the Structure & syllabus is attached herewith and it is also available on university website www.unishivaji.ac.in,NEP-2020@suk (Online Syllabus)

The question paper on the pre-revised syllabi of above mentioned course will be set for the examinations to be held in October/November 2025 & March/ April, 2026. These chances are available for repeater students, if any.

You are therefore, requested to bring this to the notice of all students and teachers concerned.

Thanking you,

Yours faithfully

Encl : As above

(Dr. S. M. Kubal)
Dy. Registrar

Copy to, For Information and necessary action.

The I/c Dean, Faculty of Science and Technology.	Eligibility Section.
Chairman, Respective Board of Studies	P. G. Seminar Section.
Director, Board of Examinations & Evaluation	P. G. Admission Section.
Appointment Section (A & B)	Affiliation Section (T. 1 & T 2)
B. Sc./M. Sc. Exam. Section.	Computer Center/I. T. Cell.
Internal Quality Assorance Cell	

Shivaji University, Kolhapur

Program Structure and Syllabus as per NEP-2020

M.Sc. Part-I Chemistry

(Inorganic, Organic, Physical, Analytical, Industrial and Applied Chemistry)

Under the Faculty of Science and Technology

To be implemented with effect from Academic Year 2025-2026

CONTENTS

This is applicable for University Department and Affiliated College PG Centres

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 M.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 Programme 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 and post graduates to undertake advanced research or in Industries as skilled chemists.

3. Terms and Definitions:

The terms used in the NEP- Regulations shall have the meaning allotted to them as follows:

Credit: It is a unit by which the coursework is measured. It determines the number of hours of instruction required per week during a semester (Minimum 15 weeks). One credit is equivalent to 15 hours of teaching (lecture and /or tutorial) or 30 hours of practical or internship or on-job training or research project, etc.

Academic Year: It means that if academic year begin in the month of June and ending is the month of May.

Semester: It means 15-16 weeks of teaching-learning sessions of which two weeks shall be set apart for examination and evaluation; A semester comprises 90 working days and an academic year is divided into two semesters.

Grade: It means a letter grade assigned to a student in a program for her/his performance at academic sessions as denoted in symbols with wide letter SU/BOS/Science & Tech./ No. 0549 dated 17/09/2019.

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

Note: i) Marks obtained > = 0.5 shall be rounded off to next higher digit. ii) The SGPA & CGPA shall be rounded off to 2 decimal points. iii) Marks obtained in 50 marks or 200 marks paper shall be converted to 100 marks.

Semester Grade Point Average (SGPA): is computed from the grades as a measure of the students' performance in a given semester.

Cumulative GPA (CGPA): is the weighted average of all courses the student has taken in a given Programme.

Credit Requirement: for a Degree/Diploma/Certificate Programme means the minimum number of credits that a student shall accumulate to achieve the status of being qualified to receive the said Degree, Diploma/Certificate as the case may be.

Multiple Entry and Multiple Exit:

a) Exit option: It means the option exercised by the students, to leave the Programme at the end of any given Academic year.

b) Lateral entry: It means a student being admitted into an ongoing Programme of the University other than in the 1st year of the programme.

Academic Bank of Credit: (ABC) shall be established which would digitally store the academic credits earned from various recognized HEIs so that the degrees from an HEI can be awarded taking into account credits earned.

4. Program Educational Objectives (PEOs):

PEO-1: To develop a strong foundation in fundamental and advanced concepts of chemistry, enabling students to apply scientific principles effectively in research, industry, and academia.

PEO-2: To equip students with practical laboratory skills and expertise in modern analytical, synthetic, and computational techniques for solving complex chemical problems.

PEO-3: To foster critical thinking, problem-solving abilities, and independent research skills to contribute to innovations in chemical sciences and interdisciplinary fields.

PEO-4: To prepare graduates for successful careers in chemical industries, research institutions, higher education, and entrepreneurship by promoting ethical practices and lifelong learning.

5. Program Outcomes (POs): Students will be able to

PO-1: Demonstrate comprehensive knowledge of core chemistry subjects including physical, organic, inorganic, and analytical chemistry.

PO-2: Apply theoretical concepts and practical techniques to design and conduct experiments, analyse data, and interpret results effectively.

PO-3: Utilize modern instrumentation and computational tools for chemical analysis, synthesis, and characterization.

PO-4: Understand the societal, environmental, and safety aspects related to chemical research and industrial practices.

6. Programme Specific Outcomes (PSOs): Students will be able to

PSO-1: Apply the chemistry knowledge to provide solutions to the contemporary societal problems in fields of materials science, environmental science, and pharmaceutical chemistry.

PSO-2: Interpret the properties of various chemicals using the analytical techniques learned and relate the chemical characteristics to functioning and performance of various functional materials.

PSO-3: Assess and evaluate facts, claims and arguments using their scientific knowledge.

PSO-4: Define a problem, analyse, interpret and draw conclusion by planning, implementing and reporting the results of an experiment.

7. Credit Framework:

Year (2 yr. PG)	Level	Semester	Major-Mandatory, Cr.	Major-Electives, Cr.	RM, Cr.	OJT/FP, Cr.	RP, Cr.	Total
1	6.0	I	14	4	4	-	-	22
		II	14	4	-	4	-	22
Exit Option: Award of PG Diploma in Chemistry on Completion of 44 credits at 6.0 level (PG First Year) or Continue with PG Second Year								
2	6.5	III	14	4	-	-	4	22
		IV	12	4	-	-	6	22
Total 4 semester			54	16	4	4	10	88

Abbreviation: yr.: Year, Cr.: Credit, RM: Research Methodology, OJT: On Job Training, FP: Field project, RP: Research project, T: Theory, P: Practical

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

9. Scheme of Teaching-Learning:

a) As per the NEP guidelines, the representative teaching-learning pedagogical approaches will be adopted to all the courses; which include i) Blended teaching-learning, ii) Research-based teaching-learning, iii) Problem based teaching-learning, iv) Project based teaching-learning, v) Practical/experiential based teaching-learning, vi) Skill based teaching-learning, vii) ICT based teaching-learning, viii) Remedial coaching teaching-learning, ix) Scholarly learner-centric activities beyond classroom, x) Field project/study tour/Industrial tour, xi) Any other Innovative teaching-learning pedagogical approaches

b) A student has to attend 1-hour classroom teaching for one credit of theory per week and 2 hours' lab work/problem-solving session/related activities for one credit of practical per week. Practical sessions (lab work/problem-solving session/related activity) will be conducted in batches. A batch for such sessions will be of maximum 10 students.

c) The Department may conduct necessary lectures/workshops as a part of OJT/FP. On-Job training (OJT/FP) is mandatory for second semester (4 Credits) and carried out after end of first semester examination.

d) Research Project is compulsory for second year (10 Credits).

e) Industrial/Study Tour: M.Sc. second year students shall visit Industry/Research Institute as a part of curriculum.

f) Attendance: Every student must have at least 80% attendance in each paper (Theory & Practical) in each semester. Shortage of attendance will be dealt with as per the university rules from time to time.

10. Scheme of Examination:

As per the UGC guidelines, there is formative (continuous internal evaluation) and summative assessment for M.Sc. Programme. The Examination will be conducted semester wise for Theory and Practicals.

A) Theory Examination

a) Each course of 4 credits will carry 100 marks having 60:40 patterns for both theory as well as practical courses and courses of 2 credits will carry 50 marks having 30:20 patterns for theory as well as practical courses.

b) For theory courses, University examination of 60 marks (2 hours duration) will be conducted at the end of each Semester.

c) Minimum 40% marks will be required for passing separately for theory and practical courses.

B) Internal Examination

a) The formative (continuous internal evaluation - CIE) assessment for M.Sc. Programme is conducted continuously in a semester.

b) The CIE will be based on minimum two class tests (CT) consists of short-answer questions with quiz/MCQ. In addition, a teacher may consider two of the followings: (i) Home Assignments/Open Book Examination (ii) Seminar/Presentation/Group Discussion (iii) Laboratory assignment/Case Study/Portfolio (iv) Oral/viva voce, (v) Research Paper/Book Review/Project Report/Review Writing/etc

c) CIE will be compulsory for all students. If a student fails/remains absent in internal Examination then he/she will have to clear the internal examination in subsequent attempt/s.
d) The CIE shall be conducted throughout the semester as per departmental academic calendar.
e) Distribution of CIE is as follows:

CT-1	CT-2	HA/OBE/if any	S/O/GD/if any	Total
10 Marks	10 Marks	10 Marks	10 Marks	40 Marks

CT-Class test, HA- Home Assignment, OBE-Open Book Examination, S- Seminar, O-Oral and GD- Group Discussion

C) Practical Examination:

a) Practical examination will be conducted at the end of each semester (before or after theory examination).

b) Practical Examination and Research Project assessment will be conducted Odd-Odd and Even-Even semester only.

c) The time duration for 2 credits practical course examination is of minimum 7 hours in a day.

d) M.Sc. I: Number of days required per batch for practical examination = 03 days.

