PERIYAR UNIVERSITY

(NAAC 'A++' Grade-State University-NIRF Rank 63-ARIIA Rank 10)

SALEM – 636 011

M.Sc., DEGREE

[Choice Based Credit System (CBCS)]

***Branch IV (A)* CHEMISTRY**

Programme Code : CHE03

REGULATIONS AND SYLLABUS

[For the candidates admitted from the academic year 2022– 2023 and onwards]

CONTENTS

I - Programme Outcomes:

1. Graduates are prepared to be creators of new knowledge leading to innovation and entrepreneurship employable in various sectors.
2. Graduates are trained to evolve new technologies in chemistry.
3. Graduates are groomed to engage in lifelong learning process by exploring their knowledge independently.
4. Graduates are nurtured to design and conduct experiments /demos/create models to analyze and interpret data independently.
5. Graduates will be able to effectively communicate the findings of Chemical Sciences.

II - Programme Specific Outcomes:

1. M.Sc. Chemistry graduates will earn human and social values and responsibilities in the context of learning Chemistry.
2. The graduates will attain positive approach towards Environment and Ecology from the Chemistry perspective.
3. Graduates will acquire critical thinking and analytical mind, with the in depth knowledge in advanced Chemistry.
4. The graduates will extend their Chemistry knowledge in solving social issues.
5. Entrepreneurial skills shall empower the students to start their own industries/ business in core Chemistry fields.

III - Objectives of the programme

Life has changed more in the past two centuries than in all the previously recorded span of human history. In one-way or another, all the changes involve CHEMISTRY. Chemistry is central to the current revolutions in Science. No educated person today can understand the modern world without a basic knowledge of chemistry. The existence of a large number of chemical factories, mines and related industries in the catchments of University necessitates chemistry education. Hence our goal in introducing the M.Sc. programme in Chemistry has been to educate the undergraduate students in the fascinating fields of chemistry in an effective manner. Rigorous and comprehensive in approach, this syllabus presents essential contents in a detailed, clear and direct way.

M.Sc. Chemistry is a unique kind of course dealing with all aspects of chemistry such as preparation, properties, structure elucidation, kinetics and mechanism of the reaction, techniques of analysis for different kinds of materials, which are very essential for the human society. The major objectives of M.Sc. Chemistry course are:

- To impart knowledge in fundamental aspects of all branches of chemistry
- To acquire deep knowledge in the study of physical, chemical, electrochemical and magnetic properties, structure elucidation using various techniques and applications of various organic and inorganic materials and
- To acquire basic knowledge in the specialized areas like Nanomaterial Chemistry, Polymer chemistry, Environmental Chemistry, Green Chemistry, Pharmaceutical Chemistry etc.

This programme is offered under Choice Based Credit System (CBCS). Outcome based Education(OBE) is followed in the syllabi. The CBCS enables the students to select variety of subjects as per their interest and requirement. Acquiring knowledge in the related fields is advantageous to the students. The programme is structured in such a way to impart more knowledge in science, in particular, in Chemistry.

IV- Eligibility for Admission

A candidate who has passed B.Sc., Degree Examination with Branch IV Chemistry as main subject of study of this university or any of the B.Sc., degree examination with specialization such as Industrial chemistry, Polymer Chemistry, Applied Chemistry, Pharmaceutical Chemistry or any other specialization in Chemistry of some other universities accepted by the syndicate as equivalent thereto, subject to such condition as may be prescribed thereto shall be permitted to appear and qualify for the M.Sc. degree in Chemistry of this University after a course of study of two academic years.

V - Duration of the Programme

The programme for the degree of Master of Science in Chemistry shall consist of two academic years divided in to four semesters. Each Semester consist of 90 working days.

VI - Course of Study

M.Sc. Chemistry - CBCS
Structure of the Programme

S. No	Paper code	Title of the Paper	Hours	L	T	P	C
First Semester							
1.	22UPCHE3C01	Core Course 1 - Aromaticity and organic reaction mechanism	72	3	1	0	4
2.	22UPCHE3C02	Core Course 2 - Bonding in main group elements, solid state and nuclear chemistry	72	3	1	0	4
3.	22UPCHE3C03	Core Course 3 - Thermodynamics and Electrochemistry	72	3	1	0	4
4.	22UPCHE3C04	Core course 4 - Analytical Chemistry	72	3	1	0	4
5.	22UPCHE3E--	Elective course - 1	72	3	1	0	4
6.	22UPCHE3C05	Core Course 5 - Organic Chemistry Practical - I	90	0	0	5	3
7.	22UPCHE3C06	Core Course 6 - Inorganic Chemistry Practical - I	90	0	0	5	3
8.	----	SWAYAM Course	ONLINE				2
		Total	**540**	**15**	**5**	**10**	**28**
Second Semester							
9.	22UPCHE3C07	Core Course 7 - Organic reactions, reagents and stereochemistry	72	3	1	0	4
10.	22UPCHE3C08	Core Course 8 - Coordination Chemistry	72	3	1	0	4
11.	22UPCHE3C09	Core Course 09 – Chemical Dynamics and Surface Chemistry	72	3	1	0	4
12.	22UPCHE3S--	Supportive Course	72	3	1	0	4
13.	22UPHR01	Compulsory Course - Human Rights-Duties	36	2	0	0	2
14.	22UPCHE3C10	Core Course 10 - Physical Chemistry Practical - I	90	0	0	5	3
15.	22UPCHE3C11	Core Course 11 - Organic Chemistry Practical - II	90	0	0	5	3
		Total	**504**	**14**	**4**	**10**	**28**
	INTERNSHIP-During Summer Vacation						
Third Semester							
16.	22UPCHE3C12	Core Course 12 - Organic Synthesis and Natural Products	72	3	1	0	4
17.	22UPCHE3C13	Core Course 13 - Organometallic and Bioinorganic Chemistry	72	3	1	0	4
18.	22UPCHE3C14	Core Course - 14 Quantum Chemistry and Group theory	72	3	1	0	4
19.	22UPCHE3E--	Elective Course - 2	72	3	1	0	4
20.	22UPCHE3E--	Elective course - 3	72	3	1	0	4
21.	22UPCHE3C15	Core Course 15 - Inorganic Chemistry Practical - II	90	0	0	5	3
22.	22UPCHE3C16	Core Course 16 - Physical Chemistry Practical - II	90	0	0	5	3
		Total	**540**	**15**	**5**	**10**	**26**
Fourth Semester							
23.	22UPCHE3C17	Core Course 17 - Spectroscopy	72	3	1	0	4

24.	22UPCHE3C18	Core Course 18 - Project	396	0	0	22	8
25.	22UPCHE3E--	Elective Course - 4	72	3	1	0	4
26.	22UPCHE3V0-	Value Added Course	-	-	-	-	-
		Total	**540**	**6**	**2**	**22**	**12**

Total Credits: 94

Elective Courses

1.	22UPCHE3E01	Medicinal Chemistry	72	3	1	0	4
2.	22UPCHE3E02	Environmental Chemistry	72	3	1	0	4
3.	22UPCHE3E03	Nanomaterials Chemistry	72	3	1	0	4
4.	22UPCHE3E04	Supramolecular Chemistry	72	3	1	0	4
5.	22UPCHE3E05	Chemical Biology	72	3	1	0	4
6.	22UPCHE3E06	Green Chemistry	72	3	1	0	4
7.	22UPCHE3E07	Natural Products Chemistry	72	3	1	0	4
8.	22UPCHE3E08	Instrumental Methods of Analysis	72	3	1	0	4
9.	22UPCHE3E09	Advanced Characterization Techniques	72	3	1	0	4
10.	22UPCHE3E10	Polymer Chemistry	72	3	1	0	4

Supportive Courses for other Departments

1.	22UPCHE3S01	Chemistry and Health	72	3	1	0	4
2.	22UPCHE3S02	Cosmetic Chemistry	72	3	1	0	4
3.	22UPCHE3S03	Water Chemistry	72	3	1	0	4
4.	22UPCHE3S04	Industrial Chemistry	72	3	1	0	4
5.	22UPCHE3S05	Chemistry in Agriculture	72	3	1	0	4
6.	22UPCHE3S06	Chemistry in Daily Life	72	3	1	0	4
7.	22UPCHE3S07	Pharmaceutical Chemistry	72	3	1	0	4
8.	22UPCHE3S08	Fundamentals of Analytical Chemistry	72	3	1	0	4

Supportive Courses for UG Programmes of other Departments

1.	22UPCHEUS01	Chemistry and Industry	72	3	1	0	4
2.	22UPCHEUS02	Agricultural Chemistry	72	3	1	0	4

Value Added Courses (Certificate course-Extra credits)

1.	22UPCHE3V01	Chemical Polishing of Metals	30	2	0	0	2
2.	22UPCHE3V02	Chemical Energy	30	2	0	0	2
3.	22UPCHE3V03	Chemical Safety and Health	30	2	0	0	2

SWAYAM Courses

1.	NOC22-CY30	Organic Chemistry in Biology and Drug Development	-	-	-	-	-
2.	NOC22-CY34	Metal Mediated Synthesis-I	-	-	-	-	-
3.	NOC22-CY35	Metals In Biology	-	-	-	-	-
4.	NOC22-CY47	One and two dimensional NMR Spectroscopy for chemists	-	-	-	-	-

Note:

1. Human Rights – Compulsory course for All P.G. students
2. C – Core Courses, E – Elective Courses & S – Supportive Courses; L – Lecture, T – Tutorial, P – Practical

Credits for Core Courses:	**70**
Credits for Elective Courses	**16**
Credits for Supportive Courses	**04**
Credits for Swayam Courses	**02**
Credits for Human rights Courses	**02**
Total Credits	**94**

VII - Teaching Methodologies

The classroom teaching would be through conventional lectures and use of OHP and Power Point presentations. The lecture would be such that the student should participate actively in the discussion. Student seminars would be conducted and scientific discussions would be arranged to improve their communicative skill.

In the laboratory, instruction would be given for the experiments followed by demonstration and finally the students have to do the experiments individually.

Periodic tests would be conducted and for the students of slow learners would be given special attention.

VIII - Examinations

The examination shall be three hours duration to each paper at the end of each semester. The candidate failing in any subject(s) will be permitted to appear for each failed subject(s) in the subsequent examination.

Practical examinations for M.Sc. course in Chemistry will be conducted at the end of the each semester except final semester.

At the end of fourth semester viva-voce will be conducted on the basis of the Dissertation / Project report submitted by the student. One internal and one external examiner will conduct the viva-voce jointly.

IX - Scheme of Examination

M.Sc., Chemistry CBCS

S. No	Paper code	Title of the Paper	Hours	I	E	M	C
First Semester							
1.	22UPCHE3C01	Core Course 1 - Aromaticity and organic reaction mechanism	3	25	75	100	4
2.	22UPCHE3C02	Core Course 2 - Bonding in main group elements, solid state and nuclear chemistry	3	25	75	100	4
3.	22UPCHE3C03	Core Course 3 - Thermodynamics and Electrochemistry	3	25	75	100	4
4	22UPCHE3C04	Core course 4 - Analytical Chemistry	3	25	75	100	4
5.	22UPCHE3E0--	Elective course - 1	3	25	75	100	4
6.	22UPCHE3C05	Core Course 5 - Organic Chemistry Practical - I	6	40	60	100	3
7.	22UPCHE3C06	Core Course 6 - Inorganic Chemistry Practical - I	6	40	60	100	3
8.	----	SWAYAM Course					
Second Semester							
9.	22UPCHE3C07	Core Course 7 - Organic reactions, reagents and stereochemistry	3	25	75	100	4
10.	22UPCHE3C08	Core Course 8 - Coordination Chemistry	3	25	75	100	4
11	22UPCHE3C09	Core Course 09 – Chemical Dynamics and Surface Chemistry	3	25	75	100	4
12.	--	Supportive Course	3	25	75	100	3
13.	22UPHR01	Compulsory Course - Human Rights-Duties	3	25	75	100	2
14.	22UPCHE3C10	Core Course 10 - Physical Chemistry Practical - I	6	40	60	100	3
15.	22UPCHE3C11	Core Course 11 - Organic Chemistry Practical - II	6	40	60	100	3
Third Semester							
16.	22UPCHE3C12	Core Course 12 - Organic Synthesis and Natural Products	3	25	75	100	4
17.	22UPCHE3C13	Core Course 13 - Organometallic and Bioinorganic Chemistry	3	25	75	100	4
18.	22UPCHE3C14	Core Course - 14 Quantum Chemistry and Group theory	3	25	75	100	4
19.	22UPCHE3E0--	Elective Course - 2	3	25	75	100	4
20.	22UPCHE3E0--	Elective course - 3	3	25	75	100	4
21.	22UPCHE3C15	Core Course 15 - Inorganic Chemistry Practical - II	6	40	60	100	3
22	22UPCHE3C16	Core Course 16 - Physical Chemistry Practical - II	6	40	60	100	3
Fourth Semester							
23.	22UPCHE3C17	Core Course 17 - Spectroscopy	3	25	75	100	4
24.	22UPCHE3C18	Core Course 18 - Project	6	50	150	200	8
25.	22UPCHE3E--	Elective Course - 4	3	25	75	100	4
26.	22UPCHE3V0-	Value Added Course	3	-	-	100	2

Elective Courses							
1.	22UPCHE3E01	Medicinal Chemistry	3	25	75	100	4
2.	22UPCHE3E02	Environmental Chemistry	3	25	75	100	4
3.	22UPCHE3E03	Nanomaterials Chemistry	3	25	75	100	4
4.	22UPCHE3E04	Supramolecular Chemistry	3	25	75	100	4
5.	22UPCHE3E05	Chemical Biology	3	25	75	100	4
6.	22UPCHE3E06	Green Chemistry	3	25	75	100	4
7.	22UPCHE3E07	Natural Products Chemistry	3	25	75	100	4
8.	22UPCHE3E08	Instrumental Methods of Analysis	3	25	75	100	4
9.	22UPCHE3E09	Advanced Characterization Techniques	3	25	75	100	4
10.	22UPCHE3E10	Polymer Chemistry	3	25	75	100	4

Supportive Courses for other Departments							
1.	22UPCHE3S01	Chemistry and Health	3	25	75	100	3
2.	22UPCHE3S02	Cosmetic Chemistry	3	25	75	100	3
3.	22UPCHE3S03	Water Chemistry	3	25	75	100	3
4.	22UPCHE3S04	Industrial Chemistry	3	25	75	100	3
5.	22UPCHE3S05	Chemistry in Agriculture	3	25	75	100	3
6.	22UPCHE3S06	Chemistry in Daily Life	3	25	75	100	3
7.	22UPCHE3S07	Pharmaceutical Chemistry	3	25	75	100	3
8.	22UPCHE3S08	Fundamentals of Analytical Chemistry	3	25	75	100	3

Supportive Courses for UG Programmes of other Departments							
1	22UPCHEUS01	Chemistry and Industry	3	25	75	100	3
2	22UPCHEUS02	Agricultural Chemistry	3	25	75	100	3

Value Added Courses (Certificate course-Extra credits)

1.	22UPCHE3V01	Chemical Polishing of Metals	3	-	-	100	2
2.	22UPCHE3V02	Chemical Energy	3	-	-	100	2
3.	22UPCHE3V03	Chemical Safety and Health	3	-	-	100	2

SWAYAM Courses (Extra credits)

1.	NOC22-CY30	Swayam Course-1-Organic Chemistry in Biology and Drug Development	3	-	100	100	3
2.	NOC22-CY34	Swayam Course 2-Metal Mediated Synthesis-I	3	-	100	100	1
3.	NOC22-CY35	Swayam Course-3-Metals In Biology	3	-	100	100	2
4.	NOC22-CY47	Swayam Course-4-One and two dimensional NMR Spectroscopy for chemists	3	-	100	100	3

X - Question Paper Pattern

Time: 3 Hours Max. Marks - 75

PART-A: 20x1=20
(Answer all questions)

(Four questions from each unit-Objective type)

PART-B: 3 x 5=15

(Answer any three questions)

(One question from each unit)

PART C: 5x8=40

(Answer all questions)

(One question from each unit with internal choice)

(Maximum two Sub-Divisions only)

6. a) or b)
7. a) or b)
8. a) or b)
9. a) or b)
10. a) or b)

XI - Distribution of Marks Theory and Practical Examinations

Theory Marks

PART-A: 6x1=6, PART-B: 2x5=10, PART-C: 3x8=24

Internal

Test	10 Marks (Average of Three Internal Tests)
Seminar	05 Marks
Assignment	05 Marks
Attendance	05 Marks
Total	25 Marks

Practical (Internal marks 40)

Internal - For All Practicals

Class Experiments	25 Marks
Model Test	15 Marks
Total	**40 Marks**

Practicals - External : 60 marks **Duration: 6 hours**

Organic Chemistry Practical – I	
Qualitative organic analysis	30 marks
Preparation	10 marks
Viva – Voce in practical	10 marks
Record	10 marks
Total	**60 marks**

Organic Chemistry Practical – II	
Quantitative organic analysis	20 marks
Preparation	20 marks
Viva – Voce in practical	10 marks
Record	10 marks
Total	**60 marks**

Inorganic Chemistry Practical -I	
Qualitative analysis	30 marks
Preparation	10 marks
Viva-voce in practical	10 marks
Record	10 marks
Total	**60 marks**

Inorganic Chemistry Practical –II	
Quantitative analysis	30 marks
Preparation	10 marks
Viva-voce in practical	10 marks
Record	10 marks
Total	**60 marks**

Physical Chemistry Practical – I	
Experiment	40 marks
Viva-voce in practical	10 marks
Record	10 marks
Total	**60 marks**

Physical Chemistry Practical – II	
Experiment	40 marks
Viva-voce in practical	10 marks
Record	10 marks
Total	**60 marks**

XII - Dissertation / Project Work

Concise Dissertation	**150 marks**
Viva-Voce	**50 marks**
Total	200 marks

(a) Topic:

The topic of the dissertation shall be assigned to the candidate before the end of

first semester and a copy of the same should be submitted to the University for Approval.

(b) Advisory Committee:

Each guide shall have a maximum of five students.

There will be an advisory committee consisting of the guide as chairman and one member from the same department or allied departments of the University.

(c) Plan of Work:

The student should prepare plan of work for the dissertation, get the approval of the advisory committee and should be submitted to the university during the second semester of their study. In case the student wants to avail the facility from other University/laboratory, they will undertake the work with the permission of the guide and acknowledge the alien facilities utilized by them.

The duration of the dissertation research shall be a minimum of three months in the fourth semester.

(d) Dissertation Work outside the Department:

In case the student stays away for work from the Department for more than one month, specific approval of the university should be obtained.

(e) No. of copies / distribution of dissertation:

The students should prepare three copies of dissertation and submit the same for the evaluation by Examiners. After evaluation one copy is to be retained in the Department library and one copy is to be submitted to the University (Registrar) and one copy can be held by the student.

(f) Format to be followed:

The format/certificate for dissertation to be submitted by the students is given below:

Format for the preparation of project work:

(a) Title page

(b) Bonafide Certificate

(c) Acknowledgement

(d) Table of contents

CONTENTS

4.	Results	
5.	Discussion	
6.	Summary	
7.	References	

Format of the Title Page:

TITLE OF THE DISSERTATION

Dissertation Submitted in part fulfillment of the requirement for the award of the Degree of Master of Science in Chemistry to the Periyar University, Salem-636 011.