M.Sc. II: Number of days required per batch for practical examination including research project evaluation = 03 days.

e) OJT/internship/FP will be evaluated through detailed report submission followed by power point presentation evaluated by the examiners/experts appointed by the Examination Section of the University. Maximum 20 students per batch will be evaluated per day for OJT/Internship/FP. The OJT/Internship/FP will be evaluated as per the following marks distributions:

Sr. No.	Particulars	Total Marks	
		100 Marks	50 Marks
1	Presentation Quality and Effectiveness	10	05
2	Knowledge depth and Practical Skills	10	05
3	Diversity and Introductory of Teaching-Experiences	10	05
4	Use of theoretical ideation in Professional practices	10	05
5	Report	30	15
6	Attendance and Overall Evaluation	30	15

11. Program Structure:

Revised Credit Frameworks for M.Sc. Chemistry Programs as per NEP 2.0 with effect from 2025-26
M.Sc. Part-I Chemistry: (Inorganic/Organic/Physical/Analytical/Industrial/Applied Chemeistry)

Year	Level	Sem	Major		RM	OJT/FP	RP	Cumm. Cr.	Degree
			Mandatory	Elective (Choose any one)					
I	6.0	I	CHT101 (4 Cr) CHT102 (4 Cr) CHT103 (4 Cr) CHP104 (2 Cr)	E-CHP105 (A) (4 Cr) E-CHP105 (B) (4 Cr)	RM-CH106 (4 Cr)	---	---	22	**PG Diploma in Chemistry (After 3yr B.Sc. Degree)**
		II	CHT201 (4 Cr) CHT202 (4 Cr) CHT203 (4 Cr) CHP204 (2 Cr)	E-CHP205 (A) (4 Cr) E-CHP205 (B) (4 Cr)		OJT/FP-CH206 (4 Cr)	---	22	
Cum. Cr. for PG Diploma in Chemistry			**28**	**8**	**4**	**4**		**44**	
Exit option: PG Diploma (40-44 Credits) after Three Year UG Degree									

Abbreviations: Yr.: Year; Sem.: Semester; OJT: On Job Training: Internship/ Apprenticeship; FP: Field projects; RM: Research Methodology; RP: Research Project; Cum. Cr: Cumulative Credits. CHT: Chemistry Theory, CHP: Chemistry Practical

M.Sc. II Inorganic Chemistry
Revised Credit Frameworks for M.Sc. Programs as per NEP 2.0 with effect from 2026-27

Year	Level	Sem	Major		RM	OJT/FP	RP	Cumm. Cr.	Degree
			Mandatory	Elective (Choose any one)					
II	6.5	III	ICHT301 (4 Cr) ICHT302 (4 Cr) ICHP304 (4 Cr) ICHP305 (2 Cr)	E-ICHT303 (A) (4 Cr) E-ICHT303 (B) (4 Cr) E-ICHT303 (C) (4 Cr) E-ICHT303 (D) (4 Cr)	---	---	RP-306 (4 Cr)	22	**PG Degree After 3-Yr UG Or PG Degree after 4-Yr UG** **Note: All the practicals/Project will be discipline specific i.e. Inorganic Chemistry oriented**
		IV	ICHT401 (4 Cr) ICHT402 (4 Cr) ICHP404 (4 Cr)	E-ICHT403 (A) (4 Cr) E-ICHT403 (B) (4 Cr) E-ICHT403 (C) (4 Cr) E-ICHT403 (D) (4 Cr)	---	---	RP-405 (6 Cr)	22	
Cum. Cr. For 2 Year PG Degree in Inorganic Chemistry			**26**	**8**			**10**	**44**	
2 Years-4 Sem. PG Degree in Inorganic Chemistry (88 credits) after Three Year UG Degree or 1 Year-2 Sem PG Degree in Inorganic Chemistry (44 credits) after Four Year UG Degree									

Abbreviations: Yr.: Year; Sem.: Semester; RP: Research Project; Cum. Cr: Cumulative Credits. ICHT: Inorganic Chem Theory, ICHP: Inorganic Chem Practical.

M.Sc. II Organic Chemistry
Revised Credit Frameworks for M.Sc. Programs as per NEP 2.0 with effect from 2026-27

Year	Level	Sem	Major		RM	OJT/FP	RP	Cumm. Cr.	Degree
			Mandatory	Elective (Choose any one)					
II	6.5	III	OCHT301 (4 Cr) OCHT302 (4 Cr) OCHP304 (4 Cr) OCHP305 (2 Cr)	E-OCHT303 (A) (4 Cr) E-OCHT303 (B) (4 Cr) E-OCHT303 (C) (4 Cr) E-OCHT303 (D) (4 Cr)	---	---	RP-306 (4 Cr)	22	**PG Degree After 3-Yr UG Or PG Degree after 4-Yr UG** **Note: All the practicals/Project will be discipline specific i.e. Organic Chemistry oriented**
		IV	OCHT401 (4 Cr) OCHT402 (4 Cr) OCHP404 (4 Cr)	E-OCHT403 (A) (4 Cr) E-OCHT403 (B) (4 Cr) E-OCHT403 (C) (4 Cr) E-OCHT403 (D) (4 Cr)	---	---	RP-405 (6 Cr)	22	
Cum. Cr. For 2 Year PG Degree in Organic Chemistry			**26**	**8**	**4**	**4**	**10**	**44**	
2 Years-4 Sem. PG Degree in Organic Chemistry (88 credits) after Three Year UG Degree or 1 Year-2 Sem PG Degree in Organic Chemistry (44 credits) after Four Year UG Degree									

Abbreviations: Yr.: Year; Sem.: Semester; OJT: On Job Training: Internship/ Apprenticeship; FP: Field projects; RM: Research Methodology; Research Project: RP; Cumulative Credits: Cum. Cr., OCHT: Organic Chem Theory, OCHP: Organic Chem Practical.

M.Sc. II Physical Chemistry
Revised Credit Frameworks for M.Sc. Programs as per NEP 2.0 with effect from 2026-27

Year	Level	Sem	Major		RM	OJT/FP	RP	Cumm. Cr.	Degree
			Mandatory	Elective (Choose any one)					
II	6.5	III	PCHT301 (4 Cr) PCHT302 (4 Cr) PCHP304 (4 Cr) PCHP305 (2 Cr)	E-PCHT303 (A) (4 Cr) E-PCHT303 (B) (4 Cr) E-PCHT303 (C) (4 Cr) E-PCHT303 (D) (4 Cr)	---	---	RP-306 (4 Cr)	22	**PG Degree After 3-Yr UG Or PG Degree after 4-Yr UG** **Note: All the practicals/Project will be discipline specific i.e. Physical Chemistry oriented**
		IV	PCHT401 (4 Cr) PCHT402 (4 Cr) PCHP404 (4 Cr)	E-PCHT403 (A) (4 Cr) E-PCHT403 (B) (4 Cr) E-PCHT403 (C) (4 Cr) E-PCHT403 (D) (4 Cr)	---	---	RP-405 (6 Cr)	22	
Cum. Cr. For 2 Year PG Degree in Physical Chemistry			**26**	**8**			**10**	**44**	
2 Years-4 Sem. PG Degree in Physical Chemistry (88 credits) after Three Year UG Degree or 1 Year-2 Sem PG Degree in Physical Chemistry (44 credits) after Four Year UG Degree									

Abbreviations: Yr.: Year; Sem.: Semester; OJT: On Job Training: Internship/ Apprenticeship; FP: Field projects; RM: Research Methodology; Research Project: RP; Cumulative Credits: Cum. Cr. PCHT: Physical Chem Theory paper, PCHP: Physical Chem Practical paper

M.Sc. II Analytical Chemistry
Revised Credit Frameworks for M.Sc. Programs as per NEP 2.0 with effect from 2026-27

Year	Level	Sem	Major		RM	OJT/FP	RP	Cumm. Cr.	Degree
			Mandatory	Elective (Choose any one)					
II	6.5	III	ACHT301 (4 Cr) ACHT302 (4 Cr) ACHP304 (4 Cr) ACHP305 (2 Cr)	E-ACHT303 (A) (4 Cr) E-ACHT303 (B) (4 Cr) E-ACHT303 (C) (4 Cr) E-ACHT303 (D) (4 Cr)	---	---	RP-306 (4 Cr)	22	**PG Degree After 3-Yr UG Or PG Degree after 4-Yr UG** **Note: All the practicals/Project will be discipline specific i.e. Analytical Chemistry oriented**
		IV	ACHT401 (4 Cr) ACHT402 (4 Cr) ACHP404 (4 Cr)	E-ACHT403 (A) (4 Cr) E-ACHT403 (B) (4 Cr) E-ACHT403 (C) (4 Cr) E-ACHT403 (D) (4 Cr)	---	---	RP-405 (6 Cr)	22	
Cum. Cr. For 2 Year PG Degree in Analytical Chemistry			**26**	**8**			**10**	**44**	
2 Years-4 Sem. PG Degree in Analytical Chemistry (88 credits) after Three Year UG Degree or 1 Year-2 Sem PG Degree in Analytical Chemistry (44 credits) after Four Year UG Degree									

Abbreviations: Yr.: Year; Sem.: Semester; OJT: On Job Training: Internship/ Apprenticeship; FP: Field projects; RM: Research Methodology; Research Project: RP; Cumulative Credits: Cum. Cr. ACHT: Analytical Chem Theory paper, ACHP: Analytical Chem Practical paper

M.Sc. II Industrial Chemistry
Revised Credit Frameworks for M.Sc. Programs as per NEP 2.0 with effect from 2026-27

Year	Level	Sem	Major		RM	OJT/FP	RP	Cumm. Cr.	Degree
			Mandatory	Elective (Choose any one)					
II	6.5	III	INDCHT301 (4 Cr) INDCHT302 (4 Cr) INDCHP304 (4 Cr) INDCHP305 (2 Cr)	E-INDCHT303 (A) (4 Cr) E-INDCHT303 (B) (4 Cr) E-INDCHT303 (C) (4 Cr) E-INDCHT303 (D) (4 Cr)	---	---	RP-306 (4 Cr)	22	**PG Degree After 3-Yr UG Or PG Degree after 4-Yr UG** **Note: All the practicals/Project will be discipline specific i.e. Industrial Chemistry oriented**
		IV	INDCHT401 (4 Cr) INDCHT402 (4 Cr) INDCHP404 (4 Cr)	E-INDCHT403 (A) (4 Cr) E-INDCHT403 (B) (4 Cr) E-INDCHT403 (C) (4 Cr) E-INDCHT403 (D) (4 Cr)	---	---	RP-405 (6 Cr)	22	
Cum. Cr. For 2 Year PG Degree in Industrial Chemistry			**26**	**8**			**10**	**44**	
2 Years-4 Sem. PG Degree in Industrial Chemistry (88 credits) after Three Year UG Degree or 1 Year-2 Sem PG Degree in Industrial Chemistry (44 credits) after Four Year UG Degree									

Abbreviations: Yr.: Year; Sem.: Semester; OJT: On Job Training: Internship/ Apprenticeship; FP: Field projects; RM: Research Methodology; Research Project: RP; Cumulative Credits: Cum. Cr. INDCHT: Industrial Chem Theory paper, INDCHP: Industrial Chem Practical paper