By

Students Name:

Register Number:

Department of Chemistry

Year:

Format of the Certificate:

CERTIFICATE

This is to certify that the dissertation entitled ---------- ---------- submitted in partial fulfillment of the requirement for the award of the degree of Master of Science in Chemistry to the Periyar University, Salem is a record of bonafide research work carried out by ----------under my supervision and guidance and that no part of the dissertation has been submitted for the award of any degree, diploma, fellowship or other similar titles or prizes and that the work has not been published in part or full in any scientific or popular journal or magazine.

Date:
Place:

Supervisor and Guide Head of the Department

External Examiner:

Internal Examiner:

Guidelines for approval of M.Sc. Chemistry guides for guiding students in their research for submitting dissertation:

1. M.Sc. Chemistry (Part fulfillment) Guide:

(i) The person seeking for recognition, as guide should have:

(a) A Ph.D. Degree in Chemistry or specializations in various branches of Chemistry (or)

(b) M.Phil. / M.Sc. degree in Chemistry with first class/second class

(c) Should have 3 years of active teaching/research experience

(ii) They should have published at least one research paper in a National Journal authored solely or jointly.

2. Procedure for submitting application for approval as guides:

(i) The University will on request give prescribed application form.

(ii) The filled in applications should be submitted before the close of said date by the University.

(iii) All such applications should be routed through the HOD with specific recommendations.

(iv) All relevant proofs should be submitted along with the applications.

3. Approval:

The committee constituted for the purpose will scrutinize the applications and recommend for approval/rejection.

Orders will then be passed by the authority of the University and communicated to each member individually through the HOD.

XIII - Passing Minimum

The candidate shall be declared to have passed the examination if the candidate secures a minimum of 50 % (Both in Internal and External) in the University examination.

For a pass in the Practical paper, a candidate has to secure a minimum of 50% marks in the University examination. There is no passing minimum for the record notebook. However submission of a record notebook is a must.

For the project work and viva-voce, a candidate should secure 50% of the marks for pass. The candidate should compulsorily attend viva-voce examination to secure pass in that paper.

Candidates who do not obtain the required minimum marks for a pass in a paper/Project Report, shall be required to appear and pass the same at a subsequent appearance.

XIV - Classification of Successful Candidates

Candidates who secure not less than 60% of the aggregate marks in the whole examination shall be declared to have passed the examination in First Class.

All other successful candidates shall be declared to have passed in the Second Class.

Candidates who obtain 75% of the marks in the aggregate shall be deemed to have passed the examination in First Class with Distinction provided they pass all the examinations prescribed for the course at the first appearance.

Candidates who pass all the examinations prescribed for the course in the first instance and within a period two academic years from the year of admission to the course only are eligible for University Ranking.

A candidate is deemed to have secured first rank provided he/she

(i) should have passed all the papers in first attempt itself

(ii) should have secured the highest overall grade point average (OGPA)

XV - Maximum Duration for the Completion of the Course

The maximum duration for completion of M.Sc. Degree in Chemistry Programme shall not exceed eight semesters.

XVI - Commencement of this Regulation

These regulations shall take effect from the academic year 2022-2023.i.e., for students who are to be admitted to the first year of the course during the academic year 2022-2023 and thereafter.

XVII - Transitory Provision

Candidates who were admitted to the M.Sc. Degree in Chemistry (before 2022-2023 shall be permitted to appear for the examinations under those regulations for a period of three years i.e., up to and inclusive of the examination of April/May 2025. Thereafter, they will be permitted to appear for the examination only under the regulations then in force.

CORE COURSES

First Semester

22UPCHE3C01 AROMATICITY AND ORGANIC REACTION MECHANISM

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

1. To understand the concept of aromaticity
2. To understand the structure and reactivity of chemically active centers
3. To study the mechanism of nucleophilic substitution reactions
4. To study the mechanism of electrophilic substitution reactions
5. To understand the mechanism of elimination as well as addition reactions.

Course Outcomes

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

CO No.	CO Statement	Knowledge Level
CO1	be familiar with the concepts of aromaticity	K2, K3 & K4
CO2	understand the basic reaction mechanism and its determination	K2, K3 & K4
CO3	understand in detail about the mechanism of both aliphatic and aromatic nucleophilic substitution reactions.	K2, K3 & K4
CO4	understand the concepts of electrophilic substitution reactions in aromatic and aliphatic compounds.	K2, K3 & K4
CO5	understand the mechanism of elimination and addition reactions – predict the products formed in the particular elimination reaction based on the rules, - predict the products of addition using Markownikoff's and anti-Markownikoff's rules.	K2, K3 & K4

UNIT - I Aromaticity

Aromaticity of benzenoid, heterocyclic and non-benzenoid compounds-Huckel rule. Effect of aromaticity on bond lengths, resonance, resonance energies, electronic absorption spectra and induced ring currents. Aromatic systems with other than six π

electrons, non-aromatic and anti-aromatic systems with more than 10 π electrons – annulenes, azulenes, sydnones, tropolones, fulvenes and ferrocenes (synthesis not necessary). Homo-aromaticity.

Tutorials: Prediction of aromaticity of given compounds.

UNIT - II Reaction Intermediates and Determination of Reaction Mechanism

Reaction intermediates-Formation, stability and structure of carbenes and nitrenes.

Kinetic and non-kinetic methods of study of reaction mechanisms - primary and secondary kinetic isotopic effects, study of intermediates, isotopic labeling, stereochemical studies and cross over experiments. Kinetic and thermodynamic control. Linear free energy relationships - Hammett equation and Taft equation, Microscopic reversibility, Hammond postulate.

Tutorials: Problems on prediction of products.

UNIT - III Nucleophilic Substitution Reactions

The S_N1, S_N2, mixed S_N1 and S_N2, S_Ni and SET mechanisms. The neighbouring group mechanism, neighbouring group participation by σ and π bonds, non-classical carbocations and anchimeric assistance. Nucleophilic substitution at allylic, aliphatic trigonal and vinylic carbon atoms. Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium. Ambident nucleophile and regioselectivity. Reactions involving substitution at carbon doubly bonded to oxygen and nitrogen- Williamson reaction, Von Braun reaction, Claisen and Dieckmann condensation. Hydrolysis of esters.

Aromatic nucleophilic Substitution - S_Nl, S_NAr and Benzyne mechanism with suitable examples (structure and reactivity of benzyne intermediate should be discussed elaborately). Zielgler alkylation and Chichibabin reactions.

Tutorials: Problems on conversions and mechanism.

UNIT - IV Electrophilic Substitution Reactions

Aromatic electrophilic substitution - arenium ion mechanism, typical reactions like nitration, sulphonation, halogenation, Friedel-Crafts alkylation, acylation and diazonium coupling. Orientation and reactivity - ortho, meta and para directing groups,

ortho-para ratio. Electrophilic substitution on mono- and di- substituted benzenes and ipso attack. Gatterman, Gatterman-Koch, Vilsmeier and Reimer-Tiemann reactions.

Aliphatic electrophilic substitution - S_E2 and S_E1 mechanisms, electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity.

Tutorials: Problems on prediction of products and mechanism.

UNIT - V Elimination and Addition Reactions

E_1, E_2 and E_1CB mechanisms. Orientation of the double bond - Hofmann and Saytzeff rules. Competition between elimination and substitution. Dehydration and dehydrohalogenation reactions. Stereochemistry of E_2 eliminations in cyclohexane ring systems. Mechanism of pyrolytic eliminations, Chugaev reaction and Cope elimination.

Addition to Carbon - Carbon and Carbon - Hetero atom Multiple bonds-Addition of halogen and nitrosyl chloride to olefins, hydration of olefins and acetylenes, hydroboration, hydroxylation, epoxydation, Michael addition and 1,3-dipolar addition.

Mechanisms of Mannich, Stobbe, Darzen Glycidic ester condensation, Benzoin condensation, Peterson olefination (Silyl Wittig reaction), Strecker synthesis, Wittig, Wittig - Horner, Perkin, Thorpe, Ritter and Prins reactions.

Tutorial: Problems on prediction of products, reagents, conditions and mechanism.

Text books

1. Jerry March, **Advanced Organic Chemistry-Reactions**, **Mechanisms and Structure**, Seventh Edition, John Wiley & Sons, 2015.
2. Robert Thornton Morrison, Robert Neilson Boyd, **Organic Chemistry**, Sixth Edition, Prentice-Hall of India Private Ltd, 1992.
3. Dr. Arun Sarkar, **Advanced Organic Chemistry: Reactions and Mechanisms**, IndramaniPandey for Swastik Publication, 2011.
4. Dr. Jagdamba Singh, Dr. L.D.S. Yadav, **Advanced Organic Chemistry**, Eighteenth Edition, K.K. Mittal for PragatiPrakashan Pub, 2020.
5. Raj. K. Bansal, **Organic Reaction Mechanism**, Sixth Edition, McGraw-Hill Companies, 2017.

Reference Books

1. T.L. Gilchrist and C.W. Rees, **Carbenes**, **Nitrenes and Arynes**, Thomas Nelson and Sons Ltd., London, 1969.
2. Francis A. Carey, **Organic Chemistry**, Eighth Edition, McGraw-Hill Companies, Inc., 2017.
3. Francis A. Carey, Richard J. Sundberg, **Advanced Organic Chemistry,** Fifth Edition Springer-Verlag New York Inc. 2008.
4. Bhupinder Mehta, Manju Mehta, **Organic Chemistry**, Second Edition, Prentice-Hall of India Pvt Ltd, 2015.
5. John E. McMurry, **Introduction to Organic Chemistry**, First Edition, Cengage Learning, 2008.
6. Thomas N. Sorrell, **Organic Chemistry**, Second Edition, University Science Books, 2005.
7. Michael B. Smith, **March's Advanced Organic Chemistry Reactions, Mechanisms and Structure,** Seventh Edition, John Wiley & Sons, Inc, 2013.
8. Reinhard Bruckner, **Advanced Organic Chemistry**, **Reaction Mechanisms**, Elsevier, 2002.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	M	M
CO2	M	S	S	S	M
CO3	S	M	S	S	M
CO4	M	M	S	S	S
CO5	S	S	M	M	S

S- Strong; **M**-Medium.

22UPCHE3C02 BONDING IN MAIN GROUP ELEMENTS, SOLID STATE AND NUCLEAR CHEMISRY

Hours	L	T	P	C
72	3	1	0	4

Objectives

1. To understand the basic concepts and bonding in main group elements.
2. To learn the structure and bonding in small molecules.
3. To learn about the important inorganic polymers and their applications.
4. To acquire awareness about the crystal structure, defect in solids and their effect in electrical properties.
5. To get knowledge on the application of nuclear chemistry.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	know thorough knowledge on the basics of solid state chemistry, X-ray crystal structure of the compounds, important feature of spinels, lattice energy, various defects in crystals and electrical properties of solids.	K2, K3 & K4
CO2	understand the various types of heterocyclic ring systems.	K2, K3 & K4
CO3	learn how to solve the problems in solid state chemistry.	K2, K3 & K4
CO4	get clear idea on the basics of nuclear chemistry and its application in various fields.	K2, K3 & K4
CO5	create the various electronic structures of main group elements.	K2, K3 & K4

UNIT- I Structure and Bonding in Main Group Elements

Synthesis, structure and bonding in polyhedral boranes and carboranes, Styx notation; Wade's rule, Mingos rule - electron count in boranes, carboranes, heteroboranes and their anions. Synthesis of Metallocarboranes, isolobal analogy. Metal cluster-carbonyl and halide type clusters. Compounds with metal-metal multiple bond. Synthesis and reactivity of di-, tri- and polynuclear clusters - Problem solving exercises.

UNIT - II Shapes and Bonding in Chemical Compounds

VB approach to bonding - Concept of hybridisation and structure of molecules. Bent rules and energetics of hybridization. Electronegativity and partial ionic character. VSEPR model- Shapes of molecules-ClF_3, ICl_4^- , TeF_5^-, H_2O, I_3^- , $TeCl_6^{2-}$, XeF_6, $SbCl_6^{3-}$, $N_2O_2^-$, H_3PO_4, IF_7, ReF_7, XeF_8^{2-} , TaF_8^{3-}. Bonds- Multicenter, Synergic and Agostic bonding. Lattice energy - Born-Lande equation and Kapustinskii equation, Zintl ions - isoelectronic relationship in solids. Molecular orbital theory: LCAO and MO diagrams of heteronuclear diatomic molecules - CO, NO, HF, ICl and Triatomic molecules - CO_2, H_2O, and NO_2 - Problem solving exercises.

UNIT - III Inorganic Polymers

Silicates - Structure, Pauling's rule, properties, correlation and application. Molecular sieves. Heterocyclic ring systems – Borazines preparation, properties and bonding. Phosphazenes - Monomer, Polymer and Structure of Craig and Peddock model, Dewar model. Synthesis, structural features and reactivity of S-N heterocycles, Homocyclic rings of S, Se and Te. Polyacids - Isopolyacids of V, Cr, Mo and W. Heteropolyacids of Mo and W (only structural aspects) - Problem solving exercises.

UNIT - IV Synthesis and Structural Modification of Inorganic Solids

Ionic radius ratio and its limitation, Structural types of ionic crystals - AX, AX_2 and ABO_3 (perovskite) type (CsCl, ZnS, NiAs, ZnO, $CdCl_2$, CdI_2, TiO_2, ReO_3, K_2NiF_4, $CaTiO_3$) crystals and spinels. Defects in solids, Review of defects in ionic solids - Thermodynamic effects of defects. Band theory, n- and p- type semiconductors and superconductors. Preparative methods: Solid state reaction, chemical precursor method, co-precipitation, sol-gel, metathesis, self-propagating high temperature synthesis, ion-exchange reactions, intercalation / deintercalation reactions; hydrothermal and template synthesis and High pressure synthesis. Electrical and magnetic properties of solids - Problem solving exercises.

UNIT - V Nuclear Chemistry

Properties of nucleus, different types of nuclear forces, liquid drop model, shell model of nucleus. Modes of decay. Radioactive series, threshold energy. Nuclear reactions induced by charged particles. Q value and its significance. Theory of nuclear fission. Atom Bomb- Nuclear reactor and its components - production of feed

materials for nuclear reactors. Nuclear Fusion - Hydrogen Bomb - Stellar energy. Synthesis of elements. Application of radioisotopes in agriculture, industry and medicine. Carbon dating, isotopic dilution analysis and neutron activation analysis - Problem solving exercises.

Text Books

1. J. E. Huheey, **Inorganic Chemistry – Principles of Structure and Reactivity**, Pearson edition, Fourth edition, 2006.
2. J. D. Lee, **Concise Inorganic Chemistry**, Fifth Edition, 2021.
3. F.A. Cotton, G. Wilkinson, **Advanced Inorganic Chemistry**, Wiley Eastern, Sixth Edition, 2021.
4. Ajai Kumar, **Chemistry of The Main Group Elements**, First Edition, 2021
5. S.K. Agarwala, Keemti Lal, **Advanced Inorganic Chemistry**, Pragathi Pragasam, 2017.
6. F. Liebau, **Structural Chemistry of Silicates: Structure, Bonding, and Classification**, Springer, 2012.
7. Gary Wulfsberg, **Foundations of Inorganic Chemistry**, University Science, 2017.
8. A. R. West, Basic Solid State Chemistry, John Wiley Sons, Second Edition, 2014.
9. A. Gurtu, J.N. Gurtu, **Solid State Chemistry**, Pragathu Prakashan, First Edition, 2017.
10. D.K. Chakrabarty, **Solid State Chemistry**, New Age Publishers, 2010.
11. G.S. Manku, **Theoretical Principles of Inorganic Chemistry**, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2006.
12. Hari. Jeevan. Arniker, **Essentials of Nuclear Chemistry**, New Age International Publications, 2011

Reference Books

1. Gary L. Miessler, Paul J. Fischer, Donald A. Tarr, **Inorganic Chemistry**, 2014.
2. M. Weller, T. Overton, **Inorganic Chemistry**, Seventh International Edition, 2018
3. Shriver And Atkins **Inorganic Chemistry**, Oxford University Press. 2013.
4. H.J. Emelius, J.S. Anderson, Alan G. Sharpe, **Modern Aspect of Inorganic Chemistry**, 1982
5. A.K. De, **Inorganic Chemistry and Analysis (Problems and Exercise)**, New Age International Publications, Third Edition, 2010.
6. A.F. Wells, **Structural Inorganic Chemistry**, Fifth Edition, Oxford University Press, Oxford, 1984.
7. L. Smart, E. Moore, **Solid State Chemistry - An Introduction**, Chapman & Hall,

2005.

8. H. V. Keer, **Principles of the Solid State**, Wiley Eastern Limited, 1993.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	M	S	S	M
CO2	M	S	S	M	M
CO3	S	M	M	M	M
CO4	S	S	M	M	M
CO5	S	S	M	M	M

S- Strong; **M**-Medium.

22UPCHE3C03 THERMODYNAMICS AND ELECTROCHEMISTRY

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

1. To understand the laws and basic concept of thermodynamics.
2. To understand the basic concepts of electrochemistry**.**
3. To understand the basic concepts of electrode reactions.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	understand the fundamental concepts and laws of equilibrium thermodynamics.	K1, K2 & K3
CO2	get in depth knowledge and understanding about the fundamental concepts of chemical and phase equilibria.	K1, K2, K3 & K4
CO3	get in depth knowledge and understanding about the fundamental concepts of statistical thermodynamics.	K2, K3 & K4
CO4	acquire in depth knowledge on laws of electrochemistry and principles of various electrochemical techniques.	K2, K3 & K4
CO5	elucidate the structures of electrical double layers and understand corrosion process.	K1, K2 & K3

UNIT-I Thermodynamics

Laws of thermodynamics, Thermodynamic description of various types of processes, Hess's law and applications, Bond energies and applications. Thermodynamic functions and their relationships - Maxwell's relations, Gibbs-Helmholtz equation. Temperature and pressure dependence on thermodynamic quantities. Absolute entropy - Partial molar quantities - Chemical potential - Gibbs-Duhem equations - Variation of chemical potential with temperature and pressure - Fugacity, Fugacity coefficient, Determination of fugacity - Activity and Activity coefficient - Thermodynamics of ideal and non-ideal gases and solutions - Raoult's law and Henry's law.

UNIT- II Equilibria

Chemical equilibria - Criteria for spontaneity and equilibrium, Thermodynamic derivation of equilibrium constant, Dependence of equilibrium constant on temperature and pressure, Van't Hoff equation and Le Chatlier principle.

Phase equilibria - Phase transitions, Gibbs Phase rule, Derivation of Phase rule. Clausius-Clapeyron equation. Phase diagram of one component systems CO_2, H_2O, S - Two component systems liquid - vapour, liquid-liquid and solid-liquid systems - Fractional distillation, Azeotropes and Eutectics.

Tutorial: Problems in calculation of equilibrium constants and standard free energy

UNIT III Statistical Thermodynamics

Boltzmann distribution, Significance of the partition function - Translational, vibrational, rotational and electronic partition functions, Partition function and their relation to thermodynamic quantities, Sackur-Tetrode equation, Maxwel-Boltzman, Bose-Einstein and Fermi-Dirac statistics, Heat capacity and equilibrium constants, Theories of specific heat capacities of solids.

Tutorial: Problems in calculation of specific heat capacities, partition functions.

UNIT IV Electrochemistry-I

Ionic mobility and conductivity - Electrolytic conductance, Kohlrausch's law and its applications - Ionic equilibria - Conductometric titrations – Debye-Huckel theory - Debye-Huckel-Onsager equation, Debye-Huckel limiting law. Standard Electrode Potentials, Electrochemical cells, Nernst equation and its applications. Relation between electrode potential and thermodynamic quantities, Potentiometric titrations. Batteries - primary and secondary and Fuel cells.

Tutorial : Problems in emf.measurements

UNIT V Electrochemistry-II

Electrode-electrolyte interface, Interionic attraction, Structures of electrical double layer - Helmholtz-Perrin model, Gouy-Chapman model. Stern model - Eelectrokinetic phenomina - Electrophoresis, Electroosmosis, Sedimentation Potential, Streaming potential. Kinetics of electrode reactions - Butler-Volmer equation, Tafel plot. Non-equilibrium electrode processes - Polarisation, Over voltage, Tafel polarization, Electrochemical impedance. Corrosion and its prevention - Pourbaix and Evans diagrams.

Text Books

1. P. Atkins, J. Paula, **Physical Chemistry**, Tenth Edition, Oxford University Press, Oxford, 2014.

2. D.A. McQuarrie, J.D. Simon, **Molecular Thermodynamics**, University Science Books, California, 2004.
3. R.S. Berry, S.A. Rice, J. Ross, **Physical Chemistry**, Second Edition, Oxford University Press, Oxford, 2007.
4. D. A. McQuarrie, **Statistical Mechanics**, University Science Books, California 2005.
5. B. Widom, **Statistical Mechanics – A Concise Introduction for Chemists**, Cambridge, University Press, 2002.
6. J. Rajaram and J.C. Kuriacose, **Thermodynamics for Students of Chemistry**, Lal Nagin Chand, New Delhi, 1986.
7. P.W. Atkins, **Physical Chemistry,** Oxford University Press; Fifth Edition, 2012.
8. D.A. McQuarrie, **Text Book of Physical Chemistry**, University Science Books, Mill Valley, California, 1983.
9. M.C. Gupta, **Statistical Thermodynamics**, Wiley Eastern, New Delhi, 1990.
10. Yi-Chen Cheng, **Macroscopic and Statistical Thermodynamics**, World Scientific 2006.
11. J. Rajaram and J.C. Kuriacose, **Irreversible Thermodynamics,** Lal Nagin Chand, New Delhi, 1989.
12. S. Glasstone, **Thermodynamics for Chemists**, Affiliated East West Press, New Delhi 1960.
13. R.P.H. Gasser and W.G. Richards, **Introduction to Statistical Thermodynamics**, World Scientific, Singapore, 1995.
14. J. Silbey, R. A. Alberty, M. G. Bawendi, **Physical Chemistry**, Fourth Edition, Wiley-India, New Delhi 2005
15. S. Berry, S. A. Rice and J. Ross, **Physical Chemistry**, Second Edition, Oxford University Press, Oxford 2007.

Reference Books

1. R.A. Alberty, R.J.Silbey, **Physical Chemistry**, John Wiley and Sons, New York, 1992
2. D. A. Skoog, D. M. West, F. J. Holler and S. R. Couch**, Fundamentals of analytical chemistry**. Brooks/ColeCengage learning, New Delhi, 2004.
3. F. Scholz, **Electroanalytical Methods**, Springer, Second Edition, 2010.
4. Schoog, Holler, Nieman, **Principles of Instrumental Analysis**, Thomson Asia Pte Ltd., Singapore, 2004.

5. D.A. Skoog, **Principles of Instrumental Analysis, Saunders College Pub.Co**, Third Edition, 1985.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	M	M
CO2	M	S	S	S	M
CO3	S	M	S	S	M
CO4	S	S	S	S	S
CO5	M	S	M	M	S

S- Strong; **M**-Medium

22UPCHE3C04 **ANALYTICAL CHEMISTRY**

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

1. To obtain skills on the various analytical techniques.
2. To learn the concepts of sampling and sample handling.
3. To understand the theory and principles of various titrimetric analysis.
4. To know the concepts of complexometric titrations.
5. To understand the theory and applications of chromatography.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	demonstrate up-to-date analytical skills required to deal with the error identification and elimination.	K2 & K4
CO2	acquire in depth knowledge and understanding about the fundamental concepts, principles and process underlying the sample and sample handling.	K1 & K2
CO3	understand the Neutralization reactions, prediction of p^H. Knowledge on the Volhard, Mohr and Fejan's methods for accurate titration.	K3 & K4
CO4	understand the complexometric titration, theory of mettallochromic indicators, masking and demasking reagents for ions separation.	K1& K2
CO5	knowledge on various types of chromatography for compounds separation and identification.	K3

UNIT - I Sampling and Sample Handling

Choice of analytical method, Literature survey, Analysis of standard samples - preparing samples for analysis, preparing laboratory samples; quality of sample, subsampling, sample handling, moisture in samples; drying the analytical sample. Good laboratory practices and implementation - Equipment's, Quality assurance practices, SOPs,

Trace Analysis in solution – Nature of trace analysis, scale of working sensitivity, sources

of errors, Contamination control in trace analysis.

UNIT - II Data Treatment and Evaluation

Precision and Accuracy, Types of errors – determinate and indeterminate errors, minimization of determinate errors. Statistical validation- statistical treatment of finite data; mean, median, average deviation, standard deviation, variance and coefficient of variation. Significant figures, computation rules, comparison of results – student's t-test, F-test, statistical Q test for rejection of a result and confidence limit. Regression analysis-Null hypothesis; correlation coefficient, detection limits. Calculations.

UNIT - III Titrimetric Analysis

Neutralization reactions – theory of acid-base titrations, mono and polyprotic systems, Titration curves and feasibility of reactions, Indicators-theory and choice, calculation of pH during titrations at different stages. Gravimetric analysis – volatilization and precipitation methods – homogeneous precipitation.

Redox titrations – Redox potentials, theory and feasibility of redox titration, redox indicators, their choice and application.

Precipitation titrations – Theory and types, Volhard, Mohr and Fajan's methods.

UNIT - IV Complexometric Titrations

Complexometric titrations – Theory, stepwise and overall formation constants, titration involving monodendate (Cl-) and multidentate ligands (EDTA). Metallochromic indicators – theory and choice. Masking and demasking reagents. Direct, indirect (including substitution) titration and applications.

UNIT - V Chromatography

Solvent extraction and Ion-exchange Chromatography - Resins used, Principle of exchange, Factors affecting the exchange, Capacity of resin and its determination, Techniques, IEC with eluent suppressor columns, Applications. Gel-permeation Chromatography – Principle, Types of gels, Theoretical principles, Techniques and applications. Plane Chromatography - Paper chromatography - Ascending, Descending, Radial, Two dimensional, solvent systems and Location. Size exclusion chromatography and super critical fluid chromatography – Principle, Instrumentation and method of detection and applications.

Tutorial: Problems on detection, isolation of compounds and applications of chromatography

Text Books

1. D.A. Skoog and D.M. West, **Fundamentals of Analytical Chemistry**, Holt Rinehart and Winston Publications, Fourth Edition, 1982.
2. D.A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, **Fundamentals of Analytical Chemistry**, Thomson Asia Pvt Ltd., Singapore, Eighth Edition, 2004.
3. D.A. Skoog, **Principles of Instrumental Analysis**, Saunders College Pub.Co, Third Edition 1985.
4. J.G. Dick, **Analytical Chemistry**, McGraw Hill Publishers, 1974.
5. T.S.Ma, V. Horak, **Microscale-Manipulations**, John, Wiley and Sons, 1976.
6. P.C.Jurns, T.L. Isenhour and C.C. Wilkins, **BASIC Programming for Chemists**, John Wiley & Sons, 1987.
7. K.V. Raman, **Computers in Chemistry**, Tata McGraw Hill, New Delhi, 1993.
8. A.I Vogel, **Text Book of Quantitative Inorganic Analysis**, Pearson, Fifth Edition 2001.

Reference Books

1. Willard, Merit, Dean, Settle, **Instrumental Methods of Analysis**, CBS Publishers and Distributors, Fourth Edition, 1989.
2. G. D. Christian and J.E.O Reilly, **Instrumental Analysis**, Allyn and Bacon Inc, Second Edition, 1986.
3. G.W. Ewing, **Instrumental Methods of Chemical Analysis**, McGraw Hill Pub, 1975.
4. A.I Vogel, **Text Book of Quantitative Inorganic Analysis**, ELBS Third Edition, 1987.
5. Larry G. Hargis, **Analytical Chemistry: Principles and Techniques**, Prentice-Hall International edition.
6. L. R. Shyder, J. J. Kirkland, J.W. Dolan, **Introduction to Modern Liquid Chromatography**, John Wiley & Sons, New York, Third Edition 2009.
7. I. M. Kolhthoff, P. J. Elving, **Treatise on Analytical Chemistry**, John Wiley & Sons, New York.
8. L. Meites, **Handbook of Analytical Chemistry**, McGraw-Hill, New York, 1982.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	M	M
CO2	S	S	S	S	M
CO3	M	M	S	S	M
CO4	M	M	S	S	S
CO5	S	S	M	M	S

S- Strong; M-Medium.

22UPCHE3C05 ORGANIC CHEMISTRY PRACTICAL – I

Hours	L	T	P	C
90	0	0	5	3

Course Objectives

1. To separate and identify the components in the binary organic mixture.
2. To be familiarise with some single stage preparation of organic compounds.
3. To learn the drawing of chemical structures using computers.

Course outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	separate the organic two component mixture using their solubility and chemical nature. Also to analyse the organic compounds and predict the functional groups, special elements present, suitable derivative preparation, etc.	**K4**
CO2	synthesize some simple organic compounds using standard procedures. Also able to use techniques like distillation, recrystallization, etc.	**K5**
CO3	use chemdraw software for drawing the chemical structures for their M.Sc. projects and further research.	**K3**

I. Identification of components in a two component mixture and preparation of their derivatives. (about 4-5 mixtures)

II. Preparation of organic compounds (single stage)

1. *β*-Naphthyl methyl ether from *β*-naphthol (methylation)
2. *β*-Glucose penta acetate from glucose (acetylation)
3. Methyl orange from sulphanilic acid (diazocoupling)
4. Anthraquinone from anthracene (oxidation)
5. Methyl-m-nitrobenzoate from methylbenzoate (nitration)

III. Practice of chemdraw for drawing organic molecules (only for internal assessment)

Text Books

1. B.S. Furniss, A.J. Hannaford, P.W.G. Smith, A.R. Tatchell, **Vogel's Practical Organic Chemistry.** Fifth Edition. ELBS, 1989.
2. Raj K. Bansal, **Laboratory Manual of Organic Chemistry**, Third Edition, New Age International, Privite Ltd, 1996.
3. N. S. Gnanapragasam, G. Ramamurthy, **Organic Chemistry Lab Manual**, New Edition, SV Publishers 2006.
4. Chemdraw 8.0 to 16.0, **Perkin Elmer-User Guide Version 16.0**, CambridgeSoft Corporation.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	S	S
CO3	S	S	S	S	S

S- Strong; **M**-Medium.

22UPCHE3C06 INORGANIC CHEMISTRY PRACTICAL – I

Hours	L	T	P	C
90	0	0	5	3

Course Objectives

1. To learn the semi-micro qualitative analysis - Separation and identification of cations.
2. To learn the preparations and crystallization of co-ordination Complexes.

Course Outcomes

On the successful completion of the practical, student will be able to:

CO Number	CO Statement	Knowledge Level
CO1	Semi-micro qualitative analysis of a mixture of salts and familiarize the test involving identification of special elements.	K3, K4 & K5
CO2	To expertise the various techniques of preparation and the techniques involving drying and recrystallization of synthesized complexes.	K4 & K5
CO3	To understand colorimetric estimation of transition metal ions.	K4 & K5

I. Semi-micro qualitative mixture analysis

Semi-micro qualitative analysis of a mixture of salts containing two common cations (Pb, Cu, Bi, Cd, Fe, Cr, Co, Ni, Mn, Zn, Ba, Sr, Ca, Mg,) and two less common cations (W, Tl, Se, Te, Mo, Ce, Th, Zr, Ti, V, U, Li).

II. Preparations and Crystallisation of Co-ordination Complexes

1. Tris(thiourea)copper (I) sulphate
2. Tetramminecopper (II) sulphate
3. Schiff base complexes of divalent metal ions
4. Potassium trioxalatoferrate
5. Potassium trioxalatochromate
6. Hexamminecobalt (III) chloride
7. Potassium tris (oxalate) aluminate (III)

III. Colorimetric Estimations:

Estimations of Copper, Iron, Nickel and Chromium using Nessler technique and/or spectrophotometry.

Note: A minimum of six inorganic mixtures containing, two common and two rare elements should be analysed by a student. Each student should do a minimum of six preparations.

Text Books

1. V. Ramanujam, **Inorganic Semi Micro Qualitative Analysis**, National Pubs. 1988.
2. R. Mukhopadhyay, P. Chatterjee, **Advanced Practical Chemistry**, Book & Allied, Privite Ltd, 2007.

Reference Books

1. A.I. Vogel, **Text Book of Quantitative Inorganic Analysis**, Fifth Edition, Longman, 1989.
2. A.I.Vogel, G.Svehla,**Vogel's Qualitative Inorganic Analysis**, Seventh Edition, Longman, 1996.
3. I.M. Koltoff, E.B. Sandell, **Text Book of Quantitative Inorganic Analysis**, Third Edition, Macmillian, 1968.

Mapping with Programme outcomes

COs	PO1	PO 2	PO 3	PO4	PO 5
CO1	S	S	M	S	H
CO2	M	S	H	M	M
CO3	S	H	S	M	S
CO4	H	S	M	S	H
CO5	S	M	S	H	M

S-Strong; H-High; M-Medium

SECOND SEMESTER

22UPCHE3C07 ORGANIC REACTIONS, REAGENTS AND STEREOCHEMISTRY

Hours	L	T	P	C
72	3	1	0	4

Course Objectives:

1. To learn the photophysical and photochemical processes especially that of carbonyl compounds and olefins
2. To learn the role of orbital symmetry in pericyclic reactions and analysis of pericyclic reactions.
3. To understand the mechanisms of common organic rearrangements.
4. To learn oxidation and reduction reactions in organic compounds along with the reagents used.
5. To learn the basics of stereochemistry, conformation and reactivity, ORD and CD curves.

Course outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	understand the theories of light absorption and fate of the excited state molecules, -to predict the products of various photochemical reactions and photochemical rearrangements with mechanism.	K2 & K3
CO2	construct the molecular orbitals from atomic orbitals with conservation of symmetry,-determine the stereochemistry of the products in pericyclic reactions.	K3 & K4
CO3	understand the mechanisms of various rearrangement reactions and to predict the products.	K2, K3 & K4
CO4	predict the conditions and products of oxidation/reduction reactions in organic compounds,- to understand the mechanism involved, and to predict the selectivity	K3, K4 & K5
CO5	understand the effect of conformation on the	K3, K4 & K5

	stabilities and reactivities of the cyclic and acyclic systems, -to use the Cotton effect curves, Octant rule and α-haloketone rule for the stereochemical prediction of complex molecules like steroids.	

UNIT - I Organic Photochemistry

Organic photochemistry - Introductory theory of light absorption. Photophysical processes - Jablonski diagram and energy transfer. Photochemical reaction of ketones - Norrish type I and type II reactions, photoreductions, Paterno - Buchi reaction. Photooxidation, photochemistry of alkenes (cis-trans isomerization and dimerizations), photochemistry of enones and aromatic compounds. Selected photochemical reactions - Photo Fries, Barton, di-π methane, oxa and aza di-π methane rearrangements.

Tutorial: Problems on prediction of products, conditions and mechanism.

UNIT - II Pericyclic Reactions

Basic concept of conservation of orbital symmetry. Classification of pericyclic reactions with suitable examples. Electrocyclic reactions-FMO approach, Woodward-Hoffman rules, correlation diagram and PMO treatment. Ring closure reactions of systems such as butadiene, pentadienylanion, pentadienylcation, allyl anion, allylcation and hexatriene.

Cycloaddition reactions - 2 + 2, 4 + 2, 4 + 4, 6 + 2, and 6 + 4 cycloaddition reactions, FMO approach, Woodward-Hoffman rules, correlation diagram and PMO treatment. Stereoselectivity, regioselectivity, periselectivity and site selectivity in cycloaddition. Secondary orbital interactions in cycloadditions. Normal and Inverse electron demand in Diels-Alder reaction, Ene reaction.

Sigmatropic reactions - FMO and PMO treatment. Hydrogen migration. Carbon migration with symmetric and asymmetric centres. Cope and Claisen rearrangements.

Tutorial: Problems on prediction of products, conditions and stereochemistry.

UNIT - III Molecular Rearrangements

Nucleophilic, Electrophilic and Free radical rearrangements - memory effects, migratory aptitudes. A detailed study of the mechanism of the following rearrangements - Pinacol-pinacolone, Wagner-Meerwin, Demyanov, Dienone-Phenol, Benzidine, Favorski, Baeyer-Villiger, Wolff, Stevens, Von-Richter, Claisen, Beckmann, Lossen, Schmidt, Sommelet-Hauser, Smiles, Dakins, and Fries rearrangements (a few examples in each rearrangement are to be studied).

Tutorial: Problems on prediction of products, reagents, conditions, mechanism and name

of the reaction.

UNIT - IV Oxidation and Reduction Reactions

Study of the following oxidation reactions with mechanism - Oxidation of alcohols by $KMnO_4$, $K_2Cr_2O_7$, CrO_3, DMSO alone, DMSO in combination with DCC, acetic anhydride and oxalyl chloride. Oxidation of arylmethane, oxidation of methylene alpha to carbonyl, allylic oxidation of olefins, oxidative cleavage of glycols and oxidative cleavage of double bonds by ozonolysis.

Study of the following reduction reactions with mechanism- Reduction of carbonyl compounds by metal hydrides, selectivity in reduction of 4-*ter*-butyl cyclohexanone using selectrides, Clemmensen, Wolff Kishner, Birch and MPV reductions. Reductions using Raney nickel and Gilman's reagent,

Tutorial: Prediction of products, reagents, conditions and mechanism

UNIT - V Stereochemistry, Conformational Analysis, ORD and CD

Definition of prochirality - Homotopic, enantiotopic and diastereotopic atoms and groups in organic molecules. Asymmetric synthesis - using chiral reagents, chiral auxillary and chiral catalyst. Crams rule and Felkin Ahn model.

Conformational analysis of simple cyclic (cyclopropane, cyclobutane, cyclopentane and cyclohexane) and acyclic (ethylene chlorohydrin and ethylene glycol) systems. Conformation and stereochemistry of decalins and perhydrophenanthrenes. Effects of conformation on reactivity in cyclohexanes - Oxidation and acylation of cyclohexanols, reduction of cyclohexanones, esterification and hydrolysis of cyclohexane carboxylic acid derivatives.

ORD and CD - Circular bireferengence and circular dichroism. Plain dispersion curves, single and multiple Cotton effect curves and their applications. Octant rule and α-haloketone rule.

Tutorial: Problems on stereochemical prediction of products

Text Books:

1. J.M. Coxon, B. Halton, **Organic Photochemistry**, Cambridge Chemistry Texts, 1984.
2. Jagdamba Singh, Jaya Singh, **Photochemistry and Pericyclic Reactions**, Third Edition, New Age International Publishers, 2010.
3. Ratan Kumar Kar, **Frontier Orbital and Symmetry Controlled Pericyclic Reactions**, Books and Allied, 2010.