M.Sc. II Applied Chemistry
Revised Credit Frameworks for M.Sc. Programs as per NEP 2.0 with effect from 2026-27

Year	Level	Sem	Major		RM	OJT/FP	RP	Cumm. Cr.	Degree
			Mandatory	Elective (Choose any one)					
II	6.5	III	APCHT301 (4 Cr) APCHT302 (4 Cr) APCHP304 (4 Cr) APCHP305 (2 Cr)	E-APCHT303 (A) (4 Cr) E-APCHT303 (B) (4 Cr) E-APCHT303 (C) (4 Cr) E-APCHT303 (D) (4 Cr)	---	---	RP-306 (4 Cr)	22	**PG Degree After 3-Yr UG Or PG Degree after 4-Yr UG** **Note: All the practicals/Project will be discipline specific i.e. Applied Chemistry oriented**
		IV	APCHT401 (4 Cr) APCHT402 (4 Cr) APCHP404 (4 Cr)	E-APCHT403 (A) (4 Cr) E-APCHT403 (B) (4 Cr) E-APCHT403 (C) (4 Cr) E-APCHT403 (D) (4 Cr)	---	---	RP-405 (6 Cr)	22	
Cum. Cr. For 2 Year PG Degree in Applied Chemistry			**26**	**8**			**10**	**44**	
2 Years-4 Sem. PG Degree in Applied Chemistry (88 credits) after Three Year UG Degree or 1 Year-2 Sem PG Degree in Applied Chemistry (44 credits) after Four Year UG Degree									

Abbreviations: Yr.: Year; Sem.: Semester; OJT: On Job Training: Internship/ Apprenticeship; FP: Field projects; RM: Research Methodology; Research Project: RP; Cumulative Credits: Cum. Cr. APCHT: Applied Chem Theory paper, APCHP: Applied Chem Practical paper

12. DETAILED SYLLABUS

M.Sc. Part – I (Semester – I)

Paper I-CHT101: Inorganic Chemistry-I [Credit 4, 60 Hrs]

COURSE OUTCOMES (COs): Students will be able to

CO-1: Learn the properties, bonding theories, and stereochemistry of transition metal complexes using Crystal Field Theory and Molecular Orbital Theory.

CO-2: Apply concepts of molecular symmetry and group theory to analyse and classify molecular structures and their spectroscopic properties.

CO-3: Study the synthesis, bonding, and catalytic applications of organometallic compounds and interpret their reaction mechanisms.

CO-4: Evaluate chemical and instrumental analytical methods, including chromatographic techniques, and apply statistical tools for data accuracy and error minimization.

UNIT-I: Chemistry of Transition Elements **15 Hrs**

General characteristics and properties of transition elements, Coordination chemistry of transition metal ions, Stereochemistry of coordination compounds, Crystal field theory (CFT) for tetrahedral, octahedral, square pyramidal, square planar, and trigonal bipyramidal fields, Crystal field stabilization energy (CFSE), Factors affecting the crystal field splitting parameters, Strong and weak field complexes, Spectrochemical series, Jahn- Teller Distortion, Applications of CFT for defining kinetic properties of complexes and site selections of cations, anions in spinels. Molecular orbital theory (MOT) for octahedral complexes involving sigma- and pi-bonding, and for tetrahedral complexes.

UNIT-II: Molecular Symmetry and Group Theory **15 Hrs**

Introduction to Symmetry, Symmetry operations, Symmetry elements, Point group and its classification (Cn-type, Dn-type, Special-type), Schoenflies symbol for point groups, Group and its Properties, Group multiplication table, Matrix representation of symmetry elements, Reducible and Irreducible representations, Properties of Irreducible representation, Great orthogonal theorem (without proof) and its importance, Construction of character table for water molecule, Mulliken symbolism rules for irreducible representations

UNIT-III: Organometallic Chemistry **15 Hrs**

Definition and criteria of organometallic compounds, Classification of organometallic compounds based on hapticity and polarity of M-C bond, Nomenclature and general characteristics, 18 electron rule-applications and exceptions, Synthesis, bonding, properties and reactivity of representative organometallic compounds (-CO, -NO, -alkene,-alkyne), Reactions of organometallic compounds: Oxidative addition, reductive elimination, Insertion and elimination, Organometallics in homogeneous catalysis: Hydrogenation of olefins, hydroformylation reaction, Monsanto Acetic Acid, and polymerization of olefins.

UNIT-IV: **8 + 7 Hrs**

A) Basics of Analysis: Chemical analysis, instrumental methods, Analytical methods, Techniques of analysis, classification of analytical techniques, Classification of instrumental methods, factors affecting choice of analytical methods, interferences

Statistical analysis: Types and sources of error, determinate and indeterminate errors, accuracy and precision Absolute and relative errors, Minimization of errors, Significant figures, Mean, median and standard deviation, Least square method.

B) Gas Chromatography: Basic Principle, Instrumentation, detectors, applications, advantages and disadvantages.

HPLC: Basic Principle, Instrumentation, detectors, applications, advantage and disadvantages.

RECOMMENDED BOOKS:

1. Fundamental Concepts of Inorganic Chemistry (Vol I to VII), A.K. Das and M. Das, CBS Publishers.
2. J. D. Lee, Concise Inorganic Chemistry, Elbs with Chapman and Hall, London
3. A. R. West, Plenum, Solid State Chemistry, and its applications
4. M. N. Hughes, Inorganic Chemistry of Biological Processes
5. F.A. Cotton, R.G. Wilkinson. Advanced Inorganic Chemistry
6. Manas Chanda, Atomic Structure and Chemical Bonding
7. N. N. Greenwood and A. Earnshaw, Chemistry of elements, Pergamon
8. A Text book of Qualitative Inorganic Analysis- A. I. Vogel

Paper II-CHT102: Organic Chemistry-I [Credit 4, 60 Hrs]

COURSE OUTCOMES (COs): Students will be able to

CO-1: Analyze the structure and reactivity of compounds and also understand different aliphatic nucleophilic substitution reaction

CO-2: Realize the terms aromaticity, anti-aromaticity, homoaromaticity in different organic molecules.

CO-3: Know about the types of reactions and mechanisms by realizing the various factors which are affecting on the reactions.

CO-4: Apply the concept of stereochemistry by writing the different projection formulae.

UNIT-I **15 Hrs**

A) Introduction to aromaticity in Benzenoid and non–Benzenoid compounds. 7 Hrs

Three, four, and five-membered systems. tropone, tropolone, tropylium salts.

B) I] Aromatic Electrophilic Substitutions 8 Hrs

Introduction, the Arenium ion mechanism, orientation and reactivity in Nitration, Sulphonation, Friedel-Crafts and Halogenation in aromatic systems, energy profile diagrams. The ortho/para ratio, ipso attack, and orientation in their ring systems. Diazo-coupling, Vilsmeier-Haak reaction, Von Richter rearrangement

II] Nucleophilic aromatic substitution reactions.

UNIT-II **15 Hrs**

A) Elimination Reactions 5 Hrs

E1, E2 and E1cB mechanisms. Orientation in Elimination reactions. Hofman versus Saytzeff elimination, Reactivity: effects of substrate structures, attacking base, the leaving group, the nature of medium on elimination reactions. Pyrolytic elimination reactions.

B) Study of following reactions 10 Hrs

Mechanism of condensation reaction involving enolates, Benzoin, Stobbe, Robinson annulation, Simon-Smith, Ullmann, Mc-Murry, Dakin, Prins, Wurtz-Fittig, Hunsdiecker, Pummerer, Corey-Chaykovsky, Nef reaction, Passerini, Baylis-Hilman, Mitsunobu.

UNIT-III: Stereochemistry **15 Hrs**

Concept of chirality Prochiral relationship, homotopic, enantiotopic and disteriotopic groups and faces. Racemic modifications and their resolution, R and S nomenclature. Conformational analysis: Cyclohexane derivatives, stability and reactivity, Conformational analysis of disubstituted cyclohexanes. Introduction of optical activity in the absence of chiral carbon (spiranes and allenes)

UNIT-IV: UV-Vis and FT-IR Spectroscopy **15 Hrs**

A) Ultraviolet and visible spectrophotometry (UV-Vis) Introduction, Beer Lambert's law, instrumentation, calculation of absorption maxima of dienes, dienones and polyenes, applications. **7 Hrs**

B) Fourier Transform -Infrared Spectroscopy (IR) Introduction, instrumentation, sampling technique, selection rules, types of bonds, absorption of common functional groups. Factors affecting stretching frequencies, applications **8 Hrs**

RECOMMENDED BOOKS

1. A guide book to mechanism in Organic chemistry (Orient-Longmens)- Peter Sykes
2. Organic Reaction Mechanism (Benjamin) R. Breslow
3. Mechanism and Structure in Organic chemistry (Holt Reinh.)E. S. Gould.
4. Organic Chemistry (McGraw-Hill) Hendrikson, Cram and Hammond.
5. Basic principles of Organic Chemistry (Benjamin) J. D. Roberts and M. C. Caserio.
6. Reactive Intermediates in Organic Chemistry (John Wiley) N. S. Issacs.
7. Stereochemistry of Carbon compounds. (McGraw-Hill) E.L. Eliel
8. Organic Stereochemistry (McGraw-Hill) by Hallas.
9. Organic Reaction Mechanism (McGraw-Hill) R. K. Bansal.
10. Organic Chemistry- R. T. Morrison and R. N. Boyd, (Prentice Hall.)
11. Modern Organic Reactions (Benjumin) H. O. House.
12. Principle of organic synthesis- R.O.C. Norman and J. M. Coxon. (ELBS)
13. Reaction Mechanism in Organic Chemistry- S. M. Mukharji and S. P. Singh.
14. Stereochemistry of Organic compounds) D. Nasipuri.
15. Advanced Organic Chemistry (McGraw-Hill) J. March.
16. Introduction to stereochemistry (Benjumin) K. Mislow.

Paper-III, CHT103: Physical Chemistry-I [Credit 4, 60 Hours]

COURSE OUTCOMES (COs): Students will be able to

CO-1: Apply thermodynamic principles to analyze entropy, chemical potential, and phase equilibria in ideal and non-ideal solutions.

CO-2: Utilize statistical thermodynamics to relate molecular partition functions to macroscopic thermodynamic properties and equilibrium constants.

CO-3: Explain surface phenomena including adsorption, micellization, and their applications in advanced scientific fields like nanotechnology.

CO-4: Demonstrate the use of electroanalytical techniques such as voltammetry, polarography, and amperometry for qualitative and quantitative chemical analysis.

UNIT-I: THERMODYNAMICS **15 Hrs**

Introduction, revision of basic concepts: Entropy and third law of thermodynamics. Methods of determining the practical absolute entropies. Entropies of phase transition. Maxwell relations and its applications, thermodynamic equation of state.

Ideal and non-ideal solutions, Thermodynamics of nonelectrolyte solutions. Raoult's law. Duhem-Margules equation and its applications to vapor pressure curves (Binary liquid mixture). Gibbs-Duhem equation and its applications to study of partial molar quantities. Chemical potential, variation of chemical potential with temperature & pressure. Henry's law. Excess and mixing thermodynamic properties. Equilibrium constants and general conditions of equilibrium in terms of thermodynamic potentials. Numerical Problems.

UNIT-II: STATISTICAL THERMODYNAMICS **15 Hrs**

Probability and distribution, Stirling's Approximation, Weights and configurations, the most probable configuration, Ensembles, ensemble average and time average of property. Statistical equilibrium, thermodynamic probability, Maxwell-Boltzmann (MB) distribution law.

Partition function and its significance. Rotational, translational, vibrational and electronic partition functions. Relationship between partition function and thermodynamic properties, thermodynamic probability and entropy: Boltzmann – Planck equation and third law of thermodynamics, Application to monoatomic gases – Sackur-Tetrode equation, applications to diatomic molecules, Statistical expression for equilibrium constant, Limitations of Maxwell-Boltzmann statistics, Numerical Problems.

UNIT-III: SURFACE PHENOMENA **15 Hrs**

Adsorption, adsorption isotherms, surface area determination, Gibbs adsorption equation and its verification, Surface tension, electrical phenomena at interfaces including electrokinetic effects, micelles, reverse micelles, solubilization.

Thermodynamics of micellisation, factors affecting critical micelle concentration (CMC), experimental methods of CMC determination. Application of photoelectron spectroscopy, ESCA and Auger spectroscopy to the study of surfaces. Significance of surface phenomena in advanced technologies like nanotechnology, drug formulation etc.

UNIT-IV: ELECTRO ANALYTICAL TECHNIQUES **15 Hrs**

Electro Analytical Techniques

Voltammetry: Voltammetric methods of analysis, voltametric techniques, current in voltammetry, shape of voltammograms

Polarography: Introduction, Instrumentation, Ilkovic equation and its verification. Polarographic measurements, Dropping mercury electrode, Determination of half wave potential, qualitative and quantitative applications.

Amperometry: Basic principles, instrumentation, Amperometric titration curves, Amperometric indicators, procedure for Amperometric titrations, Evaluation of amperometry in research and analytical applications

RECOMMENDED BOOKS

1. Physical Chemistry–R.S. Berry, S.A. Rice, J. Ross, 2ndEd., Oxford University Press, NewYork, 2000.
2. Physical Chemistry–P.W.Atkins, Oxford Universitypress, 8thedition, 2006.
3. Text book of Physical Chemistry– S.Glasstone.
4. Principles of Physical Chemistry– Marron and Pruton.
5. Physical Chemistry–G.M. Barrow, Tata-McGraw Hill, Vth edition,2003.
6. Thermodynamics for Chemists –S. Glasstone, D. Van Nostrand, 1965.
7. Elements of statistical thermodynamics- L. K. Nash, 2nd Ed. Addison Wesley 1974.
8. Theoretical Chemistry: An introduction to quantum mechanics, statistical mechanics, and molecular spectra for chemists - S. Glasstone, D. Van Nostrand Company, Inc.,1944.
9. An Introduction to Statistical Thermodynamics–T.L. Hill, Addison-Wesley. 1960
10. Instrumental methods of chemical analysis by H. Kaur.

CHP104: Physical Chemistry Practical-I [Credit 2, 60 Hours]

COURSE OUTCOMES (COs): Students will be able to

CO-1: Analyze reaction kinetics and equilibrium by conducting experiments on chemical reaction rates and solubility product determinations.

CO-2: Apply physical chemistry techniques such as adsorption, viscosity, and refractometry to characterize molecular properties and solutions.

CO-3: Use electrochemical methods including potentiometry, conductometry, and pH-metry for qualitative and quantitative analysis of acids, salts, and mixtures.

CO-4: Perform spectrophotometric experiments to verify Beer-Lambert's law and determine concentrations and molar absorptivities of substances.

EXPERIMENTS:

1) Preparation and Standardization of Solution:

2) Adsorption:

    i) Study of adsorption of acetic acid on charcoal.

    ii) To study the adsorption of certain dyes such as methyl violet, picric acid or malachite green on charcoal.

3) Viscosity: Determination of molecular weight of polymers.

4) Refractometry:

    i) Determination of molecular radius of molecule of organic compound.

    ii) Determination of concentration of sugar in unknown sample.

5) Partial molar volume: To determine the partial molar volume of ethyl alcohol in a mixture of ethyl alcohol and water.

6) Potentiometry:

    i) Determination of solubility and solubility product of silver halides.

    ii) Determination of binary mixture of weak and strong acid.

    iii) To determine the iron potentiometrically by titrating with potassium dichromate.

7) Conductometry (Any Two):

    i) Determination of mixture of acids and relative strength of weak acids.

    ii) Determination of solubility of lead sulphate.

    iii) Determination of ΔG, ΔH, ΔS of silver benzoate by solubility product method.

8) pH-metry: Determination of dissociation constant of dibasic acid.

9) To verify Beer-Lambert's Law for potassium permanganate solution and hence to determine the molar extinction coefficient and unknown concentration of given sample Spectrophotometrically.

10) Liquid State Surface Tension: Determine the surface tension of given liquid by Drop weight and Drop Number Method using Stalgmometer

11) To determine the solubility of Calcium oxalate in presence of different concentration of KCl/HCl.

12) Polarography

i) Determination of half wave potential E1/2 and unknown concentration of Cu or Pb or Zn ion.

ii) Amperometric titration of $Pb(NO_3)_2$ with $K_2Cr_2O_7$.

13) Deposition of silver on metal electrode by using electrodeposition technique

Note: Any other advanced experiments may be added.

RECOMMENDED BOOKS

1. Practical physical chemistry, A. Findlay, T.A. Kitchner (Longmans, Green and Co.)

2. Experiments in Physical Chemistry, J.M. Wilson, K.J. Newcombe, A.r. Denko. R.M.W. Richett (Pergamon Press)

3. Senior Practical Physical Chemistry, B.D. Khosla and V.S. Garg (R. Chand and Co., Delhi.).

ELECTIVE COURSE

E-CHP105 (A): Inorganic and Organic Chemistry Practical-I [Credit 4, 120 Hours]

Practical paper divides into two sections: Section I: Inorganic Chemistry Practicals (2 credits, and Section II: Organic Chemistry Practicals (2 credits)

SECTION I

Inorganic Chemistry Practical [Credit 2, 60 Hours]

COURSE OUTCOMES (COs): Students will be able to

CO-1: Perform quantitative ore and alloy analyses to determine the composition of metals and minerals using classical and instrumental methods.

CO-2: Synthesize and assess the purity of coordination compounds through standard preparation techniques.

CO-3: Apply ion exchange chromatography and colorimetric methods for separation and estimation of metal ions and inorganic species in complex mixtures.

CO-4: Utilize statistical tools and software like Excel for data analysis, including calculation of standard deviation and graphical representation of experimental results.

EXPERIMENTS:

1) Ore Analysis
    i) Determination of Silica and Manganese in Pyrolusite ore.
    ii) Determination of iron from Haematite ore.
2) Alloy Analysis
    i) Determination of tin & lead from Solder alloy.
    ii) Determination of copper and nickel from monel metal alloy.
3) Determination of concentration of phosphates in water sample colorimetrically
4) Preparations and purity (Any four)
    1. Potassimtrioxalatochromate(III)trihydrate
    2. cis-potassiumdioxalatodiaquachromate(III)
    3. Potassionhexathiocyanatochromate(III)
    4. Bis(dimethylglyoximato)nickel(II)
    5. Carbonatotetramminocobalt(III)nitrate

6. Hexamminocobaltic(III)chloride

5. Determination of standard deviation from the results obtained by redox titration of iron solution against standard potassium dichromate solution.

6. Determination of sodium from the fertilizer sample using cation exchange chromatography.

7. Determination of calcium from given drug sample.

8. Determination of hardness, alkalinity and salinity of water sample.

9. Separation and estimation of Cd^{2+} and Zn^{2+} by ion exchange chromatography for given Cd^{2+} and Zn^{2+} mixture.

10. Application of excel spreadsheet for determination of Mean, median, standard deviation and graph plot.

Note: Any other advanced experiments may be added.

RECOMMENDED BOOKS:

1 A text book of Quantitative Inorganic Analysis – A. I. Vogel

2 Experimental Inorganic Chemistry - W. G. Palmer

3 The analysis of minerals and ores of the rarer elements – W. R. Schoeller and A.R. Powell, Charles, Griffin and Company Limited.

4 Experimental Inorganic/Physical Chemistry – M.A. Malti, Horwood Series in Chemical Science, Horwood Publishing Chinchster.

SECTION II

Organic Chemistry Practical [Credit 2, 60 Hours]

COURSE OUTCOMES (COs): Students will be able to

CO-1: Perform one-step organic syntheses involving diverse reaction types and confirm product identity and purity using Thin Layer Chromatography (TLC).

CO-2: Apply classical organic reaction mechanisms such as condensation, cyclization, and substitution for the synthesis of biologically and industrially important compounds.