4. S. Sankararaman, **Pericyclic Reactions - A Textbook**, Wiley-VCH, Weinheim, 2005.
5. S.N. Sanyal, **Reactions, Rearrangements and Reagents**, Fourth Edition, Bharati Bhawan Publishers, 2019.
6. S.M. Mukherji, S.P. Singh, **Reaction Mechanism in Organic Chemistry**, Third Edition, MacMillan, 1984.
7. W. Carruthers, **Some Modern Methods in Organic Synthesis**, Cambridge University Press, 1989.
8. Jagdamba Singh, L.D.S.Yadav, **Organic Synthesis**, Seventh Revised Edition, Pragati Prakashan Educational Publishers, 2011.
9. P.S. Kalsi, **Stereochemistry - Conformation and Mechanism**, Eleventh Edition, New Age International Pvt Ltd, 2022.
10. E.L. Eliel, S.H. Wilen, L.N. Mander, **Stereochemistry of Organic Compounds**, First Edition, John Wiley & Sons, Inc., New York, NY. 2008.

References Books:

1. F.A. Carey, R.J. Sundburg, **Advanced Organic Chemistry**, Part A&B, Fifth Edition, Plenum Press, 2007.
2. R.B. Woodward, R. Hoffmann, **The Conservation of Orbital Symmetry**, Elsevier, 2013.
3. M.J.S. Dewar, R.C. Dougherty, **The PMO Theory of Organic Chemistry**, Plenum Press, New York, 1975.
4. I. Fleming, **Pericyclic Reactions**, Second Edition, Oxford University Press, Oxford, 2015.
5. R.P. Wayne, **Principles and Applications of Photochemistry**, Oxford Science Publications, Oxford University Press, Oxford, 1988.
6. A. Gilbert, J. Baggot, **Essentials of Molecular Photochemistry**, Blackwell Scientific Publications, Oxford & Boston, 1991.
7. M. Klessinger, J. Michl, **Excited States and Photochemistry of Organic Molecules**, VCH Publishers, Inc., New York, 1994.
8. Carl Djerassi, **Optical Rotatory Dispersion**, McGraw-Hill 1960, Internet Archive.

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	M	M
CO2	M	S	S	S	M
CO3	S	M	S	M	S
CO4	S	M	S	S	M
CO5	M	S	M	M	S

S- Strong; **M**-Medium.

22UPCHE3C08 **COORDINATION CHEMISTRY**

Hours	L	T	P	C
72	3	1	0	4

Course Objectives:

1. To study the principles, bonding concepts, reaction mechanism and electronic spectra of coordination compounds.

2. To study the applications of basic spectroscopic techniques in the structural elucidation of coordination compounds.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	Know about the stability of metal complexes and describe the stability of metal complexes by the use of different parameters.	K1 & K2
CO2	Learn various theories to explain the structure and properties of coordination compounds.	K1, K2, K3
CO3	Understand about the reaction mechanism of transition metal complexes.	K1, K2, K3
CO4	Apply Crystal Field Theory to understand the electronic spectra and the magnetic properties of complexes	K1, K2, K3
CO5	Apply basic spectroscopic techniques in the structural elucidation of coordination compounds.	K1, K2, K3

Unit I Coordination Chemistry- Principles

Lewis acids and Lewis bases in coordination chemistry, detection of complex formation in solution; Stability constants, stepwise and over-all formation constants, methods of determining the formation constants – spectrophotometric method, Job's method and potentiometric method. Factors affecting stability (properties of both metal ions and ligands, Irwing-William series) – statistical and chelate effects –Class (a) and class (b) acids and bases- HSAB Principle and its applications.

Stereochemical aspects - stereoisomerism in inorganic complexes, isomerism arising out of ligand distribution and ligand conformation and chirality.

Macrocyclic ligand types - porphyrins, corrins, Schiff bases, crown ethers, cryptates and catenands. (simple complexes).

Unit II Theories of Coordination Compounds

VB theory, CFT - splitting of d orbitals in ligand fields and different symmetries, CFSE, factors affecting the magnitude of 10 Dq, evidence for crystal field stabilization. Spectrochemical series, site selection in spinels, tetragonal distortion from octahedral symmetry, Jahn-Teller distortion. Nephelauxetic effect, MO theory – octahedral, tetrahedral and square planar complexes. π-bonding and molecular orbital theory - experimental evidence for π-bonding.

Unit III Reactions

Substitution reactions in square planar complexes - the rate law for nucleophilic substitution in a square planar complex. The trans effect, theories of trans effect. Mechanism of nucleophilic substitution in square planar complexes - kinetics of octahedral substitution, ligand field effects and reaction rates, mechanism of substitution in octahedral complexes. Reaction rates influenced by acids and bases - racemization and isomerization. Mechanisms of redox reactions. Outer sphere mechanisms - excited state outer sphere electron transfer reactions. Inner sphere mechanisms - mixed valence complexes.

Unit IV Electronic Spectra and Magnetism

Microstates, terms and energy levels for d1– d9 ions in cubic and square fields - selection rules, band intensities and band widths, Orgel and Tanabe-Sugano diagrams, evaluation of 10 Dq and β for octahedral complexes of cobalt and nickel. Charge transfer spectra. Magnetic properties of coordination compounds - change in magnetic properties of complexes in terms of spin orbit coupling, temperature independent paramagnetism and spin cross over phenomena.

Unit V Applications of IR and UV-Visible Spectroscopy to Complexes

Effect of coordination on ligand vibrations - uses of group vibrations in the structural elucidation of metal complexes of urea, thiourea, cyanide, thiocyanate, nitrate, sulphate and DMSO. Effect of isotopic substitution on the vibrational spectra of molecules. Application of UV-Visible spectra in the identification of electronic transitions in complexes.

Text Books

1. F. A. Cotton and G. Wilkinson, **Advanced Inorganic Chemistry**, Wiley Interscience, Sixth Edition, 1999.
2. J. D. Lee, **Concise Inorganic Chemistry**, Fifth Edition, 2021.
3. W.U. Malik, G.D. Tuli, R.D. Madan, **Selected Topics in Inorganic Chemistry**,

S.Chand & Co., 2004.

4. B.R. Puri, L.R. Sharma, K.C. Kalia, **Principles of Inorganic Chemistry**, Milestone Publishers, 2013.
5. D.F. Shriver, P.W. Atkins, C.H. Langford, **Inorganic Chemistry**, Oxford University Press, l994.

Reference Books

1. J.E. Huheey, E.A. Keiter, R.L. Keiter, **Inorganic Chemistry: Principles of Structure and Reactivity**, Harper Collin College Publishers, Fourth Edition, 1993.
2. J. Lewis, R. G. Wilkins, **Modern Coordination Chemistry**, Wiley Interscience, 1960.
3. K. Nakamoto, **Infrared and Raman Spectra of Inorganic and Coordination Compounds**, Part A & Part B, Second Edition, Wiley, 2009.
4. G. L. Miessler, D. A. Tarr, **Inorganic Chemistry**, Third Edition, Pearson Prentice Hall, 2005.
5. J. E. House, **Inorganic Chemistry**, Elsevier, 2008.
6. C. E. Housecroft, A. G. Sharpe, **Inorganic Chemistry**, Prentice Hall, 2005
7. K.F. Purcell, J.C. Kotz, **Inorganic Chemistry**, WB. Sanders Co., USA 1977.

Mapping with Programme Outcomes

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	S	S	M	S	M
CO2	M	M	M	S	S
CO3	S	M	S	M	M
CO4	S	S	M	M	M
CO5	M	S	M	S	M

S- Strong; **M**-Medium.

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

1. To understand the chemical dynamics and mechanism of various reactions.
2. To study the theory and mechanism of catalytic and surface reactions.
3. To understand the concepts of photochemistry.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	analyse the concepts and the application of chemical dynamics.	K1, K2 & K3
CO2	analyse the concepts and their application to fast reactions.	K1, K2 & K3
CO3	evaluate the kinetics of catalysis.	K1, K2, K3 & K4
CO4	understand the kinetics and mechanism of surface reactions and properties of colloids.	K1, K2, K3 & K4
CO5	evaluate the concepts and the application of photochemistry.	K1, K2 & K3

UNIT I Chemical Dynamics - I

Empirical rate laws. Kinetics of Elementary, parallel, opposing and consecutive reactions. Steady state approximation, Determination of reaction mechanisms. Theories of reaction rates - Hard sphere collision theory. Transition state theory - Eyring equation, Thermodynamic aspects, Kinetic isotopic effect. Reaction rates in solution - Factors affecting reaction rates in solution - Effect of dielectric constant and ionic strength, Bronsted-Bjerrum equation, Primary and secondary salt effect, Influence of solvent on reaction rates.

Tutorial: Problems in reaction rates and activation energy determination

UNIT II Chemical Dynamics - II

Unimolecular reactions - Lindemann, Hinselwood, Rice-Ramsperger-Kassel (RRK) and Rice-Ramsperger-Kassel-Marcus [RRKM] theories. Marcus theory of

electron transfer reactions. Potential energy surfaces - Concept of saddle point. Kinetics of fast reactions - flow method, pulse method, relaxation method, shock-tube method, magnetic resonance method, molecular beam method. Diffusion controlled reactions in solution, Debye-Smoluchowski equation. Kinetics of polymerization.

UNIT III Catalysis

Concepts of catalysis - pH and temperature dependence of rate constants of catalysed reactions. Homogeneous catalysis - Theory and mechanism of Acid base catalysis. Enzyme catalysis – Mechanism, Factors affecting enzyme catalysis and Kinetics of enzyme catalysis. Heterogeneous catalysis. Kinetics and mechanism of Micellar catalysis.

UNIT IV Surfaces and Colloids

Kinetics of surface reactions - Unimolecular and bimolecular reactions - Langmuir-Hinshelwood mechanism, Rideal-Eley mechanism - Adsorption of gases on solids - Factors affecting adsorption. Adsorption isotherms - Theory, derivation and applications of Freundlich, Langmuir and BET adsorption isotherms. Surface tension, Viscosity. Self assembly. Surface area and its determination. Colloids - Preparation methods, stability and properties of colloids.

UNIT V Kinetics of Photochemical reactions

Kinetics of photochemical and Photophysical processes. Theory of radiationless transitions - Jablonski diagram. Fluorescence and Phosphorescence - Factors affecting fluorescence, Prompt and delayed fluorescence, Fluorescence quenching, static and dynamic quenching. Excimers and exciplexes. Quantum yield measurement. Kinetics of photochemical reactions-Stern-Volmer equation. Bioluminescence and chemiluminescence.

Text Books

1. P. Atkins, J. Paula, **Physical Chemistry**, Tenth Edition, Oxford University Press, Oxford, 2014.
2. J. Silbey, R. A. Alberty, M. G. Bawendi, **Physical Chemistry**, Fourth Edition, Wiley-India, New Delhi, 2005.

3. S. Berry, S. A. Rice, J. Ross, **Physical Chemistry**, Second Edition, Oxford University Press, Oxford, 2007.
4. K.J. Laidler, **Chemical Kinetics**, Third Edition, Harper & Row, New York, 2003.
5. K. Rohatgi – Mukherjee, **Fundamentals of Photochemistry**, New Age International Pvt. Ltd.; Third Edition, New Delhi, 2014.
6. I.Steindeld, J. S. Francisco, W. L. Hase, **Chemical Kinetics and Dynamics**, Second Edition, Prentice Hall International Inc., New York, 1989.
7. J. Rajaram, J.C. Kuriacose, **Kinetics and Mechanism of Chemical Transformations**, Macmillan India Ltd., 1993.
8. A.W. Adamson, **Physical Chemistry of surfaces**, Fourth Edition, Wiley - Interscience, Newyork, 1982.

Reference Books

1. R.G. Frost, Pearson, **Kinetics and Mechanism**, Wiley New York, 1961
2. C.Capellos, B.H.J.Bielski, **Kinetic Systems**, Wiley Interscience, New York, 1968.
3. R.G. Frost and Pearson, **Kinetics and Mechanism**, Wiley New York, 1961
4. G.M. Harris, D.C. Health, **Chemical Kinetics**, 1966.
5. A.W. Anderson, **Physical Chemistry of Surfaces**, Wiley - Interscience, Newyork, 1990.
6. N.J. Turro, **Modern Molecular Photochemistry,** Benjamin/Cummings, Menlo Park, California, 1978

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	M	S
CO2	M	S	M	S	S
CO3	S	M	S	M	M
CO4	S	M	S	M	S
CO5	M	S	M	S	S

S- Strong; **M**-Medium.

22UPCHE3C10 **PHYSICAL CHEMISTRY PRACTICAL – I**

Hours	L	T	P	C
90	0	0	5	3

Course Objectives

1. To understand the principles of various experimental techniques.
2. To learn various experiments related to chemical kinetics, phase rule, chemical equilibrium and conductivity measurements and titrimetric analysis.
3. To understand and construct the phase diagram for different component systems

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	understand the kinetics of acid hydrolysis and determination of the reaction coefficient	K5
CO2	learn the phase diagram for binary and ternary system.	K5
CO3	gain knowledge on the kinetics of the equilibrium constant and equivalent conductivity of week and strong acids	K6

DETAILED LIST OF EXPERIMENTS

Typical list of possible experiments are given. Experiments of similar nature and other experiments may also be given. The list given is only a guideline. A minimum of 10 experiments have to be performed.

1. Study the kinetics of acid hydrolysis of an ester, determine the temperature coefficient and the activation energy of the hydrolysis of ethylacetate.
2. Study the kinetics of the reaction between acetone and iodine in acidic medium by half life method and determine the order with respect to iodine and acetone.
3. Study the degree of hydrolysis of urea hydrochloride by kinetics method.
4. Study of the saponification of ethylacetate by sodium hydroxide conductometrically and determine the order of the reaction.
5. Determine association factor of benzoic acid in benzene by distribution method.
6. Study the phase diagram for m-toluidine and glycerine system.
7. Construct the phase diagram for a simple binary system (naphthalene –

phenanthrene and benzophenone – diphenylamine)

8. Construct the phase diagram of the three component of partially immiscible liquid systems (DMSO – Water – Benzene; Water-Benzene –Acetic acid; Ethyl alcohol – Benzene – Water; Acetone-Chloroform – Water; Chloroform – Acetic acid-Water).
9. Determine the equilibrium constant of the reaction between Iodine and KI by partition method.
10. Determine the equivalent conductance of a weak acid at different concentrations and verify Ostwald's dilution law and calculate the dissociation constant of the acid.
11. Determine the equivalent conductivity of a strong electrolyte at different concentrations and examine the validity of the Onsager's theory as limiting law at high dilutions.
12. Carry out conductometric titrations of a mixture of HCl and CH_3COOH against Sodium hydroxide. And determine the strength of HCl and CH_3COOH.
13. Compare the relative strength of acetic acid and monochloroacetic acid by conductivity method.
14. Determine the solubility and solubility product of sparingly soluble salt conductometrically.

Reference Books

1. B.P. Levitt (Ed.). **Findlay's Practical Physical Chemistry**, Nineth Edition, Longman, London, 1985.
2. J.N. Gurtu, R.Kapoor, **Advanced Experimental Chemistry**, Vol I. S. Chand & Co. Ltd., New Delhi, 1980.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	M
CO2	S	S	M	S	M
CO3	S	S	M	S	M

S- Strong; **M**-Medium.

22UPCHE3C11 ORGANIC CHEMISTRY PRACTICAL – II

Hours	L	T	P	C
90	0	0	5	3

Objectives

1. To analyse the organic compounds quantitatively.
2. To execute double stage preparation of organic compounds.
3. To familiarise the chromatographic separation techniques.

Course outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	estimate the quantity of the given organic compound precisely. He/She will be also able to predict the quality of oils by estimating their saponification and iodine values.	K4
CO2	synthesize important organic compounds using standard procedures. Also they will be familiar with the techniques like distillation, separation and purification methods like recrystallization.	K5
CO3	separate pure compounds by chromatographic techniques for further characterization.	K4
CO4	analyse the separated pure product using FT-IR	K4

I. Quantitative Analysis of Organic Compounds Estimation of

i. Phenol
ii. Ketone
iii. Glucose
iv. Saponification value of an oil
v. Iodine value of an oil

II. Preparation of Organic Compounds (Double stage)

i. 1,3,5-Tribromobenzene from aniline (bromination, diazotization and hydrolysis)
ii. *p*-Nitroaniline from acetanilide (nitration and hydrolysis)
iii. Benzanilide from benzophenone (Beckmann rearrangement)
iv. *m*-Nitroaniline from nitrobenzene (Nitration and reduction)

III. Practice of thin layer and column chromatography (only for internal assessment)

IV. Analysis of the synthesized compounds using FT-IR spectroscopy (only for internal assessment)

Text Books:

1. B.S. Furniss, A.J. Hannaford, P.W.G. Smith, A.R. Tatchell, **Vogel's Practical Organic Chemistry.** Fifth Edition, ELBS, 1989.
2. Raj K. Bansal, **Laboratory Manual of Organic Chemistry**, Third Edition, New Age International Pvt Ltd, 1996.
3. N.S. Gnanapragasam, G. Ramamurthy, **Organic Chemistry Lab Manual**, New Edition, SV Publishers, 2006.
4. P.S. Subramanian, R. Gopalan, K. Rangarajan, **Elements of Analytical Chemistry**, Sultan Chand & Sons, New Delhi, 2003.

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	M
CO2	S	S	M	S	M
CO3	S	S	M	S	M

S- Strong; **M**-Medium.

22UPCHE3C12 ORGANIC SYNTHESIS AND NATURAL PRODUCTS

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

1. To understand the Retro-synthetic analysis of organic molecules with C-X disconnections.
2. To familiarise the C-C disconnections and functional group interconversions.
3. To learn about the protecting groups and important reagents in organic synthesis.
4. To learn the structure, synthesis and properties of heterocyclic compounds.
5. To understand the structure and chemistry of natural products like alkaloids and steroids.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	plan the fundamental organic synthesis and design syntheses of organic molecules with carbon-heteroatom bond formation.	K3, K4, K5
CO2	plan organic synthesis with C-C bond formation reactions	K4, K5
CO3	plan a synthesis by protecting reactive functional groups and to predict the reagents, products of important organic transformations and the mechanism involved.	K2, K3, K4
CO4	have a broad idea on heterocyclic compounds	K3, K4
CO5	elucidate the structures of alkaloids and steroids and also plan the inter-conversions of steroids	K2, K3, K4

UNIT - I Retrosynthetic Analysis and C-X Disconnections

An introduction to organic synthesis-linear versus convergent synthesis. Disconnection approach- synthons and synthetic equivalents. The importance of the order of events in organic synthesis - one group C-X and two group C-X disconnections with

suitable examples, chemoselectivity, reversal of polaritiy, cyclization reactions, amine synthesis.

Tutorial: Problems on retrosynthetic analysis of target molecules.

UNIT - II C-C Disconnections and Functional Group Interconversions

One group C-C disconnections - Alcohols and carbonyl compounds, regioselectivity, alkene synthesis and olefination of carbonyl compounds - McMurry's method. Two group C-C disconnections - Diels Alder reaction and Michael addition. Functional group inter conversions involving C=O, CHO, OH, C=C, NH_2, COOH, C-Cl and C-Br functional groups.

Tutorial: Problems on disconnection and functional group inter conversion.

UNIT - III Protecting Groups and Reagents in Organic Synthesis

Protection and deprotection of functional groups (R-OH, R-CHO, RCOR, R- NH_2 and R-COOH).

Synthesis of simple organic molecules using standard reactions like acylation and alkylation of enamines and active methylene compounds. Use of acetylenes and aliphatic nitro compounds in organic synthesis.

Reagents and their uses - DCC, trimethylsilyl iodide, trimethylsilyl chloride, 1,3-dithiane (umpolung), diisobutylaluminium hydride (DIBAL), 9-BBN, Osmium tetroxide, DDQ, Selenium dioxide, Phase transfer catalysts, crown ethers and baker's yeast.

Tutorial: Problems on prediction of reagents, conditions, and mechanism.