CO-3: Quantitatively estimate organic compounds including dyes, amino acids, and pharmaceuticals using colorimetric and spectrophotometric techniques.

CO-4: Analyze and interpret experimental data to determine the concentration and purity of organic substances in pharmaceutical and food samples.

EXPERIMENTS:

A) Organic Preparations:

(One-stage preparations involving various types of reactions and confirmation of product by TLC)

1. Coumarin Synthesis- 7-OH-4-methyl coumarin from Resorcinol and EAA.
2. Knoevenagel condensation reaction-Reaction of aldehyde and malononitrile.
3. Preparation of Hydantoin.
4. Synthesis of triazoles- Reaction of aldehyde and thiosemicarbazide.
5. Preparation of benzimidazole from OPD
6. Preparation of Orange II
7. Synthesis of dihydropyrimidone by Biginelli reaction
8. Synthesis of Dibenzylidene acetone
9. Preparation of Benzanilide from Benzophenone Oxime.
10. Benzoic acid and benzyl alcohol from benzaldehyde (Cannizarro reaction).
11. Preparation of m-dinitrobenzene from nitrobenzene. (Any suitable preparation may be added)
12. **Organic Estimations:(Any Three)**
    1. Estimation of Unsaturation.
    2. Estimation of formalin.
    3. Colorimetric Estimation of Dyes.
    4. Estimation of Amino acids.
    5. Estimation of Glycine.
13. Analysis of pharmaceutical tablets for ibuprofen content.
14. To verify the Beer-Lamberts Law and determine the concentration of given organic dye solution colorimetrically/spectrophotometrically.
15. To estimate the amount of D-glucose in a given solution colorimetrically.
16. To determine the acid value of given oil.

Note: Any advanced experiments related to Organic and Analytical Chemistry may added.

RECOMMENDED BOOKS:

1. Practical Organic Chemistry- Mann and Saunders.
2. A Handbook of Quantitative and Qualitative Analysis- H. T. Clarke.
3. A Text Book of Practical Organic Chemistry- A. I. Vogel

E-CHP105 (B): Inorganic and Organic Chemistry Practicals-I [Credit 4, 120 Hours]

Practical paper divides into two sections: Section I: Inorganic Chemistry Practicals (2 credits, and Section II: Organic Chemistry Practicals (2 credits)

SECTION I

Inorganic Chemistry Practical [Credit 2, 60 Hours]

COURSE OUTCOMES (COs): Students will be able to

CO-1: Analyze ore samples to quantitatively determine the concentration of key metal and non-metal components using classical wet chemical methods.

CO-2: Perform alloy composition analysis to accurately estimate the percentages of constituent metals in common industrial alloys.

CO-3: Apply chromatographic and colorimetric techniques for the separation and estimation of metal ions and anions in complex mixtures.

CO-4: Utilize statistical tools and software like Excel to analyze experimental data, calculate error parameters, and graphically represent analytical results for precision and accuracy assessment.

EXPERIMENTS:

1) Ore Analysis

i) Determination of aluminium and silica from bauxite ore.

ii) Determination of copper and sulphide from chalcopyrite ore.

iii) Estimation of calcium and magnesium carbonates in dolomite using EDTA titration, and gravimetric analysis of insoluble residue.

iv) Haematite: Iron by volumetric (potassium dichromate and Ceric ammonium sulphate) method and by colorimetric method.

2) Alloy Analysis

i) Determination of iron and chromium from stainless steel alloy.

ii) Determination of copper and zinc from brass alloy.

3. Heterogeneous Photo-Catalysis: Removal and kinetics of photo-catalytic dye degradation (methylene blue) on synthesized ZnO.

4. Synthesis of TiO_2 by Sol-Gel method and determine band gap by absorption

spectroscopy

5. Heterogeneous Photo-Catalysis: Removal and kinetics of photo-catalytic dye degradation (methylene blue) on synthesized TiO2.

6. Synthesis of colloidal silver nanoparticles (suspension) and determine band gap by absorption spectroscopy.

7. Synthesis of Cu_2O nanoparticles of different colours.

8. Determination of calcium from given drug sample.

9. Determination of hardness, alkalinity and salinity of water sample.

10. Separation and estimation of Cd^{2+} and Zn^{2+} by ion exchange chromatography for given Cd^{2+} and Zn^{2+} mixture.

11. Application of excel spreadsheet for determination of Mean, median, standard deviation and graph plot.

12. Determination of COD and BOD of polluted water.

Note: Any other advanced experiments related to Inorganic and Analytical Chemistry may be added.

RECOMMENDED BOOKS:

1. A text book of Quantitative Inorganic Analysis– A. I. Vogel
2. Experimental Inorganic Chemistry -W. G. Palmer
3. The analysis of minerals and ores of the rarer elements–W.R. Schoeller and R. Powell, Charles, Griffin and Company Limited.
4. Experimental Inorganic / Physical Chemistry–M. A. Malti, Horwood Series in Chemical Science, Horwood Publishing Chinchster.
5. Instrumental Methods of analysis- Willard, Merrit, Dean and Settle.
6. A Text book of Qualitative Inorganic Analysis- A. I. Vogel
7. Physical Methods in Inorganic Chemistry (DWAP)- R. Drago
8. Fundamentals of Analytical Chemistry – D.A. Skoog and D. M. West (Holt Rinehart and Winston Inc.)

SECTION II

Organic Chemistry Practical [Credit 2, 60 Hours]

COURSE OUTCOMES (COs): Students will be able to

CO-1: Perform single-step organic syntheses involving various reaction types and confirm product purity through recrystallization and Thin Layer Chromatography (TLC).

CO-2: Apply purification techniques including recrystallization and simple distillation to isolate and characterize organic compounds.

CO-3: Execute quantitative organic estimations such as unsaturation, formalin, dyes, and pharmaceutical contents using colorimetric and spectrophotometric methods.

CO-4: Understand and verify fundamental analytical principles like Beer-Lambert's Law through practical experiments involving organic dyes and biochemical samples.

EXPERIMENTS:

1. Organic Preparations

a) Single stage preparation and Recrystallization

i. Reduction of aromatic aldehyde using sodium borohydride.
ii. To study the base catalyzed Aldol condensation using $LiOH.H_2O$ as catalyst. (Recrystallization)
iii. Synthesis of p-chlorotoulene from p-toluidine by using Sandmeyer reaction.
iv. Vilsmeier-Haack reaction of N, N-dimethyl aniline.
v. Bromination of acetanilide using Ceric Ammonium Nitrate
vi. Synthesis of β-naphthyl methyl ether from β-naphthol.
vii. Reduction of p-nitrotoluene using Sn/HCl. (Chemical Separation and Crystallization)

b) Single stage preparation and Simple Distillation

i. Purification of crude aniline by distillation and its conversion to acetanilide
ii. Reduction of acetophenone using hydrazine hydrate.
iii. In situ preparation of sodium hypochlorite (NaOCl) using bleaching powder and NaOH and its application in the oxidation of cyclohexanol to cyclohexanone.

2. Organic Estimations

i) Estimation of Unsaturation.
ii) Estimation of formalin.
iii) Colorimetric Estimation of Dyes.

iv) Estimation of Amino acids.

v) Estimation of Glycine.

3. Analysis of pharmaceutical tablets for ibuprofen content.
4. To verify the Beer-Lamberts Law and determine the concentration of given organic dye solution colorimetrically/spectrophotometrically.
5. To estimate the amount of D-glucose in a given solution colorimetrically.
6. To determine the acid value of given oil.

Note: Any other advanced experiments related to Organic and Analytical Chemistry may perform.

RECOMMENDED BOOKS:

1. Practical Organic Chemistry- Mann and Saunders.
2. A Handbook of Quantitative and Qualitative Analysis- H. T. Clarke.
3. Organic Synthesis Collective Volumes by Blat.
4. A Text Book of Practical Organic Chemistry- A. I. Vogel
5. Practical Med. Chem.. -Dr. K. N. Jayveera, Dr. S. Subramanyam, Dr. K. Yogananda Reddy
6. A text book of Quantitative Inorganic Analysis– A. I. Vogel
7. Experimental Inorganic Chemistry -W. G. Palmer

RM-CH106 Research Methodology [Credit 4, 60 Hours]

COURSE OUTCOMES (COs): Students will be able to

CO-1: Demonstrate understanding of various research types, methodologies, and ethical considerations in scientific research.

CO-2: Perform effective literature search and critically evaluate scientific information using modern research databases and tools.

CO-3: Develop scientific reports, research proposals, and technical documents with appropriate structure, referencing tools, and scientific writing techniques.

CO-4: Apply quantitative techniques, computer applications, and presentation skills to analyze data and communicate scientific findings effectively.

UNIT-I

A) Introduction to Research Methodology **15 Hrs**

Objective of research, motivation in research, Introduction to research methodology, design and implementation of research methods, types of research, Fundamental research, applied research, experimental research, and interdisciplinary research, the research process, formulating, reviewing the literature.

B) Scope of Research and Ethics:

Scientific methods of research, criteria of good research, and characteristics of a good research, Research problem: Identification, Selection, developing research title, Criteria for prioritizing topics for research, Prioritizing Topics for Research, Formulation of research objectives.

Types and importance of research ethics, Institutional ethics committee, Plagiarism, Patenting and intellectual property rights. Publication ethics: definition, introduction, and importance.

UNIT-II Literature Search and Techniques **15 Hrs**

A) Literature review, Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author. Index, and Formula Index. Literature Search technique: SCOPUS, Google Scholar, PUBMED, Web of Science, science direct, Indian Citation Index, Research Gate, and scifinder, Scirus, ChemIndustry, Wiki-Databases, Chem Spider.

Overview of the journal article: Selection of journals, Data bases and research metrics Databases: i) indexing databases ii) Citation databases: Web of Science, Scopus, UGC-Care List etc.

Research Metrics: a) Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score b) Metrics: h-index, g index, i10 index. Citation Index, Impact Factor

B) Indian Knowledge System in Chemical Sciences

Introduction of IKS in Chemistry, Ancient Chemical Landscape of India, Vedic Metallurgy, Chemistry of Ayurveda in Ancient India, Practical Applications of IKS in Chemistry.