UNIT - IV Heterocyclic compounds

Preparation, chemical reactions and properties of three membered and four membered heterocycles - aziridines, oxiranes, thiranes, azetidines, oxitanes and thietanes. Preparation, chemical reactions and properties of pyrrole, furan, thiophenes, pyridine, indole, quinoline and isoquinoline.

Benzo fused Heterocycles - benzofurans, benzothiophenes, carbazoles, chromones, flavanones and isoflavones.

Tutorial: Problems on prediction of preparation, reactivity and mechanism.

UNIT - V Alkaloids and Steroids

General methods of structural determination of alkaloids, structural elucidation of Chinconine, Papaverine, Morphine and Reserpine.

Steroids - Structure elucidation and Stereochemistry of Cholesterol (synthesis not required). Conversion of cholesterol into progesterone, testosterone and oestrone. Structural features of bile acids. Artificial hormones - Stilboestrol and Hexoestrol.

Tutorial: Problems on conversions in structural elucidation

Text books:

1. S. Warren, **Organic Synthesis: The Disconnection Approach**, John Wiley & Sons, 2008.
2. W. Carruthers, **Some Modern Methods in Organic Synthesis**, Cambridge University Press 1989.
3. W. Carruthers, I. Coldham, **Modern Methods in Organic Synthesis,** Cambridge University Press, Fourth Edition, 2004.
4. Jerry March, **Advanced Organic Chemistry-Reactions - Mechanisms and Structure**, Seventh Edition, Wiley, 2015.
5. S.M. Mukherji, S.P. Singh, **Reaction Mechanism in Organic Chemistry,** Third Edition, Macmillan, 1984.
6. R.O.C. Norman, J.M. Coxon, **Principles of Organic Synthesis**, Nelson Thornes, Third Edition, 2005. 1993.
7. John A. Joule, Keith Mills, **Heterocyclic Chemistry at a Glance,** Fifth Edition, Blackwell Publishing, 2007.
8. M. Sainbury, **Heterocyclic Chemistry**, Royal Society of Chemistry, 2001.
9. J.A. Joule, K. Mills, **Heterocyclic Chemistry**, Fifth Edition, J. Wiley & Sons, 2010.
10. I.L. Finar, **Organic Chemistry**, Volume II, Fifth Edition, First Indian Reprint, Pearson Education Asia Pvt. Ltd., 2000.
11. Jagdamba Singh, L.D.S. Yadav, **Organic Synthesis**, Seventh Revised Edition, Pragati Prakashan Educational Publishers, 2011.

References Books:

1. F.A. Carey, R.J. Sundburg, **Advanced Organic Chemistry**, Part A & B", Fifth Edition, Plenum Press, 2007.
2. G.S. Zweifel, M.H. Nantz, **Modern Organic Synthesis-An Introduction**, Second Edition, Wiley, 2006.
3. S. Warren, **Organic Synthesis: The Disconnection Approach**, John Wiley & Sons, 2008.

4. T.W. Greene, **Protecting Groups in Organic Synthesis**, Fourth Edition, J. Wiley & Sons, 2006.
5. E.J. Corey, X. Cheng, **The Logic of Chemical Synthesis**, John Wiley, 1989.
6. Thomas L. Gilchrist, **Heterocyclic Chemistry**, Third Edition, Pearson Education, 2007.
7. G. Chatwal, **Organic Chemistry of Natural Products**, Vol I & II, Himalaya Publishing House, 1988.
8. S.W. Pelletier, Van Nostrand, **Chemistry of Alkaloids**, Reinhold, 1970.
9. K. Nakanishi, T. Goto, S. Ito, S. Najori, S. Nozoe, **Natural Products Chemistry**, Vol. I & II, Academic Press, 1974.
10. S.W. Pelletier, Van Nostrand, **Chemistry of the Alkaloids**, Reinhold, 1970.
11. C.W. Shoppee, **Chemistry of the Steroids**, Second Edition, Butter worths, 1964.

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5
CO1	M	S	S	M	M
CO2	S	M	S	S	M
CO3	S	S	S	M	S
CO4	S	S	S	S	M
CO5	M	S	M	M	S

S- Strong; **M**-Medium.

22UPCHE3C13 ORGANOMETALLIC AND BIOINORGANIC CHEMISTRY

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

1. To learn the basics of organometallics and bonding concepts in organometallic compounds.
2. To study the mechanistic aspects of several well-known industrial catalytic techniques.
3. To understand the role of metal ions in biological process.
4. To learn the fundamentals of medicinal bio-inorganic chemistry.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	understand the organometallic bonding principles.	K1 & K2
CO2	know reaction mechanism in organometallic catalysis.	K1, K2 & K3
CO3	learn the role of carbenes in organometallic chemistry.	K1, K2 & K3
CO4	understand the role of metal ions in biological process.	K1, K2 & K3
CO5	know the role of metal-based drugs in cancer, rheumatoid arthritis and psychopharmacology.	K1, K2 & K3

UNIT - I Structure and Bonding in Organometallic Compounds

The 18 electron rule – limitations and applications. Synthesis, properties, structure and bonding in metal carbonyls, nitrosyls, metal olefins, acetylenes, allyls. Metallocene-ferrocene and Half – sandwhich compounds-arene complexes. Fluxional molecules, Isolobal analogy and its applications.

(Metal alkyl complexes – synthesis and properties)

UNIT - II Reaction Mechanism and Catalysis

Oxidative addition and reductive elimination- Insertion reactions. Reactions of coordinated ligands in organometallics - Homogeneous catalysis - alkene isomerization, hydrocyanation, hydrogenation of olefins - Wilkinson's catalyst - Assymetric Hydrogenation - hydroformylation of olefins-Wacker-Process - Monsanto acetic acid process, Fischer-Tropsch process - Hydrosilylation - Water gas Shift reaction, Ziegler-Natta polymerization.

UNIT - III Carbenes

Classification of carbene complexes. Fisher carbene complexes – structure and bonding in Fisher carbene complexes – Schrock carbenes – structure and bonding in Schrock carbene complexes. Transition metal complexes N-heterocyclic carbenes, pincer N-hereocyclic carbenes activation, bond activation and catalysis of pincer NHC complexes, bridging carbenes, carbines. Fisher carbynes complexes – structure and bonding in Fisher carbyne complexes. Schrock carbynes – structure and bonding in Schrock carbynes complexes. Nucleophilic and electrophilic attack on coordinated ligands – dehydrogenation reactions – amidation reactions – alkane activation – intramolecular and intermolecular C–H activation.

UNIT - IV Metal Complexes in Life Processes

Metalloporphyrins - the porphyrin ring systems - Chlorophyll, cytochromes. Oxygen carriers - haemoglobin and myoglobin. Ferridoxins and rubredoxins, enzymes - vitamin B_{12} and B_{12}. Coenzymes - structure and function. Synthesis model of enzyme action - Inhibition and poisoning, Nitrogen fixation, Biochemistry of essential and trace elements in biological systems.

UNIT - V Metal Complexes in Medicine

Deficiency and disease – Fe, Cu, Zn. Toxic effects of metals – Ca, Fe, Cr, Ni, Cu, Pb, Cd, Hg, Pu. Detoxification by metal chelation. Metals used for diagnosis and chemotherapy – Radiodiagnostic agents (^{57}Co, ^{67}Ga, ^{123}I), MRI, Lithium and mental health, Gold and Rheumatoid Arthritis, Anticancer drugs (Platinum complexes) and their mode of action.

References

1. G.O. Spessard, G. L. Miessler, **Organometallic Chemistry**, Second Edition, Oxford University Press, 2009.
2. R.H. Crabtree, **The Organometallic Chemistry of Transition Metals**, Fourth Edition Wiley-VCH, 1998.
3. J. Haiduc, J.J. Zuckerman, **Basic Organometallic Chemistry**, Walter de Gruyter, Brelin, 1985.
4. Bockmann, **Organometallics 1, Complexes with Transition Metal-Carbon Bonds**, Oxford science publications, Oxford, 1996.
5. Bockmann, **Organometallics 2, Complexes with Transition Metal-Carbon Bonds**, Oxford Science Publications, Oxford, 1996.
6. W. Kaim, B. Schwederski, **Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life**, John Wiley, 1994.

7. S.J. Lippard, J.M. Berg, **Principles of Bioinorganic Chemistry**, Panima Publ. Corpn, 2005.
8. J.E. Huheey, E.A. Keiter, R. L. Keiter, **Inorganic Chemistry, Principles of Structure and Reactivity**, Fourth Edition, Harper Collin College Publishers, 1993.
9. C. Elschenbroich, **Organometallics**, Third Edition, Wiley VCH, 2006.
10. Indrajit Kumar, **Organometallic Compounds**, Pragati Prakashan publication, 2018.
11. A. K. Das, **Bioinorganic Chemistry**, Books and Allied Ltd. Kolkatta, 2016.

Mapping with Programme Outcomes

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	S	S	M	M	M
CO2	M	S	S	S	M
CO3	S	M	S	S	M
CO4	M	M	S	S	S
CO5	M	S	M	M	S

S- Strong; **M**-Medium.

22UPCHE3C14 QUANTUM CHEMISTRY AND GROUP THEORY

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

1. To understand the quantum mechanical concept and their applications.
2. To determine energy of quantum particles, atom and molecules.
3. To understand the concepts of group theory of molecules and crystals.
4. To predict point group of molecules and crystals
5. To study the applications of group theory.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	understand the basics of quantum mechanics, wave equation, Oscillators and postulates.	K1, K2, K3 & K4
CO2	get in depth knowledge in the applications of quantum chemistry to atoms	K2, K3 & K4
CO3	acquire knowledge in the applications of quantum mechanics in molecular structure and chemical bonding	K2, K3 & K4
CO4	learn the basics of group theory and solving problems in assigning point groups of molecules	K2, K3 & K4
CO5	analyse the concepts and the application of group theory to crystals.	K2, K3 & K4

UNIT I Quantum Chemistry - I

Planck's quantum theory, Wave particle duality, Uncertainty Principle. Postulates of quantum mechanics. Operators. Time dependent and time independent Schrodinger equations. Born interpretation. Application to simple systems - Particle in 1D, 2D and 3D boxes - Infinite and finite square wells. Concept of tunneling. Applications to Harmonic oscillator - Harmonic and Anharmonic potentials, Hermite polynomials. Rigid rotator.

Tutorial: Problems in energy and wave function of simple systems

UNIT II Quantum Chemistry - II

Application to atoms - Hydrogen and hydrogen-like atoms - Radial distribution function, Orbital and spin Angular momenta. Multi-electron atoms - Orbital approximation, Electron spin, Pauli exclusion and antisymmetry principle, Slater determinants. Term symbols and spectroscopic states - Russel-Saunders coupling. Approximation Methods - Variation method and secular determinants, Perturbation theory applications (up to second order in energy calculations);

UNIT III Quantum Chemistry - III

Molecular structure and Chemical bonding - Born-Oppenheimer approximation, Valence Bond theory. Linear Combination of Atomic Orbitals Molecular Orbital (LCAO-MO) theory - Hybrid orbitals, Applications of LCAO-MO theory to H_2^+, H_2. Molecular orbital theory (MOT) of homo and heteronuclear diatomic molecules. Huckel approximation and its application to annular π-electron systems. Hartree and Hartree-Fock Self consistent field methods - Roothan equation.

Tutorial: Problems in energy and wave function of multi electron atoms and polyatomic molecules

UNIT IV Group Theory of Molecules

Symmetry elements, Symmetry operations, Point groups – Determination - Reducible and Irreducible representations - Rules of irreducible representations - Orthogonality theorem, direct product representation, Character table - Internal coordinates and vibrational modes. Selection rules for IR, Raman and electronic spectra of formaldehyde and ethylene - Symmetry adopted LCAO-MO. Construction of Hybrid orbitals using symmetry aspects.

Tutorial : Problems in assigning point groups of molecules

UNIT V Group Theory of Crystals

Elements of crystallography, Comparison of molecular and crystallographic symmetry, laws of crystallography - Miller indices, 7 crystal systems, 14 bravais lattices and 32 crystal classes. Translational symmetry elements and space groups. Crystal structures - X-Ray diffraction - Bragg's law and its applications

Tutorial : Problems in assigning space groups and structure of crystal

Text books

1. E. Kreyszig, **Advanced Engineering Mathematics**, Fifth Edition, Wiley Eastern, 1989.
2. G. Arfken and Hans J. Weber, **Mathematical methods for physicists**, Prism Indian Edition, 1995.
3. D. A. McQuarrie, **Quantum Chemistry**, University Science Books, 1983. P. W. Atkins, **Molecular Quantum Mechanics**, Second Edition, Oxford University Press, 1983.
4. I. N. Levine, **Quantum Chemistry**, Third Edition, Allyn and Bacon, 1983.
5. D. J. Griffiths, **Introduction to Quantum Mechanics**, Pearson Education, 2005.
6. H. Kuhn, H.-D. Försterling, and D.H. Waldeck, **Principles of Physical Chemistry**, Second Edition, Wiley, 2009.
7. J. P. Lowe, **Quantum Chemistry**, K. A. Peterson, Third Edition, Academic Press, 2006.
8. R.K. Prasad, **Quantum Chemistry**, Wiley Eastern, New Delhi,1992.
9. Ramakrishnan, M.S. Gopinathan, **Group theory in Chemistry**, Vishal Publications, 1988.
10. F.A. Cotton, **Chemical Application of Group Theory**, John Wiley and Sons Inc. New York, 1996.
11. K.V. Raman, **Group Theory and its Applications to Chemistry**, Tata McGraw-Hill Publishing Company, 1990.
12. Szabo, N. S. Ostlund, **Modern Quantum Chemistry**, Dover, 1996.
13. M. Bishop, **Group theory and Chemistry**, Dover, 1989.
14. R. West, **Solid State Chemistry and its Applications**, Reprint Edition, John Wiley & Sons, 1984.
15. E. Smart and E. A. Moore, **Solid State Chemistry – An Introduction**, Fourth Edition, CRC Press, 2012.
16. H.V. Keer, **Principles of the Solid State**, Second Edition, New Age International, 2017.
17. M. Weller, T. Overton, J. Rourke, F. Armstrong, **Inorganic Chemistry**, Sixth Edition, Oxford University Press, 2014.

Reference Books

1. W. Atkins, **Molecular Quantum Mechanics**, Oxford University Press, Oxford, 1983.
2. M.W. Hanna, **Quantum Mechanics in Chemistry**, W.A. Benjamin Inc. London, 1965.

3. I.N. Levine, **Quantum Chemistry**, Allyn and Bacon, Boston, 1983.
4. H. Eyring, J. Walter, G.Kimball, **Quantum Chemistry**, John Wiley and Sons, New York, 1944.
5. A. Walton, **Molecular and Crystal Structure Models,** Ellis Horwood, Chichester, 1978.
6. F. C. Phillips, **An Introduction to Crystallography,** John Wiley and Sons, New York, 1963.
7. A.R. West, **Solid State Chemistry and its applications,** John Wiley and Sons, New York, 1984.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	M	M
CO2	M	S	M	S	S
CO3	S	M	S	S	M
CO4	S	M	S	M	S
CO5	M	S	M	M	S

S- Strong; **M**-Medium.

22UPCHE1C15 INORGANIC CHEMISTRY PRACTICAL – II

Hours	L	T	P	C
90	0	0	5	3

Course Objectives

1. To estimate the amount of metal ion present in the sample mixture quantitatively by complex formation.
2. To estimate the amount of metal ion present in the sample, mixture, quantitatively by volumetric and gravimetric analysis.
3. To prepare simple coordination complexes.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	estimate the amount of the sample by complex formation.	K5
CO2	estimate the amount of the sample by volumetric and gravimetric analysis.	K5
CO3	prepare the simple coordination complexes.	K6

1. **Complexometric Titrations** involving the Estimation of Ca, Mg, Ni, Zn and hardness of water.
2. **Quantitative Analysis**

   Volumetric and gravimetric estimations of mixtures of cations like copper and nickel, copper and zinc, iron and nickel, iron and zinc, calcium and magnesium.
3. **Preparation**

   Simple Co-ordination Complexes.

Note: Quantitative analysis (involving volumetric and gravimetric estimations) of atleast five mixtures of cations should be done by a student. The volumetric procedure may also include EDTA titrations for the estimation of mixture of cations.

Reference Books

1. J. Basset, R.C. Denney, G.H. Jeffery, J. Mendham, **Vogel's Text Book of Quantitative Inorganic Analysis**, ELBS, 1994.
2. W.G. Palmer, **Experimental Inorganic Chemistry**, Van Nostrand Reinhold Co., London, 1972.
3. D.N. Grindley, **An advanced course in practical Inorganic Chemistry**,

Butterworths, 1964.

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	M
CO2	S	S	M	S	M
CO3	S	S	M	S	M

S- Strong; **M**-Medium.

22UPCHE3C16 PHYSICAL CHEMISTRY PRACTICAL – II

Hours	L	T	P	C
90	0	0	5	3

Course Objectives:

1. To determining physical and surface properties.
2. To determine Emf, solubility, strength, pH and activity coefficient by potentiometry.
3. To evaluate the rate constant, order, activation energy of reaction.

Course Outcome:

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

CO Number	CO Statement	Knowledge Level
CO1	determining physical and surface properties	K3, K4 & K5
CO2	determine Emf, solubility, strength, pH and activity coefficient by potentiometry	K3, K4 & K5
CO3	evaluate the rate constant, order, activation energy of reaction	K3, K4 & K5

Physical Chemistry Practical – II

Physical Properties

i) Determination of surface tension by using pyknometer.
ii) Determination of the viscosities of mixtures of different compositions of liquids and finding the composition of a given mixture.
iii) Determine the radius of glycerol molecule from viscosity measurements.

Potentiometric titration

i) Determination of the standard electrode potential of silver electrode.
ii) Determination of the strength of a given solution of KCl using differential potentiometric titration technique.
iii) Determination of solubility and solubility products by emf method.
iv) Determination of the activity coefficient of an electrolyte at different molalities by emf measurements.
v) Determination of the strength of mixture of acids by emf method.
vi) Determination of the strength of mixture of halides by emf method.
vii) Determination of the pH of a given solution by emf method using hydrogen electrode and quinhydrone electrode.
viii) Determination of the formation constant of silver ammonia complex and stoichiometry of the complex potentiometrically.

Colorimetry

i) Determination of the pH of the given solutions with the help of the indicators using buffer solutions by colorimetric method.
ii) Verification of Beer's law and calculation of molar absorption coefficient using $CuSO_4$ and $KMnO_4$ solutions

pH Metry

i) Preparation of phosphate buffers and verify them by using Henderson's equation.

Distribution

i) Distribution of I_2 between CCl_4 and aq.KI solution- calculation of equilibrium constant.
ii) Distribution of acetic acid between n-butanol andwater.

Chemical Kinetics

i) Study the primary salt effect on the kinetics of ionic reactions and test the Bronsted relationship (iodide ion is oxidized by persulphate ion.)
ii) Study of stoichiometry of persulphate - iodide reaction.
iii) Determination of the rate constant, temperature coefficient and energy of activation and order of reaction between potassium persulphate and potassium iodide.

Reference Books

1. B.P. Levitt (Ed.). **Findlay's Practical Physical Chemistry**, Nineth Edition, Longman, London, 1985.
2. J.N. Gurtu, R. Kapoor, **Advanced Experimental Chemistry**, Vol I. S. Chand & Co. Ltd., New Delhi, 1980.

Text Books

1. M. Satish Kumar, **Practical Physical Chemistry**, Sankalp Publication.
2. B. Viswanathan, P. S. Raghavan, **Practical Physical Chemistry**, MV Learning, 2015.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	M	S	M	S
CO3	S	S	S	M	S

S- Strong; **M**-Medium.

FOURTH SEMESTER

22UPCHE3C17 **SPECTROSCOPY**

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

1. To understand the theory, principles and instrumentation of various spectroscopic techniques.
2. To get an idea on the applications of various spectral analysis.
3. To predict the structure of molecules from the spectral data.

Course outcomes

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

CO No.	CO Statement	Knowledge Level
CO1	understand the theory and principles of NMR and use the 1H NMR for structure elucidation.	K1, K2 & K3
CO2	characterize the compounds using the 13C NMR and mass spectral techniques.	K2, K3 & K4
CO3	predict the structures of inorganic complexes using EPR.	K2, K3 & K4
CO4	predict the structures of metal complexes using NQR and Mossbauer spectra.	K2, K3 & K4
CO5	elucidate the structures of the compounds applying various spectral data provided	K2, K3 & K4

UNIT - I ^{1}H NMR Spectroscopy

^{1}H NMR spectroscopy - theory & principles, instrumentation, Zeeman effect, chemical shift and the factors affecting it. Spin-spin coupling-theory and magnitude of coupling constant, factors affecting coupling constant. Proton exchange reactions, NMR of simple AX and AMX type molecules, Non first order spectra, simplification of complex NMR spectra- spin decoupling, double resonance and shift reagents. NMR spectra of solids-magic angle spinning-NMR spectra of paramagnetic compounds-Applications to inorganic ligands and organic molecules.

UNIT - II ^{13}C NMR and Mass Spectroscopy

^{13}C-NMR Spectroscopy**:** Theory and principles, Fourier Transformation, Decoupled spectra - ^{1}H decoupling, noise decoupling, broadband decoupling, off

resonance, spin tickling. Nuclear Overhauser effect. 2D NMR, CIDNP, INDOR (Basic idea only).

Mass spectra – Theory and instrumentation, isotopic abundance, molecular ions, meta stable ions, fragmentation pattern-alkanes, cycloalkanes, alcohols, carbonyl compounds and aromatic hydrocarbons. McLafferty rearrangement.

UNIT - III EPR Spectroscopy

EPR spectroscopy-Theory, principle, instrumentation and hyperfine splitting of paramagnetic species and metal complexes. Dragos rule and its application, g value and factors affecting the magnitude of g and A tensors in metal complexes. Jahn-Teller Distortion in metal complexes, Zero-field splitting and Kramers degeneracy. Applications of EPR to a few metal complexes and biological molecules containing Cu(II) and Fe(III) ions.

Tutorial: Problem solving exercises.

UNIT - IV NQR and Mossbauer Spectroscopy

Nuclear quadrupole resonance spectroscopy- principle, Characteristics of quadrupolar nucleus - Effects of field gradient and magnetic field upon quadrupolar energy levels - NQR transitions - Applications of NQR spectroscopy. Mossbauer Spectroscopy - Principle, Mossbauer effect, Doppler shift, Isomer shifts and factors affecting it. Quadrupole splitting - Magnetic interactions - Applications to iron and tin compounds.

Tutorial: Problem solving exercises.

UNIT - V Combined problems

Applications of UV, IR and NMR-^{1}H, ^{13}C, ^{11}B, ^{19}F and ^{31}P spectra of structural elucidation of organic and inorganic molecules. Mass spectroscopic techniques for the structural elucidation of organic molecules.

Tutorial: Problem solving exercises.

Text books

1. C.N.R. Rao, J.R. Ferraro, **Spectroscopy in Inorganic Chemistry**, Methven Co., London, 1968.
2. William Kemp, Organic Spectroscopy, Palgrave Macmillan, Third Edition, 1991.
3. C.F. Banwell, **Fundamentals of Molecular Spectroscopy**, McGraw Hill, New York, 2017.
4. Donald Pavia, George Kriz, Gary Lampman, James Vyvyan, **Introduction to Spectroscopy**, Fifth Edition, 2014.

5. E.A.V. Ebsworth, D.WH. Rankine, S. Craddock, **Structural methods in Inorganic Chemistry**, Black well Scientific Publication, 1987.
6. Y.R. Sharma, **Elementary Organic Spectroscopy**. S. Chand, Fourteenth Edition, 2021
7. Robert M. Silverstein, Francis X. Webster, **Spectroscopic Identification of Organic Compounds**, Eighth Edition, Wiley, 2022.
8. G.R. Chatwal, Sham Anand, **Instrumental Methods of Chemical Analysis**, 2011.
9. Kazuo Nakamoto, **IR and Raman Spectra of Coordination compounds**, Wiley, Sixth Edition, 2009.
10. P.S. Kalsi, **Spectroscopy Of Organic Compounds,** New Age International Private Limited, Eighth Edition, 2020.

Reference

1. A. Carrigton and A.D. McLachlan, **Introduction to Magnetic Resonance**, Harper and Row, New York 1967.
2. William Kemp, Organic Spectroscopy, Palgrave Macmillan, Third Edition, 1991.
3. Raymond Chang, **Basic Principles of Spectroscopy,** Mc Graw Hill Ltd., New York, 1993.
4. R.S. Drago, **Physical Methods in Chemistry**, Reinhold, New york, 1968.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	M	S	S	S	M
CO2	S	S	M	S	M
CO3	M	S	S	S	M
CO4	S	M	S	S	S
CO5	S	S	M	S	M

S- Strong; **M**-Medium.

ELECTIVE COURSES

22UPCHE3E01 MEDICINAL CHEMISTRY

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

1. To understand the basic concepts of medicinal chemistry.
2. To understand the structure activity relationships of selected drug molecules.
3. To know the preparation and function of various drugs.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	understand the drug design and drug action.	K2, K3 & K4
CO2	understand the synthesis and action of antiviral, antimalarial antiulcer agent and antibacterial drug.	K2, K3 & K4
CO3	learning the preparation and function of antipyretic, analgesics, antiallergic and other agents.	K2, K3 & K4
CO4	understand the essential trace elements in biological systems and metal complex drugs.	K2, K3 & K4
CO5	learn about various inorganic pharmaceuticals.	K2, K3 & K4

UNIT - I Basic Concepts

1.1 Drug Discovery and Drug design - Molecular modification of lead compounds, advantages and side effects of drugs, Principles of drug action - Acid-base chemistry, Biologically significant nitrogen-containing compounds and their physicochemical properties, Bioisosteric replacement.

1.2 Drug-receptor bonding, Receptor theories, Occupancy, Rate, induced fit, Activation-aggravation theory and interaction of a drug with receptor. Agonists and Antagonists. Covalent and Non-covalent bonding - Ionic bonding, Ion-Dipole bonding, Dipole-Dipole bonding, Hydrogen bonding, Hydrophobic interation, Charge-Transfer interation and Van der Waals forces. G protein-coupled receptors. Drug metabolism - Phase I and Phase II reactions. Prodrugs - classification and application.

UNIT - II Antiviral, Antimalarials Drugs and Antiulcer Agent and Antibacterials Drug:

2.1 Antiviral Drugs-Classification, synthesis and mechanism of action. Amatidine hydrochloride, Idoxuridine, Methisazone and Arildone.

2.2 Antimalarials Drugs- Classification, synthesis and mechanism of action- Chloroquine phosphate, Mepacrine hydrochloride and Pyrimethamine.

2.3 Antiulcer Agents- importance, structure activity relationship. Histamine H_2-receptor antagonist. Synthesis and characteristic features and uses of cimetidine, famotidine, ranitidine and nizatidine

2.4 Sulpha Drugs-Classification, synthesis and mechanism of action - sulphanilamide, sulphapyridine, sulphadiazine and sulphisoxazole.

UNIT - III Antipyretic Analgesics, Antiallergic and Other Agents

3.1 Antipyretic Analgesics - Classification, synthesis and mechanism of action- paracetamol, asprine, salsalate, cinchophen, phenazone and aminopyrine.

3.2 Antiallergic Agents - Classification, Synthesis and mechanism of action- diphen hydramine hydrochloride, pyrilamine maleate and methapyrilene hydrochloride.

3.3 Anaesthetic - Classification, synthesis and mechanism of action - ketamine hydrochloride, methohexital sodium, fentanyl citrate, tribromo ethanol.

3.4 Sedative and Hypnotics-Classification, synthesis and mechanism of action- pheno barbital, amobarbital, thiopental sodium and structure-activity relationship.

UNIT - IV Essential and Trace Elements in Biological Systems

4.1 Electronic structure and functions, essential elements in diet, metal deficiency and disease, concentration and physiological effect, toxicity of mercury, cadmium, chromium, lead, beryllium, selenium and arsenic.

4.2 Metals used in diagnostic and chemotherapy-metal activation of organic drugs, radio diagnostic agents, Magnetic Resonance Imaging (MRI) and photo chemotherapeutic metallodrug.

UNIT - V Inorganic Pharmaceuticals

5.1 Chelation therapy, Metallodrugs as antimicrobial, antiulcer, antiviral, anti-inflammatory, antiparasitic, antiarhritic, antidiabetic, cardio vascular and insulin-mimetic agents.

5.2 Anticancer drug - Pt, Ru and other metal complexes.

5.3 Metallodrug for neurological, gastrointestinal, and overload disorder.

Text Books

1. Ashutosh Kar, **Medicinal Chemistry**, New Age International, 1996.
2. W.O. Foye, **Principles of Medicinal Chemistry**, Second Edition, Lea & Febiger, Philadelphia, 1981.
3. L.M. Artherden, **Bentley and Driver's Textbook of Pharmaceutical Chemistry**, Eighth Edition, Oxford University Press, New Delhi, 2003.

4. J.H. Block, E. Roche, T.O. Soin, C.O. Wilson, **Inorganic Medicinal & Pharmaceutical Chemistry**, First Edition, Varghese Publishing House, Mumbai, 1986.
5. K.S. Rao and C.V. Suresh, **Pharmaceutical Inorganic Chemistry**, Pharma Med Press, 2011.
6. A.V. Kasture, S.G. Wadodkar, **Pharmaceutical Chemistry-I**, Nirali Prkashan, Twenty Fifth Edition, 2008.
7. V.N. Rajasekaran, **Text Book of Pharmaceutical Inorganic Chemistry Theory and Practical**, Second Edition, Sun Publication, Chennai, 2005.
8. J. Ghosh, **A Text book of Pharmaceutical Chemistry**, S. Chand, Third Edition, 2003.

Reference Books

1. G.R. Chatwal, **Pharmaceutical Chemistry Inorganic**. Third Edition, Himalaya publishing house, Mumbai, 2010.
2. T.O. Soine, C.O. Wilson, **Roger's Inorganic Pharmaceutical Chemistry**, Fourth Edition, Lea & Febiger, Philadelphia, 1948.
3. G.L. Miessler, D.A. Tarr, **Inorganic Chemistry**, Pearson Education, 2005.
4. S.J. Lippard, Berg, **Principles of Bioinorganic Chemistry**, Univ. Science Books, 1994.
5. J. A. Cowan, **Inorganic Biochemistry**, Wiley-VCH, New York, 1997.
6. N.V. Chenchu Lakshmi, **Pharmaceutical Inorganic Chemistry: Theory and Practice**, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
7. M.E. Wolff, **Burger's medicinal chemistry**, Fourth Edition, John Wiley & Sons, New York, 1981.
8. F.F. Blicke, R.H. Cox, **Medicinal Chemistry**, John Wiley & Sons, New York, 1959.
9. D. Lednicer and L.A. Mitscher, **Organic Chemistry of Drug Synthesis**, John Wiley & Sons, New York, 1959.
10. J.E. Hoover, **Remington's Pharmaceutical Sciences**, Fifteenth Edition, Mack Publ.Company, Easton, 1975.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	M	M
CO2	M	S	S	S	M
CO3	S	M	S	S	M
CO4	M	M	S	S	S
CO5	M	S	M	M	S

S- Strong; **M**-Medium

22UPCHE3E02 ENVIRONMENTAL CHEMISTRY

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

1. To understand the fundamentals of environmental chemistry.
2. To study water, soil and hazardous wastes.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	understand the fundamentals of environmental chemistry.	K1, K2 & K3
CO2	understand the water pollutants and purification techniques.	K2, K3 & K4
CO3	study the impact of chemical composition in atmosphere.	K2, K3 & K4
CO4	understand the impact of chemical components & pollutants in soil.	K2, K3 & K4
CO5	know the detailed issues of hazardous chemicals in environmental.	K2, K3 & K4

UNIT - I Fundamentals

Concept and scope of environmental chemistry, Origin and development of elements.

Natural Cycles - Hydrological cycle, Carbon cycle, Oxygen cycle, Nitrogen cycle, Phosphorus cycle and sulphur cycle. Natural and Man-made Disasters - Recent natural disasters and their case studies.

UNIT - II Water Chemistry

Properties of water, nature of metal ions in water, solubility of gases in water. occurrence of chelating agents in water and microorganisms. The catalyst of aquatic chemical reactions. Water pollution and its effects, Eutrophication concept of DO, BOD and COD, International standards of drinking water. sampling techniques for water.

Water resources - Properties of water, nature of metal ions in water, solubility of gases in water, occurrence of chelating agents in water and microorganisms. The catalyst of aquatic chemical reactions, source of water pollutants and its effects, eutrophication

concept of DO, BOD and COD. Waste water treatment, international standards of drinking water and sampling techniques for water.

UNIT - III Atmospheric Chemistry

Structure and composition of atmosphere. Gaseous organic and inorganic pollutions in the atmosphere. Environmental ethics - Function, problem and solution to environmental problems. Climate - causes and effect of climate change. Chemical and photochemical reactions in the atmosphere. Green house effect, Global warming, Acid rain, Ozone layer depletion, Photochemical smog and control methods for removing particulates from exhaust gases.

UNIT - IV Soil Chemistry

Inorganic and organic components of soil. Nitrogen pathways. NPK in soils, Toxic chemicals in the environment - pesticides and their toxicity. Industrial wastes. Strategies to control soil pollution. Biochemical aspects of arsenic, cadmium, lead and mercury. Sampling techniques for soil.

UNIT - V Hazardous Wastes

Environmental chemistry of hazardous wastes - hazardous wastes in hydrosphere, geosphere and atmosphere. Industrial production of hazardous wastes and health effects of hazardous wastes. Nuclear radioactive wastes - anthropogenic sources and effects of radioactive pollution. Strategies to control environmental pollution. Solid waste management - causes, effects and control measures of wastes. Green chemistry in day-to-day life. Energy from wastes – Water based biomass and biogas.

Text Books

1. Sharma and Kaur, **Environmental Chemistry**, Krishna Publishers, New Delhi, 2000.
2. A.K. De, **Environmental Chemistry**, Wiley Eastern Ltd, New Delhi, 2014.
3. S.E. Manahan, **Environmental Chemistry**, Lewis Publishers, London, 2001.
4. S.K. Banerji, **Environmental Chemistry**, Prentice Hall of India, New Delhi, 2005.
5. S.C. Bhatia, **Environmental Chemistry**, CBS Publishers, 2003.

Reference Books

1. J. Rose, **Environmental Toxicology**, Gordon and Breach Science Publication, New York, 1998.
2. S. Ladsberger, Creatchman (Ed.), **Elemental Analysis of Airborne Particles**, Gordon and Breach Science Publication New York, 1998.
3. S.M. Khopkar, **Environmental Pollution nalysis**, Wiley Eastern, New Delhi, 1994.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	M	M	S	M	M
CO2	M	M	S	M	S
CO3	M	M	S	M	M
CO4	M	M	S	M	S
CO5	M	M	S	M	S

S- Strong; **M**-Medium.

22UPCHE3E03 NANOMATERIALS CHEMISTRY

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

1. To learn about the fundamentals of nanomaterials.
2. To study the various preparation techniques for the fabrication of nanostructure.
3. To apply the characterization techniques to assess nanomaterials.
4. To evaluate the specific properties of the nano particles.
5. To provide knowledge on various application of nanomaterials.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	explain the basic concepts, definitions and significance of nanoscience. Get in depth knowledge on classifications of nanomaterials.	K1, K2 & K3
CO2	apply knowledge and demonstrates the various fabrication techniques of nanomaterials.	K2, K3 & K4
CO3	learn practical competence in principles and functions of nanomaterials using different characterization devices.	K2, K3 & K4
CO4	understand the physical, chemical and surface properties of the nanomaterials.	K2, K3 & K4
CO5	recognize various applications of nanomaterials and various fields.	K2, K3 & K4

UNIT - 1 Fundamentals

Nanoscale Science and Technology - Introduction and implications for physics, chemistry, biology and engineering. Definition of nanostructures. Nanomaterials - Size and scale, units, scaling, atoms, molecules, clusters and supramolecules. Classifications of nanostructured materials. Structure and bonding in nanomaterials - chemical bonds, intermolecular forces. Molecular and crystalline structure, hierarchical structures. Bulk to

surface transition, surface reconstruction. Challenges in nanotechnology. Quantum dots, nanowires-ultrathin films, multilayered materials.

UNIT - II Fabrication

Introduction to synthesis of nanostructured materials - bottom-up approach and top-down approach. Sol gel synthesis, Ceramic processing, lithographic, machining process, mechanical alloying, milling and self assembly. Bio-inspired synthesis: Green and biological synthesis of metal nanoparticles - Gold, silver and copper. Advanced deposition techniques - electrochemical deposition, chemical vapor deposition, physical vapor deposition, galvanic deposition, spin coating, Langmuir-Blodgett growth. Advantages and disadvantages of the methods.

UNIT - III Characterization

Characterization Tools and usage. Spectroscopic techniques - UV-Visible spectroscopy, FT-IR spectroscopy. Surface analysis - SEM, TEM, AFM. Diffraction analysis - powder X-ray Diffractometry, Photo luminescence spectroscopy and X-ray Photoelectron spectroscopy. Size and charge determination of nanomaterials.

UNIT - IV Properties of Nanomaterials

Physical and chemical properties. Aggregation and disaggregation-Surface Properties - Zeta Potential, Surface Plasma resonance. Optical Properties, Quantum Confinement. Magnetic, mechanical, thermal and photocatalytic properties.

UNIT - V Applications

Biomedical Application- Nanoprobes in medical diagnostics and biotechnology, Nano medicines, Targeted drug delivery, nanosensors. Applications of biomaterials - Short term and long term applications in medicine. Nanoparticles for sunbarrier products. Application of nanoparticles in photostat, printing, solar cell, batteries. Information storage, Nano computer, molecular switch, super chip, nanocrystal. Fuel cells and energy storage devices.

Text Books

1. A. Jones, M. Mitchell, **Nanotechnology-Commercial Opportunity**, Evolution Capital Ltd., London, 2001.
2. G. Schmid (Eds), **Nanoparticles**, Wiley-VCH, 2004.
3. G. Hodes (Eds.), **Electrochemistry of Nanomaterials**, Wiley-VCH, 2001.
4. M. Kohler, W. Fritzsche, **Nanotechnology**, Wiley-VCH, 2004.
5. T. Pradeep, **Nano: The Essentials**, Tata McGraw Hill, 2007.