UNIT-III Scientific Report Writing 15 Hrs

Publication Process: Types of technical documents- Full length research paper, Short/Brief communications, Letters to editor, Book chapter, Review, Conference report, Patents, dissertation.

Components of a research publication/proposal: Title/Topic statement, Abstract/key words, Aims and objectives, Hypothesis building, Rationale of the paper, Work plan, Materials and methodology, Results and discussion, mechanism, Key issues, and arguments, Acknowledgement, Conflict of interest statement, bibliography, Technical Resumes & Cover Letters. Softwares in Chemistry: Data Plotting, Structure Drawing, Grammar Checkers and Sentence

Correction Tools. Use of bibliography tools (Endnote/Zotero/Mendeley).

UNIT IV

A) Quantitative Techniques 15 Hrs

Classification of quantitative methods, General steps required for quantitative analysis, reliability of the data, classification of errors, accuracy, precision, statistical treatment of random errors, the standard deviation of complete results, error proportion in arithmetic calculations, Uncertainty and its use in representing significant digits of results, confidence limits, Estimation of detection limit.

B) Computer Applications: Presentation and Communication skills

The students will learn how to operate a PC and how to run standard programs, software and packages. Execution of linear regression, X-Y plot, numerical integration, and differential as well as differential equation solution programming, Chemo metrics – Computer-based laboratory, instrumental data interpretation, statistical data interpretation

Conference presentation, preparation of effective slides and presentation. Tables, Figures and Pictures using Excel, PowerPoint slide preparation, Preparation of Posters, Electronic submission of manuscripts, oral and poster, Communication skills.

RECOMMENDED BOOKS:

1) Fundamentals of Analytical Chemistry by D. A. Skoog, D. M. West, and F. J. Hooler.

2) Quality in the Analytical Chemistry Laboratory by R. D. Treble and D. G. Holcombe.

3) Molecular dynamics simulations elementary methods by J. M. Haile.

4) The art of molecular dynamics simulations by D. C. Rapaport.

5) Introduction to computational chemistry by F. Jensen.

6) Molecular modeling principles and applications by A. R. Leach.

7) Computer Education by Prof. Lalini Varanasi, Prof. V. Sudhakar, and Dr. T. Mrunalini, Neelkamal Publications PVT. LTD.

8) History of Chemistry in Ancient And Medieval India: Incorporating the History of Hindu Chemistry, Acharya Prafulla Charndra Ray.

9) A History of Hindu Chemistry, Acharya Prafulla Charndra Ray.

10) History of Chemistry in Ancient and Medieval India, P. Ray.

M.Sc. Part – I (Semester – II)

Paper IV-CHT201: Inorganic Chemistry-II [Credit 4, 60 L Hours]

COURSE OUTCOMES (COs): Students will be able to

CO-1: Gain the periodic properties, bonding, structure, and reactivity of non-transition elements and their compounds.

CO-2: Analyze the properties, oxidation states, and spectral characteristics of lanthanides and actinides, and evaluate their industrial and chemical applications.

CO-3: Interpret crystal structures, electronic properties, and defects in solids, and describe the role of metal ions in biological systems.

CO-4: Demonstrate understanding of thermal analysis techniques (TGA, DTA, DSC) and apply them to interpret decomposition, phase transitions, and thermal behavior of materials.

UNIT-I: Chemistry of Non-transition Elements and their compounds 15 Hrs

Periodic properties of the non–transition elements, Polymorphism in carbon, phosphorous and sulphur, Synthesis, properties and structure of boranes, carboranes, silicates, carbides, phosphazenes, sulphur–nitrogen compounds, peroxo compounds of boron, carbon, sulphur, Structure and bonding in oxy acids of nitrogen, phosphorous, sulphur and halogens, interhalogens, psudohalides

UNIT-II: Chemistry of f-block elements (Lanthanides and Actinides) 15 Hrs

Occurrence, properties of the f-block elements, colour, oxidation state, Spectral and magnetic properties of lanthanides and actinides, lanthanide contraction, Use of lanthanide compounds as shift reagents, compounds of lanthanides, Photoluminescence properties of lanthanide compounds, Modern methods of separation of lanthanides and actinides, Applications of
lanthanide and actinide compounds in Industries.

UNIT-III

A) Solid state chemistry 8 Hrs

Crystal structure, Crystal types, Crystal defects, Electronic structure of solids, Band theory, Theory of Metals, Semiconductors and Insulators, Superconductivity, optical and magnetic properties, Solid state reactions, AB [Nickel arsenide (NiAs)], AB2 [fluorite (CaF_2) and anifluorite], layer structure [cadmium chloride and iodide ($CdCl_2$ & CdI_2)]

B) Bioinorganic Chemistry **7 Hrs**

Role of metal ions in biological processes, structure and properties of metalloproteins, porphyrines, metalloenzymes, oxygen transport, electron transfer reactions, cytochromes, ferrodoxins and iron sulphur proteins, ion transport across membranes, Nitrogen fixation-nitrogenase, metal complexes in medicines.

UNIT-IV: Thermal Analysis Techniques **15 Hrs**

Introduction to thermal analysis, types of thermal analysis, significance of thermal analysis in Analytical Chemistry, effect of heat on materials, chemical decomposition, phase transformation etc. and general thermal analysis applications, advantages and disadvantages.

a) Thermogravimetry analysis (TGA), principle, instrumentation, working, types of TGA, factors influencing TGA, curve to show nature of decomposition reactions, the product and qualities of compounds expelled, TGA in controlled atmosphere, TGA curves, analysis, research and analytical implications of TGA. Differential Thermogravimetric Analysis (DTG) and its significance.

b) Differential thermal analysis (DTA) and differential scanning calorimetry (DSC), instrumentation, methodology, application and research implications. Thermometric titrations method and applications. Problems: Simple problems based on TG, DTG, DTA and DSC.

RECOMMENDED BOOKS

1. A. F. Wells, Structural Inorganic Chemistry – 5th edition (1984)
2. J. H. Huheey, Inorganic Chemistry - Principles, structure and reactivity, Harper and Row Publisher, Inc. New York (1972)
3. J. D. Lee, Concise inorganic Chemistry, Elbs with Chapman and Hall, London
4. M. C. Day and J. Selbin, Theoretical Inorganic Chemistry, Reinhold, EWAP
5. Jones, Elementary coordination Chemistry
6. Martell, Coordination Chemistry
7. T. S. Swain and D. S. T. Black, organometallic Chemistry
8. John Wulff, structure and properties of materials, vol – 4, electronic properties, Wiley Eastern
9. L. V. Azoroff, J. J. Brophy, Electronic processes in materials, Mc Craw Hill
10. F. A. Cotton, R. G. Wilkinson. Advanced Inorganic chemistry

Paper V-CHT202: Organic Chemistry-II [Credit 4, 60 L Hours]

COURSE OUTCOMES (COs): Students will be able to

CO-1: Explain the mechanisms and synthetic applications of key organic rearrangement reactions and photochemical processes.

CO-2: Analyze various organic oxidation and reduction reactions using classical and modern reagents and catalysts.

CO-3: Apply the concepts of hydroboration, enamine chemistry, and functional group protection-deprotection in organic synthesis.

CO-4: Interpret organic molecular structures using advanced analytical techniques such as NMR and Mass Spectrometry.

UNIT-I **15 Hrs**

A) Study of following rearrangements **06 Hrs**

Curtius, Lossen, Wittig, Neber, Orton, Hofmann-Martius, Rupe, Gabriel–Colman and Demjanov.

B) Photochemistry **09 Hrs**

Effect of light intensity on the rate of photochemical reactions. Types of photochemical reactions, photochemistry of alkynes, intramolecular reactions of the olefinic bonds, geometrical isomerism, cyclisation reactions, rearrangements of 1,4 and 1,5-dienes, photochemistry of carbonyl compounds, intramolecular reactions of carbonyl compounds saturated cyclic and acyclic α, β-unsaturated compounds, cyclohexadienones, intermolecular cycloaddition reactions, dimerisation and oxetane formation, photochemistry of aromatic compounds, photo Fries reactions of anilides, photo Fries rearrangements. Singlet molecular oxygen reactions.

UNIT-II **15 Hrs**

A) Reduction **8 Hrs**

Study of the following reductions-Catalytic hydrogenation using homogeneous and heterogeneous catalysts. Study of the following reducing reagents and reactions: Wolff-Kishner, Birch, Sodium cyano borohydride, Sodium in alcohol, Fe in HCl, Adam’s catalyst, Lindlar catalyst, TBTH.

B) Oxidation **7 Hrs**

Applications of oxidizing agents like chromium trioxide, manganese dioxide, Woodward-Prevost hydroxylation, Chloranil, and hydrogen peroxide. Swern oxidation. PCC (Corey's reagent), PDC (Cornforth reagent), Baeyer-Villiger oxidation.

UNIT-III **15 Hrs**

A) Hydroboration and Enamines **8 Hrs**

Various hydro borating agents their mechanism and synthetic applications of 9-borabicyclo-[3.3.1]nonane (9-BBN), thexylborane, and diisoamylborane. (Sia_2BH), BH_3•SMe_2. (BMS).

B) Protection-deprotection of functional groups **7 Hrs**

Principle of protection of alcohol, amine, carbonyl and carboxyl group.

UNIT-IV: Advanced Analytical Tools **15 Hrs**

a) Nuclear Magnetic Resonance (NMR): Magnetic and nonmagnetic nuclei, Larmor frequency, absorption of radio frequency. Instrumentation (FT-NMR). Sample preparation, chemical shift, anisotropic effect, spin spin coupling, coupling constant, applications to structural problems.

b) Mass spectrometry (MS): Basic principle, working of mass spectrometer, ionization, types of ionization and classification of MS based on ionization, analysers (magnetic sector, quadrupole, ion-trap, time of flight, formation of different types of ions, Mclafferty rearrangements, fragmentation of alkanes, alkyl aromatics, alcohols and ketones.