References Books

1. M. Wilson, K. Kannangara, G. Smith, M. Simmons, B. Raguse, **Nanotechnology**, Overseas Press, 2005
2. C.N.R. Rao, A. Muller, A.K. Cheetham (Eds.), **The Chemistry of Nanomaterials** Vol. I & II, Wiley-VCH, 2004.
3. P. Ajayan, L.S. Schadler, P.V. Brawn, **Nanocomposite Science and Technology**, Wiley-VCH, 2003.
4. A.S. Edelstein, R.C. Cammarata, **Nanomaterials: Synthesis, Properties and Applications**, Institute of Physics Publication, 1998.
5. G. Cao, **Nanostructures & Nanomaterials: Synthesis, Properties & Applications**, Imperial College Press, 2004.
6. G.A. Ozin, A.C. Arsenault, **Nanochemistry: A Chemical Approach to Nanomaterials**, Royal Society of Chemistry, 2005.
7. J. I. Gersten, **The Physics and Chemistry of Materials**, Wiley, 2001.
8. K. W. Kolasinski, **Surface Science: Foundations of Catalysis and Nanoscience**, Wiley, 2002.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	S
CO2	M	S	S	S	S
CO3	S	M	M	M	M
CO4	M	M	S	S	S
CO5	S	S	M	M	M

S- Strong; **M**-Medium.

22UPCHE3E04 SUPRAMOLECULAR CHEMISTRY

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

1. To understand basics of supramolecular chemistry.
2. To gain knowledge on host-guest interactions.
3. To obtain knowledge in crystal engineering.
4. To know about the supramolecules by self-assembly.
5. To understand the bio mimics.

Course outcomes

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

CO No.	CO Statement	Knowledge Level
CO1	understand the nature of interactions in supramolecular structures	K1, K2 & K3
CO2	know the preparation of supramolecules using host-guest concepts	K2, K3 & K4
CO3	get an idea on various interactions in the coordination polymers and metal organic frameworks	K2, K3 & K4
CO4	understand the formation of supramolecules by self- assembly	K3, K4 & K5
CO5	know the applications of supramolecular chemistry in various areas	K3, K4 & K5

UNIT - I Basic Concepts

Terminology and nomenclature in supramolecular chemistry, definition of supramolecular chemistry, chemical interactions leading to supramolecular assemblies. Nature of binding interactions in supramolecular structures - ion-ion, ion-dipole, dipole-dipole, H-bonding, cation-pi, anion-pi, pi-pi and Van der Waals interactions.

UNIT - II Host-Guest Chemistry

Synthesis and structure of crown ethers, lariat ethers, podands, cryptands, spherands, calixarenes, cyclodextrins, cyclophanes, cryptophanes, carcerands, and hemicarcerands. Host-guest interactions- pre-organization and complimentarity, lock and key analogy, binding of cationic, anionic, ion pair and neutral guest molecules.

UNIT - III Crystal Engineering

Engineering - role of H-bonding, halogen bonding and other weak interactions,

Co-crystals, salts, polymorphs and their physico-chemical properties. Coordination polymers, metal organic frameworks and their properties.

UNIT - IV Self-Assembly

Self-assembly of molecules - Design, synthesis and properties of the molecules, self assembling by H-bonding, Metal-ligand interactions and other weak interactions, Metallomacrocycles, catenanes, rotaxanes, helicates and knots. Examples of recent developments in supramolecular chemistry.

UNIT - V Molecular Devices

Molecular electronic devices, molecular wires, molecular rectifiers, molecular switches, molecular logic. Relevance of supramolecular chemistry to mimic biological systems - cyclodextrins as enzyme mimics, ion channel mimics, supramolecular catalysis.

Text Books

1. Jonathan W. Steed, Jerry L. Atwood, **Supramolecular Chemistry**, WILEY, Third Edition, 2022.
2. Katsuhiko Ariga, Toyoki Kunitake, **Supramolecular Chemistry-Fundamentals and Application**, Springer, 2006.
3. J.W. Steed, J.L. Atwood, **Supramolecular Chemistry**, First Edition, Wiley, 2000.
4. J.W. Steed, **Core Concepts in Supramolecular Chemistry and Nanochemistry**, First Edition, John Wiley & Sons, 2007.
5. J.D. Seader, I.W. Hamley, **Introduction to Soft Mater Synthetic and Biological Self Assembly Materials**, **Separation Process Principles**, Second Edition, Wiley, 2010.
6. G.R. Desiraju, J.J. Vittal, A. Ramanan, **Crystal Engineering: A Textbook**, World Scientific, 2011.

Reference Books

1. J.M. Lehn, **Supramolecular Chemistry-Concepts and Perspectives**, Wiley-VCH, 1995.
2. P.D. Beer, P.A. Gale, D.K. Smith, **Supramolecular Chemistry**, Oxford University Press, 1999.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	M	M	S	S	M
CO2	S	S	M	S	M
CO3	M	M	S	M	M

CO4	S	M	S	S	S
CO5	S	S	M	S	M

S- Strong; **M**-Medium.

22UPCHE3E05 CHEMICAL BIOLOGY

Hours	L	T	P	C
30	3	1	0	4

Course Objectives

1. To learn the various protein and their structure.
2. To understand the biological membrane and fluorescent molecules.
3. To understand the nuclic acid and its biological process.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	understand the structure of proteins.	K1, K2 & K3
CO2	learn synthesis of proteins.	K2, K3 & K4
CO3	understand the biological membrane and its importance.	K2, K3 & K4
CO4	learn about the fluorescence markers.	K3, K4 & K5
CO5	understand the function and structure of nucleic acids	K3, K4 & K5

UNIT I Introduction

Chemical biology - Definition, history. peptide and protein: amino acids, peptides, primary, secondary, tertiary, and quaternary structure of proteins, protein folding.

UNIT II Protein Synthesis

Protein Synthesis - Biosynthesis, chemical synthesis, solid phase peptide synthesis, strategy of combinatorial synthesis, combinatorial solid phase synthesis of antibiotics. Lipids, fatty acids, bilayer, lipidation of proteins and peptides, farnesylation of the Ras protein.

UNIT III Biological Membranes

Insertion of lapidated peptides into model membrane - biological membranes, transport across membranes, model membrane, biophysical properties of lipidated peptides in model membranes,

UNIT IV Fluorescent Molecules

Basic concepts of fluorescence and fluorescence markers, synthesis of vesicles containing fluorescence quencher and lapidated peptides.

UNIT V Nucleic Acids

Nucleic acids - Base pairing, double helices, DNA replication, genetic

information storage, transmission and gene expression, chemical synthesis of oligonucleotides, hybridization with synthetic oligonucleotides. Peptide nuclic acids (PNAs) - synthesis of PNAs, doubly labeled PNAs as probes for the detection of point mutations. Use of small molecules to link a protein target to a cellular phenotype and as probes for biological processes.

Text Books:

1. H. Waldmann, P. Janning, **Chemical Biology: A practical course**, First Edition, Wiley – VCH Verlag GmbH & Co, 2004
2. C.M. Dobson, J.A. Gerrard, A.J. Pratt, **Foundations of Chemical Biology**, Oxford Univ. Press. 2002.
3. J. M. Berg, J. L. Tymoczko, L. Stryer, **Biochemistry,** New York:W. H. Freeman, 2007.

Reference Books:

1. L. Schreiber, T. Kapoor and G. Wess, **Chemical Biology: From Small Molecules to Systems Biology and Drug Design**, Vol.-1, Wiley – VCH Verlag GmbH & Co. 2007.
2. Banafshe Larijani, Colin A. Rosser, Rudiger Woscholski, **Chemical Biology: Application and Techniques,** John Wiley & Sons Ltd. England, 2006
3. Lehninger, Nelson, Cox, **Principles of Biochemistry**, CBS Publishers, 1993.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	M	M	M	S	S
CO2	M	S	S	M	M
CO3	S	M	M	S	M
CO4	M	M	S	M	S
CO5	M	S	M	M	S

S- Strong; **M**-Medium.

22UPCHE3E06 GREEN CHEMISTRY

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

1. To understand the theory, principles and applications of green chemistry.
2. To gain awareness on the green practices in the laboratory.
3. To obtain skill in green practices.
4. To carry out green experiments in the place of conventional experiments.

Course outcomes

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

CO No.	CO Statement	Knowledge Level
CO1	understand the need for green chemistry and get an idea on the twelve principles of green chemistry.	K1, K2 & K3
CO2	get an idea on the reactions under solvent free Conditions and under greener solvents leading to greener protocols.	K3, K4 & K5
CO3	familiarize with the use of catalysts for chemical conversions leading to waste free environment.	K3, K4 & K5
CO4	know the newer techniques used for waste water treatment.	K3, K4 & K5
CO5	use the green chemistry principles in microwave and ultra sound assisted reactions	K3, K4 & K5

UNIT - I Introduction

Green Chemistry - Need for green chemistry, origin and history of green chemistry, Twelve principles - Scope of green chemistry. Inception and awards.

UNIT - II Solvent Free Reactions

Planning a green synthesis in a chemical laboratory - Solvent-less reactions, Selection of appropriate solvent. Functional group transformations, protection and deprotection reactions, condensation reactions, reduction and oxidation.

Ionic liquids - Synthesis of ionic liquids and applications in organic synthesis. Super critical fluids.

UNIT - III Catalysis as Green Technique

Homogeneous verses heterogeneous catalysis. Solid acid catalysis, Heterogenised reactions - Solid supported catalysts. Biocatalysts - Modified biocatalysts. Transition metal catalysts - Supported metal catalysts.

UNIT - IV Alternative Treatment Technologies

Oxidation at ambient conditions for waste water treatment, Photocatalytic reactions, Electrocatalytic reactions. Fentons chemistry - Hybrid processes. Chemical methods for dye removal, Oxidative processes, Physical treatments, Biological treatments.

UNIT - V Microwave and Ultrasonic Reactions

Microwave assisted organic synthesis - Principle, conventional Vs microwave heating, advantages, microwave assisted reactions. Solvent free reactions - microwave assisted synthesis of heterocyclic compounds (synthesis of pyrimidine and pyridine derivatives). Ultrasound assisted green synthesis - Introduction, instrumentation, the phenomenon of cavitation. Sonochemical esterification, substitution, addition, alkylation, oxidation, reduction and coupling reactions.

Text Books

1. Sanjay Kumar Batra, Shefali Shula, Shikha Gulati, **A Textbook of Green Chemistry: Benign by Design**, Shree Kala Prakshan, 2020.
2. Indu Tucker Sidhwani, Rskesh K. Sharma, **An Introductory Text on Green Chemistry**, Wiley.2020.
3. V. Kumar, **An Introduction to Green Chemistry**, Vishal Publishing Co, 2013.
4. P.T. Anastas, T.C. Williamson (Eds.) **Green Chemistry: Frontiers in Chemical Synthesis and Processes**, Oxford University Press, Oxford, 1985.

Reference Books

1. Rashmi Sanghi, M.M. Srivastava (Eds.), **Green Chemistry - Environment Friendly Alternatives**, Narosa Publishing house, New Delhi, 2003.
2. P.T. Anastas, J.C. Warner, **Green Chemistry: Theory and Practice**, Oxford Science Publications, Oxford, 1998.
3. P. Tundo, P.T. Anastas (Eds.) **Green Chemistry: Challenging Perspectives**, OxfordUniversity Press, Oxford, 2000.
4. P.T. Anastas, T.C. Williamson (Eds.) **Green Chemistry: Frontiers in Chemical Synthesis and processes**, Oxford University Press, Oxford, 1985.
5. A.S. Matlach, **Introduction to Green Chemistry**, Marcel Decker Inc. New York, 2001.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5

CO1	M	S	M	S	M
CO2	S	S	M	S	M
CO3	S	M	S	S	M
CO4	S	M	S	S	S
CO5	S	S	M	M	M

S- Strong; **M**-Medium.

22UPCHE3E07 NATURAL PRODUCTS CHEMISTRY

Hours	L	T	P	C
72	3	1	0	4

Objectives

1. To understand the structure and synthesis of carbohydrates, terpenoids and flavonoids.
2. To know the structural elucidation of alkaloids and steroids.

Course Outcomes

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

CO No.	CO Statement	Knowledge Level
CO1	know the structure of carbohydrates	K2 & K3
CO2	understand the structure and synthesis of some terpenoids	K2, K4 & K5
CO3	understand the structure and synthesis of flavonoids and isoflavonoids	K3, K4 & K5
CO4	understand the nature and structural elucidation of alkaloids	K3, K4 & K5
CO5	know the structure of steroids and a few hormones of biological interest	K2, K3 & K4

UNIT - I Carbohydrates

Carbohydrate - Introduction, definition and classification. Monosaccharides – configuration of aldotrioses, aldotetroses, aldopentoses, aldohexoses, ketohexoses. Deoxy-sugars - Ring structure of monosaccharides. Mechanism of mutarotation and anomeric effect. A brief introduction on the structure of disaccharides (sucrose and maltose as representative examples) and polysaccharides (starch, cellulose and cyclodextrins as representative examples).

UNIT - II Terpenoids

Terpenoids - Occurrence, classification and isoprene rule; Monoterpenoids - Structure elucidation and total synthesis of citral, α - terpineol, camphor and α - pinene.

UNIT - III Flavonoids and Isoflavonoids

Occurrence, nomenclature and general methods of structure determination. Isolation and synthesis of apigen, quercetin, and daidzein. Biological importance of flavonoids and isoflavonoids

UNIT - IV Alkaloids

Introduction, classification and general characteristics Structural elucidation and

synthesis of nicotine, caffeine, atropine, quinine and morphine.

UNIT - V Steroids

Introduction, structural elucidation of cholesterol, bile acids and ergosterol. Sex hormones and corticosteroids: Brief discussion on homosteroids, norsteroids and oral contraceptives.

Text Books

1. I.L. Finar, **Organic Chemistry, Vol.II**, Fifth Edition, Pearson Education Asia Pvt. Ltd. 2000.
2. Atta-Ur-Rahman, M.I. Choudhary, **New Trends in Natural Product Chemistry,** Gordon & Breach Science Publishers, First Edition, 1998.
3. A.R. Pinder, **The Chemistry of Terpenes**, Chapman and Hall, 1960.
4. K.W. Bentley, **The Natural Pigments**, Interscience, 1960.
5. L.F. Fisher, M. Fisher, **Steroids**, Reinhold, 1959.

Reference Books

1. S.W. Pelletier, Van Nostrand, **Chemistry of Alkaloids**, Reinhold, 1970.
2. A.A. Newman (Ed.), **Chemistry of Terpenes and Terpenoids**, Academic Press, London, 1972.
3. T.A. Hendry, **The Plant Alkaloids**, Churchill Publishers, Fourth Edition 1949.
4. W. Templeton, **An Introduction to the Chemistry of Terpenoids and Steroids**, Butterworth & Co Publishers Ltd, 1969.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	M	S	S	S	M
CO2	S	S	M	S	M
CO3	M	S	S	S	M
CO4	S	M	S	S	S
CO5	S	S	M	S	M

S- Strong; **M**-Medium.

22UPCHE3E08 INSTRUMENTAL METHODS OF ANALYSIS

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

1. To understand the concepts and instrumentation of micro wave spectroscopy.
2. To learn the background aspects of the vibrational spectroscopy.
3. To study the theory, principles and instrumentation of absorption spectroscopy.
4. To provide the basic knowledge on the emission spectroscopy.
5. To grasp the basic concepts and theory of polarography and amperometry.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	understand the basic theory, selection rules and instrumentation of rotational spectroscopy in atoms and molecular level.	K2, K3 & K4
CO2	get in depth knowledge and understanding the fundamental concepts, principles and instrumentation of vibrational spectroscopy.	K2, K3 & K4
CO3	get the knowledge on the principles, Elementary theory and instrumentation of atomic absorption spectroscopy.	K2, K3 & K4
CO4	describe the theory, principles and instrumentation of Atomic, Flame and Plasma emission spectroscopy. Explain the applications and limitations of the spectroscopy.	K2, K3 & K4
CO5	get knowledge on theory, principles, apparatus of polarography and amperometry titrations.	K2, K3 & K4

UNIT - I Rotational Spectroscopy

Micro wave spectroscopy- Theory, selection rules, Instrumentation, Energy levels in atoms and molecules. Fourier transformation Rotational spectra of diatomic and polyatomic molecules– P, Q, R branches- effect of isotopic substitution.

Non-rigid rotator- Linear molecules, Effect of isotopic substitution on the transition frequencies, Linear and nonlinear polyatomic molecules. Relative intensities of spectral lines, Stark effect. Theory and applications of Rotational Raman spectroscopy.

UNIT - II Vibrational Spectroscopy

Vibrational spectra of diatomic molecules – Theory, Instrumentation, Zero point

energy, Anharmonicity. Vibration - Rotation spectroscopy - Selection rules, Overtones, combination and hot bands, Factors influencing vibrational frequencies.

Fermi resonance energy of diatomic molecule- simple harmonic and unharmonic oscillator. Rotational character of vibration spectra- Theory and applications of Vibrational Raman spectroscopy.

UNIT - III Atomic Absorption Spectroscopy

Atomic Absorption spectroscopy (AAS) – Principles, elementary theory and instrumentation. Flames, nebulizer burner system, non-flame techniques, resonance line sources, detectors, chemical interferences and applications. Photometric titration.

Atomic Fluorescence spectroscopy (AFS) – Instrument of fluorimetry. Turbidimetry and nephelometry.

Flame photometry – Principles, theory, instrumentation, advantage and disadvantage of flame photometry and a few important applications.

UNIT – IV Atomic Emission Spectroscopy

Atomic emission spectroscopy (AES)– Principles, theory, instrumentation, advantage and disadvantage of AES, origin of spectra, measurement of light intensity, applications of emission spectroscopy.

Flame emission spectroscopy (FES) – Principles, instrumentation, evaluation methods in flame photometry, factors affecting intensity of emitted radiation, limitation and applications of Flame photometry.

Plasma emission spectroscopy (PES) – Principle, instrumentation, process of atomization and excitation, direct current and inductively coupled plasma, sample introduction, application, ICP-AES- instrumentation and its applications.

UNIT - V Polarography and Amperometry

Polarography- Theory, apparatus, DME, diffusion kinetic catalytic currents, current voltage curves for reversible and irreversible systems, qualitative and quantitative applications to inorganic system.

Amperometric titrations- Theory, apparatus, types of titration curves, successive titrations and two indicator electrodes, applications.

Text Books

1. G.M. Barrow, **Introduction to Molecular Spectroscopy**, Mc Graw Hill, New York, 1962.
2. J.R. Dyer, **Application of Absorption Spectroscopy of Organic Compounds**, Prentice Hall of India Pvt. Ltd., New Delhi, 1965.

3. W. Kemp, **Organic Spectroscopy**, ELBS, New Delhi, 1982.
4. D.A. Skoog, D. M. West, F. J. Holler, S. R. Crouch, **Fundamentals of Analytical Chemistry**, Thomson Asia Pvt. Ltd., Singapore, Eighth Edition, 2004.
5. Willard, Merit, Dean, Settle, **Instrumental Methods of Analysis**, CBS Publishers and Distributors, Fourth Edition, 1989.
6. J. Bassett, R.C. Denny, G. Jeffery and J. Mendham. **Vogel's text book of inorganic Quantitative analysis**, Fourth Edition, Longman group Ltd, Harlow, 1985.
7. D.J. Pietrazyk, C.W. Frank. **Analytical Chemistry**, 1990.
8. H. Kaur, **Instrumental Methods of Chemical Analysis**, Pragati Prakashan Meerut, Tenth Edition, 2014.
9. C.N. Banwell, E.M. McCash, **Fundamentals of Molecular Spectroscopy**, Tata McGraw-Hill, Fourth Edition, 2017.