RECOMMONDED BOOKS

1. Modern synthetic reactions-(Benjamin) H. O. House.
2. Reagents in organic synthesis-(John Wiley) Fieser and Fieser
3. Principles of organic synthesis-(Methuen) R. O. C. Norman
4. Hydroboration- S. C. Brown.
5. Advances in Organometallic Chemistry- (A.P.) F. C. A. Stone and R. West.
6. Organic Chemistry (Longman)Vol. I & Vol. II- Finar
7. Oxidation by-(Marcel Dekker) Augustin
8. Advanced Organic chemistry 2nd Ed. R R. Carey and R. J. Sundburg.
9. Tetrahydron reports in organic chemistry- Vol.1, No. 8.
10. Organic Synthesis- (Prentice Hall) R. E. Ireland.

Paper VI-CHT203: Physical Chemistry-II [Credit 4, 60 L Hours]

COURSE OUTCOMES (COs): Students will be able to

CO-1: Apply the fundamental principles of quantum mechanics to solve problems involving wavefunctions, operators, and spectroscopic applications.

CO-2: Explain the concepts of electrochemistry including activity coefficients, electrode types, and electrokinetic phenomena with theoretical models.

CO-3: Analyse reaction kinetics using experimental methods, steady-state approximations, and catalytic mechanisms in homogeneous and heterogeneous systems.

CO-4: Describe the properties, classification, and applications of colloids, emulsions, and gels in analytical chemistry and research.

UNIT-I QUANTUM CHEMISTRY **15 Hrs**

Introduction: Wave particle duality of material and DeBroglie's hypothesis, uncertainty principle, Schrodinger equation, wave function, conditions for acceptable wave functions and its interpretation, properties of wavefunctions, Operators and related theorems, algebra of operators, commutator, linear operators, Normalization and orthogonality, Eigenfunctions and Eigenvalues, postulate of quantum mechanics. Solutions of wave equation for a free particle and particle in a box problem, Transition dipole moment integral and selection rules, particle in a box application to electronic spectra of conjugated linear organic molecules. Linear and angular momentum operators, eigen function and eigen values of angular momentum operator, Ladder operator, addition of angular momenta. Spin angular momenta, symmetric and antisymmetric wavefunctions, Pauli Exclusion Principle, spectroscopic term symbols. Numerical problems

UNIT-II ELECTROCHEMISTRY **15 Hrs**

Activity and Activity coefficients: forms of activity coefficients and their interrelationship, Types of electrodes, Determination of activity coefficients of an electrolyte using concentration cells, instability constant of silver ammonia complex Electrokinetic phenomena: Electrical double lever, theories of double layer-Helmholtz-Perrin theory, Gouy and Chapman theory, Stern theory. electro-capillary phenomena, electro- capillary curve. Electro-osmosis, electrophoreses. Streaming and Sedimentation potentials. Zeta potentials and its determination by electrophoresis, influence of ions on Zeta potential.

UNIT-III CHEMICAL KINETICS **15 Hrs**

Introduction to basic concepts, Experimental methods of following kinetics of a reaction, chemical and physical (measurement of pressure, volume, EMF, conductance, diffusion current and absorbance) methods and examples. Steady state approximation and study of reaction between NO_2 and F_2, decomposition of ozone, and nitrogen pentoxide. Ionic reaction: Primary and secondary salt effect, Catalysis: Classification of catalysis, mathematical expression of autocatalytic reactions, Michaelis–Menten enzyme catalysis, Homogeneous catalysis: acid and base catalyzed reactions, Heterogeneous catalysis: Adsorption of gas on a surface and its kinetics, Catalyzed hydrogen-deuterium exchange reaction.

UNIT IV: COLLOIDS AND EMULSION **15 Hrs**

Colloids: Colloidal solution, classification of colloids, Theories of origin of charge on sol particles, Determination of charge on a colloidal particle, Stability of sols, Association colloids, Spontaneous ageing of colloids, Factors affecting the spontaneous ageing, theories of spontaneous ageing, coagulation, kinetics of coagulation. Practical applications in analytical chemistry and research.

Emulsion: Types of emulsion, preparation, properties, Characteristics, Identification test between two types of emulsions, emulsifiers, demulsification. Gels: classification, methods for the preparation of gels, properties of gels, Applications of colloid science. Practical applications in analytical chemistry and research.

RECOMMENDED BOOKS:

1. Introductory Quantum Chemistry-A. K. Chandra.TataMcGraw-Hill.1988.
2. Quantum Chemistry–Donald A. McQuarrie, Viva Books, NewDelhi,2003.
3. Quantum Chemistry-W. Kauzmann, Academic press.
4. Quantum Chemistry-R.K. Prasad, New Age International, New Delhi.
5. Principles of Physical Chemistry– Marron and Pruton.
6. Physical Chemistry–G.M. Barrow, Tata-McGraw Hill, Vth edition,2003.
7. Thermodynamics for Chemists –S. Glasstone, D. Van Nostrand, 1965.
8. An Introduction to Statistical Thermodynamics–T.L. Hill, Addison-Wesley. 1960
9. Instrumental methods of chemical analysis by H. Kaur.
10. Advanced Physical chemistry by Gurudeep Raj.

CHP205 Physical Chemistry Practical-II [Credit 2, 60 Hours]

COURSE OUTCOMES (COs): Students will be able to

CO-1: Learn advanced instruments and techniques, such as a conductometer, refractometer, pH meter, colourimeter, spectrometer, potentiometer, and polarimeter.

CO-2: Perform the calibration and handling of different instruments.

CO-3: Connect theoretical principles to observed phenomena and explain the underlying mechanisms.

CO-4: Analyse experimental data, identify trends, and interpret results in the context of theoretical knowledge.

EXPERIMENTS:

1) Refractometry:

i) Determination of atomic refractions of H, C and Cl atoms.

ii) Determination of composition of mixture of liquids.

2) Cryoscopy: Determination of apparent weight and degree of dissociation a strong electrolyte

3) Chemical kinetics (any Two):

i) Kinetics of iodination of acetone in presence of strong acid.

ii) To investigate the reaction between bromic acid and hydroiodic acid.

iii) Kinetics of reaction between bromate and iodide.

4) Phase Equilibrium: To construct phase diagrams for binary/ternary system.

5) Viscosity:

i) To determine the radius of sucrose molecules.

ii) To determine the radius of glycerol molecule by viscosity measurements.

6) Potentiometry:

i. Determination of formal redox potential of system (Fe^{2+}, and Fe^{3+})

ii. Determination of binary mixture of halides.

iv. Determination of dissociation constant of acetic acid.

7) Conductometry:

i. Titration of ternary acid mixture of acids.

ii. Verification of Onsagar Equation for 1:1 type of strong electrolyte.

8) pH metry

i) Determination of the acid and base dissociation constant of an amino acid and hence the isoelectric point of the acid.

ii) Determination of dissociation constants of dibasic/tribasic acid.

9) **Colloidal State:**

i) To study the interaction between Arsenious Sulphide sol and Ferric Hydroxide sol

ii) To study the Tyndall Effect by using Colloidal Silver nanoparticles

10) To estimate the amount of NH_4Cl colorimetrically using Nesseler's Reagent.

11) To determine the solubility of PbI_2 in presence of different concentration of KNO_3/KCl.

12) **Polarimetry:** To determine the specific and molar rotation of Optical active substances and determine the concentration of unknown sugar solution

13) Fluorimetry: To determine unknown concentration of riboflavin fluorometrically.

Note: Any other advanced experiments may be added.

RECOMMENDED BOOKS

1. Practical physical chemistry, A. Findlay, T.A. Kitchner (Longmans, Green and Co.)

2. Experiments in Physical Chemistry, J.M. Wilson, K.J. Newcombe, A.r. Denko. R.M.W. Richett (Pergamon Press)

3. Senior Practical Physical Chemistry, B.D. Khosla and V.S. Garg (R. Chand and Co., Delhi.).

4. A comprehensive guide to physical chemistry experiments and viva questions, Neelam Seedher.

ELECTIVE COURSE

E-CHP-205(A)- Inorganic and Organic Practical-II [Credit 4, 120 Hours]

This paper divides into two sections: Section I: Inorganic Chemistry Practicals (2 credits, and Section II: Organic Chemistry Practicals (2 credits)

Section I

Inorganic Chemistry Practical [Credit 2, 60 Hours]

COURSE OUTCOMES (COs): Students will be able to

CO-1: Analyze the composition of ores and alloys through classical and instrumental quantitative methods.

CO-2: Synthesize and assess the purity of coordination compounds using standard laboratory techniques.

CO-3: Demonstrate the principles of ion exchange by separating and quantifying metal ions using cationic and anionic resins.

CO-4: Apply nephelometry and turbidimetry for water quality assessment and quantify analytes such as sulphate and iron in real-world samples.

EXPERIMENTS

1) Ore Analysis
   - i) Determination of calcium and magnesium from Dolomite ore.
   - ii) Determination of copper and iron from Chalcopyrite ore.

2) Alloy Analysis
   - i) Determination of copper and zinc from brass alloy.
   - ii) Determination of iron & chromium from steel alloy.

3) Separation of Fe^{2+}, Cu^{2+}, and Ni^{2+} by anion exchange.

4) Preparations and purity
   - i) Tris (acetylacetonato)cobalt (III)trihydrate
   - ii) Penta-aquaphor chromium (III)chloride
   - iii) Hexathioureaplumbus (II)nitrate
   - iv) Bis (acetylacetonato) copper (II)
   - v) Diaquabis (ethylediammine) copper (II)iodide
   - vi) Copper ferrite

5) Determination of capacity of cation exchanger

6. Determination of capacity of anion exchanger

7. Determination of turbidity of water sample using nephelometer

8) Determination of sulphate by nephalometry/tubidimetry

9) Determination of iron from iron tablet samples

Note: Any other advanced experiments may be added.

RECOMMENDED BOOKS:

1. A text book of Quantitative Inorganic Analysis – A. I. Vogel

2 Experimental Inorganic Chemistry - W. G. Palmer

3 The analysis of minerals and ores of the rarer elements – W. R. Schoeller and A.R. Powell, Charles, Griffin and Company Limited.

4 Experimental Inorganic/Physical Chemistry – M.A. Malti, Horwood Series in Chemical Science, Horwood Publishing Chinchster.

Section II

Organic Chemistry Practical [Credit 2, 60 Hours]

COURSE OUTCOMES (COs): Students will be able to

CO-1: Perform the separation and identification of binary organic mixtures using micro-analytical and TLC techniques.

CO-2: Prepare and characterize derivatives of organic compounds to confirm structure and purity.

CO-3: Estimate pharmaceutical and bioactive compounds such as ibuprofen, aspirin, isoniazid, and caffeine from various samples.

CO-4: Determine the composition and properties of industrial and natural products, including oils, soaps, and tea extracts, through quantitative organic analysis.

EXPERIMENTS:

1. Qualitative Analysis: Separation of Binary Mixture by Micro analytical Technique

Separation of binary mixture using physical and chemical methods. Identification of individual compounds and checking its purity by TLC. Preparation of the derivative of one of the compounds. The following types are expected: (i) Solid-Solid (ii) Non-volatile liquid-Non-volatile liquid (iii) Water-soluble/insoluble solid-Non-volatile liquid with compounds from the same or different chemical classes in all three categories.

The candidate is expected to carry out separation of at least 08 mixtures.

2. Organic Estimations:

i) Determination of percentage of Keto-enol form.

ii) Estimation of Ibuprofen.

iii) Estimation of Aspirin.

iv) Estimation of the Acid value of an oil.

v) Estimation of Caffeine.

3. Estimation of fatty acid from soap sample.

4. Determination of isoniazid from pharmaceutical tablet

5. Determination of caffeine from tea powder

Note: Any other advanced experiments may be added.

RECOMMENDED BOOKS:

4. Practical Organic Chemistry- Mann and Saunders.
5. A Handbook of Quantitative and Qualitative Analysis- H. T. Clarke.
6. Organic Synthesis Collective Volumes by Blat.
7. A Text Book of Practical Organic Chemistry- A. I. Vogel
8. Practical Med. Chem..-Dr. K. N. Jayveera, Dr. S. Subramanyam, Dr. K. Yogananda Reddy
9. A text book of Quantitative Inorganic Analysis– A. I. Vogel

E-CHP-205(B)- Inorganic and Organic Practical-II [Credit 4, 120 Hours]

This paper divides into two sections: Section I: Inorganic Chemistry Practicals (2 credits, and Section II: Organic Chemistry Practicals (2 credits)

Section I

Inorganic Chemistry Practical [Credit 2, 60 Hours]

COURSE OUTCOMES (COs): Students will be able to

CO-1: Analyze the composition of ores and alloys through classical and instrumental analytical techniques.

CO-2: Synthesize coordination compounds and assess their purity using appropriate laboratory methods.

CO-3: Apply titrimetric, gravimetric, and colorimetric methods to determine the concentration of metal ions and non-metals in various samples.

CO-4: Utilize chromatographic and spectrophotometric techniques for separation and estimation of ions in complex mixtures.

EXPERIMENTS

Ore Analysis

1. Determination of Silica and Manganese in pyrolusite

2. Determination of iron from hematite.

Alloy Analysis

3. Determination of tin & lead from solder

4. Determination of copper and nickel from monel metal

Preparations and purity (Any four)

5. Potassim trioxalatochromate(III) trihydrate

6. cis-potassium dioxalatodiaquachromate(III)

7. Potassion hexathiocyanatochromate(III)

8. Bis(dimethylglyoximato)nickel(II)

9. Carbonatotetramminocobalt(III) nitrate

10. Hexamminocobaltic(III) chloride

11. Determination of concentration of phosphates in water samples colorimetrically

12. Determination of standard deviation from the results obtained by redox titration of iron solution against standard potassium dichromate solution.

13. Determination of sodium from the fertilizer sample using cation exchange chromatography

14 Determination of calcium from given drug sample.

15. Determination of hardness, alkalinity and salinity of water sample

16. Separation and estimation of Cd^{2+} and Zn^{2+} by ion exchange chromatography for given Cd^{2+} and Zn^{2+} mixture.

(Any other experiments may be added)

RECOMMENDED BOOKS:

1. A text book of Quantitative Inorganic Analysis – A. I. Vogel

2 Experimental Inorganic Chemistry - W. G. Palmer

3 The analysis of minerals and ores of the rarer elements – W. R. Schoeller and A.R. Powell, Charles, Griffin and Company Limited.

4 Experimental Inorganic/Physical Chemistry – M.A. Malti, Horwood Series in Chemical Science, Horwood Publishing Chinchster.

Section II

Organic Chemistry Practical [Credit 2, 60 Hours]

COURSE OUTCOMES (COs): Students will be able to

CO-1: Perform one-stage organic syntheses involving condensation, substitution, and cyclization reactions, and confirm product formation using Thin Layer Chromatography (TLC).

CO-2: Quantitatively estimate organic compounds such as amino acids, dyes, and aldehydes using classical titrimetric and colorimetric methods.

CO-3: Analyze pharmaceutical and food samples to determine active ingredients and quality parameters like acid value and unsaturation index.

CO-4: Apply spectrophotometric techniques to verify Beer-Lambert's Law and quantify organic analytes in solution accurately.

EXPERIMENTS

Preparations

(One stage preparations involving various types of reactions and confirmation of product by TLC)

1.Coumarin Synthesis- 7-OH-4-methyl coumarine from Resorcinol and EAA.

2. Knoevenagel condensation reaction-Reaction of aldehyde and malononitrile.

3. Preparation of Hydrantoin.

4. Synthesis of triazoles- Reaction of aldehyde and thiosemicarbazide.

5. preparation of benzimidazole from OPD,

6. Preparation of Orange II

7. Fischer Indole Synthesis-Reaction of phenyl hydrazine and cyclohexanone.

(Any suitable Expt. may be added)

Estimations:

8. Estimation of Unsaturation.

9. Estimation of formalin.

10. Colorimetric Estimation of Dyes.

11. Estimation of Amino acids.

12. Estimation of Glycine.

13. Analysis of pharmaceutical tablets for ibuprofen content

14. To verify the Beer-Lamberts Law and determine the concentration of given organic dye solution colorimetrically/spectrophotometrically.

15. To estimate the amount of D-glucose in given solution colorimetrically.

16. To determine the acid value of given oil

Note: Any other advanced experiments may be added.)

RECOMMENDED BOOKS

1.A text book of practical organic chemistry- A. I. Vogel.

2.Practical organic chemistry- Mann and Saunders.

3.A handbook of quantitative and qualitative analysis- H. T. Clarke.

4.Organic Synthesis Collective Volumes by Blat.

5. Practical Med. Chem.- Dr. K. N. Jayveera, Dr. S. Subramanyam, Dr. K. Yogananda Reddy.

OJT/FP-CH206: On Job Training/Field Project (4 credits, 120 hours)

The course will be run as per the guidelines of the Shivaji University and Government of Maharashtra. Under this course, students are required to enroll for On Job Training (OJT) or an internship or field projects in the relevant industries, or government departments, or research institutes, etc. This course is designed to offer students for gaining practical skills, hands-on experience that complements their academic learning and enhances their professional readiness.

To support students in this transition, the department needs to organize lectures, workshops, and seminars for mentoring them with the necessary knowledge and skills. Most of our graduates are expected to seek employment in industries, pursue teaching careers, or establish small enterprises after obtaining their M.Sc. degree. Therefore, the following options would be provided to the students to develop skilled and competent students.

- Internship in Industry/National research laboratory.
  OR
- Field projects that are aligned with the Chemistry Subject.
  OR
- **Hands on Training on various analytical instruments:** Gas Chromatography, HPLC, UV-Visible Spectrometer, Fourier Transform Infrared Spectrometer, Nuclear Magnetic Resonance Spectrometer, Mass Spectrometry, X-Ray Diffractometer, Powder X-ray Diffractometer, Transmission electron microscope, BET Surface Analyzer, Raman Spectrometer, CHN Analyzer, Thermal Analyzer (TGA-DSC), Scanning electron microscope etc.

Note: i) Student has to spend minimum 120 hrs. for OJT/FP course

Report Submission and Evaluation

i) Student of University Department is required to submit a hard copy of detailed report of their OJT/Internship/FP to the department as well as upload a softcopy on the University Online portal for further evaluation.

ii) Students from affiliated colleges (PG centers) must submit their detailed report of OJT/Internship/FP at their respective colleges for further evaluation.

iii) The OJT/Internship/FP will be evaluated as per the aforementioned guidelines (pg.no. 9)

13. Nature of Question paper (M.Sc. First Year)

13.A Nature of Question paper for Theory Courses

Question papers will be set in the view of the entire syllabus and preferably covering each unit of the syllabus. Equal weightage should be provided to each unit.

Total Marks: 60

Instructions:
1. Attempt in all five questions.
2. Question No. 1 is compulsory.
3. Attempt any two questions from Section-I and any two questions from Section-II.
4. All questions carry equal marks.
5. Figures to right indicate marks.

Question Number	**Question/s**	**Marks**	**CO mapped (CO1 to CO4)**	**Bloom's Taxonomy Level (BTL1 to BLT6)**
Q.1	Answer the Following (1 Mark each)	12		
a)				
b)				
..				
l)				
SECTION I				
Q.2 a)		06		
b)		06		
Q.3 a)		06		
b)		06		
Q.4 a)		06		
b)		06		
SECTION 2				
Q.5 a)		06		
b)		06		
Q.6 a)		06		
b)		06		
Q.7	Write a note on any three of the followings (Out of Six)	12		

13.B Nature of Question paper for Practical Course

(Choose any one pattern of following)

Practical Course	Pattern	Q.1 Expt.1	Q.2 Expt.1	Q.3 (Oral)	Q.4 (Journal)	Total (Marks)
Inorg./Org./Phy.	I	15	15	10	10	50
	II	20	10	10	10	50

Note: Journal writing with submission and oral/viva voce examination is considered as internal evaluation having 40% weightage, while experiments (1 and 2) are considered as external evaluation having 60% weightage.