Reference Books

1. D.A. McQuarrie, **Quantum Chemistry, University Science Books**, MilValley, California, 1998.
2. C.N. Banwell, E.M. McCash, **Fundamentals of Molecular Spectroscopy**, Tata McGraw-Hill, Fourth Edition, 2017.
3. D.A. Skoog, D.M. West, **Fundamentals of Analytical Chemistry**, Holt Rinehart and Winston Publications, Fourth Edition, 1982.
4. D.A. Skoog, D. M. West, F. J. Holler, S. R. Crouch, **Fundamentals of Analytical Chemistry**, Thomson Asia Pvt. Ltd., Singapore, Eighth Edition, 2004.
5. D.A. Skoog, **Principles of Instrumental Analysis**, Saunders College Pub. Co, Third Edition, 1985.
6. G. D. Christian, J. O. E. Reilly, **Instrumental Analysis**, Allyn and Bacon Inc, Second Edition, 1986.
7. R. S. Drago, **Physical Methods in Chemistry**, Affiliated East-west press pvt. Ltd, New delhi, 2012.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	M
CO2	M	M	M	S	S
CO3	M	S	S	M	M
CO4	M	M	M	S	S
CO5	S	M	S	M	M

S- Strong; **M**-Medium.

22UPCHE3E09 ADVANCED CHARACTERIZATION TECHNIQUES

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

1. To learn the principle and instrumentation of surface analysis techniques.
2. To explore various microscopic techniques for surface analysis.
3. To learn the fundamentals of qualitative and quantitative analysis.
4. To study the principle and instrumentation of chromatographic techniques.
5. To learn the principle and instrumentation of thermal analysis techniques.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	explore the basic description and instrumentation of electronic spectroscopy.	K1, K2 & K3
CO2	understand the basics of electron microscopic techniques and explore the adequate knowledge on instrumentation.	K1, K2 & K3
CO3	get in depth knowledge on the qualitative and quantitative analysis.	K2, K3 & K4
CO4	acquire knowledge on chromatographic techniques and its separation procedures.	K2, K3 & K4
CO5	comprehend the basic theories and instrumentation of thermo gravimetric analysis.	K2, K3 & K4

UNIT - I Surface Analysis Methods

Introduction, types of surface measurements. Photon Probe Techniques. X-Ray Photoelectron spectroscopy - Principle, instrumentation, applications.

X-ray powder diffraction - single crystal diffraction techniques, determination of accurate lattice parameters, structure analysis, profile analysis, particle size analysis using Scherer formula.

UNIT - II Electron Microscopic Techniques

Principles, instrumentation and application of Electron microscopes - Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Scanning

transmission electron microscopy (STEM), Scanning probe microscopy (SPM) - Scanning tunneling microscopy (STM), Atomic manipulations, Atomic force microscopy (AFM).

UNIT - III Qualitative and Quantitative Analysis

Principles, instrumentation and applications of Electron energy loss spectroscopy, High resolution imaging techniques, Atom probe field ion microscopy, Focused ion beam techniques, X-ray fluorescence (XRF) - EDAX and WDA analysis.

UNIT - IV Chromatography

Gas liquid chromatography (GLC) – Theory, instrumentation and applications of GLC, Sample injection, Column types, Solid/liquid stationary phases, Column switching techniques, Gas chromatographs - chemical analysis, carrier gas. Detectors - flame ionization and electron capture and few applications of GLC.

High performance liquid chromatography (HPLC)- Principles, instrumentation and application of HPLC. Optimization of column performance, gradient elution, mobile phase delivery system, sample injection, column separation and detectors.

UNIT - V Thermal Methods of Analysis

Thermogravimetry (TGA) - Theory, instrumentation and TG study of oxalates and chromates.

Differential thermal analysis (DTA) - Principle, instrumentation and applications with special reference to the clays, minerals & coals (fuels).

Differential Scanning Calorimetry (DSC) - Principle, instrumentation and applications to inorganic materials like chlorates and per chlorates, ammonium nitrate. Interpretation of various thermal analysis curves.

Text Books:

1. R.A. Day, A.L. Underwood, **Quantitative Analysis**, Prentice-Hall of India Pvt. Ltd., 1985.
2. D.A. Skoog, D.M. West, **Fundamentals of Analytical Chemistry**, Fourth Edition, Philadelphia : Saunders College Pub 1982.
3. Jr. L.L. Merritt, J.A. Dean, Jr. F.A. Settle, **A Instrumental Methods of Analysis**, C.B.S Publishers and Distributors, Seventh Edition, 1992.

Reference Books:

1. C. F. Banwell, **Fundamentals of Molecular Spectroscopy**, Fourth Edition, McGraw Hill, New York, 2017.

2. D.A. Skoog, D.M. West, **Fundamentals of Analytical Chemistry**, Holt Rinehart and Winston Publications, Fourth Edition, 1982.
3. D.A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, **Fundamentals of Analytical Chemistry**, Thomson Asia Pvt, Ltd., Singapore, Eighth Edition, 2004.
4. D.A. Skoog, **Principles of Instrumental Analysis**, Saunders College Pub. Co., Third Edition, 1985.
5. G.D. Christian, J.E.O. Reilly, **Instrumental Analysis**, Allyn and Bacon Inc, Second Edition, 1986.
6. R.S. Drago, **Physical Methods in Chemistry**, Reinhold, New York, 1968.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	M	M	S	M	S
CO2	S	S	M	S	M
CO3	S	S	S	M	S
CO4	M	M	S	S	S
CO5	S	S	M	M	M

S- Strong; **M**-Medium.

22UPCHE3E10 POLYMER CHEMISTRY

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

1. To learn about polymers, types and basic concepts of polymerization.
2. To study the principles of polymer reactivity and stereochemistry of polymerization.
3. To develop background knowledge and core expertise in mechanism of polymerization.
4. To learn the fundamentals of polymer processing techniques.
5. To evaluate the specific properties of the commercial polymers.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	understand the importance, basic concepts and grafting in polymerization reaction.	K1, K2 & K3
CO2	obtain knowledge in the synthesis, properties and applications of various ionic polymers.	K1, K2 & K3
CO3	gain knowledge in kinetics and mechanism of polymerization.	K2, K3 & K4
CO4	demonstrate up-to-date knowledge on the various compound processing techniques of polymers.	K2, K3 & K4
CO5	explain functionality and biomedical behavior of the polymers. Get in depth knowledge on the polymer properties.	K2, K3 & K4

UNIT - I Introduction to Macromolecular Chemistry

Importance, basic concepts, raw materials for polymers, concept of functionality, comparison of chain and step-growth. Examples of polymerization reactions (polyadditions, polycondensations). Constitution of polymers, homopolymers and copolymers, polymer architectures (graft copolymers, hyper branched and dendrimers), configuration and conformation of polymers, coil formation, mobility in polymers.

UNIT - II Ionic and Functional Polymers

Ionic Polymers - Introduction, classification, synthesis, physical properties and applications. Ionomers based on polyethylene, ionomers based on polystyrenes, ionomers based on polytetrafluoroethylene (PTFE), Applications of ionomers in packaging.

Functional Polymers - Conducting polymers, polymeric reagents, polymer supports and catalysts, Photo responsive polymers, polymers in lithography immobilization of Enzymes.

UNIT - III Kinetics and Mechanism of Polymerization

Kinetics and mechanism of stepwise and addition polymerization - Free radicals, cationic and anionic polymerization.

Coordination Polymerization – Kinetics, mono and bimetallic mechanism. Copolymerization - Kinetics, mechanism and evaluation of monomer. Reactivity ratio and rate of copolymerization. Polymerization in homogeneous and heterogeneous systems.

UNIT - IV Processing of Polymers

Polymer Processing – Processing of plastics elastomers and fibres. Compounding processing techniques - calendaring, die casting, rotational casting, film casting, injection moulding, blow moulding, extrusion moulding, thermoforming, foaming, reinforcing and fibre spinning.

UNIT - V Commercial Polymers and their Properties

Polyethylene, polyvinyl chloride, polyamides, polyesters, phenolic resins, epoxy resins and silicone polymers. Functional polymers - Fire retarding polymers, electrically conducting polymers and biomedical polymers.

Molecular weight determination - Determination of molecular weight of polymer by end group analysis, membrane osmometry, vapour phase osmometry, light scattering measurements, viscometry, gel permeation.

Polymer structure and physical properties – crystalline melting point T_m. Determination of T_g. Relationship between T_m and T_g..

Text Books

1. F.W. Billmeyer, **Text Book of Polymer Science**, Third Edition, John Wiley & Sons, New York, 2003.
2. V.R. Gowarker, N.V. Viswanathan, J. Sreedhar, **Polymer Science**, New Age International, New Delhi, 2005.

References Books

1. R. Alcock, F.W. Lamber, **Contemporary Polymer Chemistry**, Prentice Hall, 1981.
2. K.L. Choy, **Process Principles and Applications of Novel and Cost-effective SAVD Based Methods**, World Scientific Publishing, Singapore, 2002.
3. A. Jones, M. Mitchell, **Nanotechnology-Commercial Opportunity**, Evolution Capital Ltd., London, 2001.
4. P.J. Flory, **Principles of Polymer Chemistry**, Cornell University Press, New York, 1953.
5. G. Odian, **Principles of Polymerization**, Second Edition, John Wiley & Sons, New York, 1981.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	M	S	S	S	S
CO2	S	M	M	S	M
CO3	S	M	M	M	S
CO4	M	S	S	S	S
CO5	M	S	S	M	M

S- Strong; **M**-Medium.

SUPPORTIVE COURSES

22UPCHE3S01 CHEMISTRY AND HEALTH

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

1. To know the essentials of health and drugs.
2. To learn the functions of enzymes, hormones and body fluids.
3. To know the common diseases and their treatment.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	understand the basic concepts of organic chemistry.	K1, K2 & K3
CO2	understand the biomolecules and their importance.	K1, K2 & K3
CO3	understand the impact of chemicals on health.	K2, K3 & K4
CO4	learn about the measurement of chemicals in human bodies	K3 & K4
CO5	understand the influence of chemicals on health.	K2, K3 & K4

UNIT - I Introduction

Fundamental chemical concepts including atomic composition, chemical bonding and chemical forces, and organic chemistry.

UNIT - II Biomolecules

Concepts related to biological molecules such as nucleic acids, proteins, lipids, and carbohydrates. Discussion on chemicals and chemical processes involved in living systems. Types of enzymes and enzyme action, Characters of hormones action, examples of essential hormones.

UNIT - III Health and Toxicology

Definition, Food, Food pyramid, Health-hygiene-mal, under and over nutrition,

their causes and remedies, sanitation. Role of chemicals in our bodies-sense of chemicals exposed to bodies, impact of chemicals on our health. Toxicology-study of poisons, review, evaluation and grading.

UNIT - IV Biomonitoring

Measurement of chemicals in our bodies, need for measurements of chemicals. National Biomonitoring Program - translation of national program to the local level - relationship of communities to the government.

UNIT - V Health effects of chemicals

Effects of chemicals on human health - assessing the impact of chemicals on our health - environmental, occupational medicine and epidemiology - assessment of risk and drive policy on chemicals and health.

Text Books

1. Alex V Ramani, **Food Chemistry**, MJP Publishers, Chennai, 2009
2. Jayashree Ghosh, **A Text book of Pharmaceutical Chemistry**, S. Chand and Co.Ltd, 1999.
3. Ashutosh Kar, **Medicinal Chemistry**, Wiley Easterns Limited, New Delhi, 1993.

Reference Books

1. A.C. Deb, **Fundamentals of Biochemistry**, New Central Book Agency, Calcutta, 1994.
2. M. Satake, Y. Mido, **Chemistry for Health Science**, Discovery Publishing House, New Delhi, 2003.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	M	M	M	M
CO2	S	M	M	M	M
CO3	M	M	M	M	M
CO4	M	M	M	S	M
CO5	M	M	M	M	M

S- Strong; **M**-Medium.

22UPCHE3S02 Cosmetic Chemistry

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

1. To familiarise with the basic concepts of cosmetics.
2. To know the theoretical aspect of basic formulations
3. To know the commonly used additives in cosmetic formulations.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	understand the basic concepts of Cosmeceutical and Hair Care products.	K1, K2 & K3
CO2	understand the skin care products.	K1, K2 & K3
CO3	understand the impact of oral care products.	K2, K3 & K4
CO4	learn about the properties of cosmetic products	K3 & K4
CO5	understand the influence of cosmetic problems.	K2, K3 & K4

UNIT - I Cosmeceutical and Hair Care products

Definition of cosmetics as per Indian and EU regulations, Classification of cosmetic and cosmeceutical products. Cosmetic excipients- Surfactants, rheology modifiers, humectants, emollients, preservatives. Classification and application. Hair- Basic structure of hair and hair growth cycle. Conditioning shampoo, hair conditioners, antidandruff shampoo and hair oils. Chemistry and formulation of para-phylene diamine based hair dye. Role of herbs in cosmetics:. Hair care: Henna and amla. Analytical cosmetics: BIS specification and analytical methods for shampoo.

UNIT - II Skin Care Products

Skin Care- Basic structure and function of skin, Principles of formulation and building blocks of skin care products. Face wash, Moisturizing cream, Cold Cream and Vanishing cream. Their relative skin sensory, advantages and disadvantages. Application of these products in formulation of cosmecuticals. sun protection, Classification of Sunscreens and SPF. Aloe and turmeric. **Analytical cosmetics:** BIS specification and analytical methods for skin-cream. and toothpaste.

UNIT - III Oral Care Products

Oral care: Neem and clove. Principles of formulation and building blocks of oral care products. Oral Cavity- Common problems associated with teeth and gums.

Toothpaste for bleeding gums, sensitive teeth. Teeth whitening and mouthwash. BIS specification and analytical methods for toothpaste.

UNIT - IV Properties of cosmetic products

Evolution of cosmeceuticals from cosmetics, cosmetics as quasi and OTC drugs. Principles of cosmetic evaluation. Principles of sebumeter and corneometer. Measurement of TEWL, skin color, hair tensile strength, Hair combing properties. Soaps, and syndet bars. Evolution and skin benefits.

UNIT - V Cosmetic problems

Oily and dry skin causes leading to dry skin, skin moisturisation. Basic understanding of the terms comedogenic, dermatitis. Cosmetic problems associated with hair and scalp - Dandruff, Hair fall causes cosmetic problems associated with skin - blemishes, wrinkles, acne, prickly heat and body odor. Antiperspirants and deodorants- Actives and mechanism of action.

Text books

1. Takeo Mitsu, **New Cosmetic Science**, Elsevier Science Ltd, 1997.
2. Meyer R. Rosen, **Harry's Cosmetology**, IFSCC, Nineth Edition, 2019.
3. C.B. Sagrin, **Cosmetic Science and Technology**, Wiley India Pvt Ltd, Second Edition, 2008.
4. Marc Paye, Andre. O. Barel, **Handbook of Cosmetic Science and Technology**, CRC Press, 2014.

Reference books

1. K.R. Kirtikar, B.D.Basu, **Archeological Survey, Medicinal Plants, Herbs, Plant, Analysis**, 1963.
2. A. P. Purohit C. K. Kokate, S. B. Gokhale, **A Text Book Of Pharmacognosy**, Nlrali Prakashan.
3. Marc Avram, Sandy Tsao, Zeina Tannous, Matthew Avram, **Color Atlas of Cosmetic Dermatology: A Medical and Surgical**, McGraw-Hill Medical, First Edition, 2007.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	M	S	M	M	M
CO2	M	M	S	S	S
CO3	S	M	S	M	M
CO4	M	S	M	S	M
CO5	M	S	M	S	M

S- Strong; **M**-Medium.

22UPCHE3S03 WATER CHEMISTRY

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

1. To understand water pollution and treatment techniques for water purification.
2. To understand the sludge treatment and disposal methods.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	get the knowledge on the analysis and uses of water.	K2 & K3
CO2	understand the water sampling techniques.	K2 & K3
CO3	get an insight about the waste water treatment.	K2, K3 & K4
CO4	get knowledge on industrial waste water treatment and removal of particular organic matters.	K3 & K4
CO5	understand about sludge and disposal treatment.	K2, K3 & K4

UNIT - I Introduction

Physical and chemical characteristics of water, potable water, WTO standard and uses of water. Association between water use and water quality requirements. Water quality parameters and standards. Aquatic environment and impact of waste water discharges on the environment.

UNIT - II Water Pollution

Waste water generation, constituents and characteristics of wastewater. Sampling and preservation. Monitoring techniques and methodologies. Classification of water pollutants - Organic and inorganic pollutants, DO, BOD, COD, TOC, suspended solids and bacteriological measurements. Eutropication of water bodies. Quality standards for wastewater discharges and water bodies.

UNIT - III Water Treatment

Treatment of water for industrial use. Pretreatment - screening, grit removal and prechlorination. Waste water flow rates and waste water composition. Sewage treatment – Primary waste treatment - settling and sedimentation. Secondary water treatment by biological processes, trickling filter process, activated sludge process. Tertiary waste treatment. Physical-chemical treatment of municipal waste water. Chemical treatment - Precipitation, neutralization, adsorption, disinfection and ion-exchange processes.

UNIT - IV Industrial Waste Water Treatment:

Nature of industrial wastewater, preliminary unit processes. Removal of suspended solids, oil, grease, inhibitory substances, pH adjustment, nutrients supplementation, and equalization. Microbes and biological treatment. Reactor configurations. Removal of solids, metals, dissolved organic and inorganic compounds : Electrodialysis, reverse osmosis, phosphorous and nitrogen removal.

UNIT - V Sludge Treatment and Disposal

Solid by-products generated in waste water treatment. Relationships in sludge – solids levels, concentration and flow. Sludge treatment stages - Thickening, stabilization, dewatering and disinfection. Disposal of the sludge. Design and staging periods of treatment plant. Reuse and recycling of water.

Text books

1. A.K. De, **Environmental Chemistry**, Wiley Eastern, 1989.
2. S.C. Bhatia, **Environmental Chemistry**, CBS Publishers, New Delhi, 2003.
3. S.K. Banerji, **Environmental Chemisty**, Prentice Hall of India, New Delhi, 2003.
4. A.G.S. Reddy, **A Text Book on Water Chemistry: Sampling, Data Analysis and Interpretation**, 2020.
5. C.S. Rao, **Environmental Pollution Control Engineering**, New Age International Pvt Ltd, Fourth Edition, 2021.

Reference books

1. M.V. Sperling, **Wastewater Characteristics, Treatment and Disposal**, IWA Publishing, London, 2007.
2. N.G. Wun Jern, **Industrial Wastewater Treatment**, Imperial College Press, London, 2006.
3. L. Winther, **Wastewater Engineering**, Polyteknisk Forlag, Lyngby, 1978.
4. M. Henze, P. Harremoes, J.C. Jansen, E. Arvin, (Ed.), **Waste Water Treatment**, Springer Verlag, New York, 1995.
5. P. Harremoes, **Water Chemistry**, Polyteknisk Forlag, 1989.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	M	S	M	M	M
CO2	M	M	S	S	S
CO3	S	M	S	M	M
CO4	M	S	M	S	M
CO5	M	S	M	S	M

S- Strong; **M**-Medium.

22UPCHE3S04 INDUSTRIAL CHEMISTRY

Hours	L	T	P	C
72	3	1	0	4

Course Objective

1. To learn the chemical technology and unit operation processes.
2. To learn the synthesis of industrial products.
3. To learn industrial application of chemical compounds.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	Understand the unit operation processes – Evaporation, Distillation and Crystallization	K2 & K3
CO2	learn the water treatment for domestic and industrial purpose	K2 & K3
CO3	learn the industrial application of chemical compounds	K2, K3 & K4
CO4	expertise the various techniques of preparation and increase the yield of the Synthesized compounds	K3 & K4
CO5	understand the raw materials involved in synthesizing industrially important products	K2, K3 & K4

UNIT - 1 Unit Operations

Evaporation - Introduction, principle, Types of evaporation - vacuum, steam heated, open vessel, closed vessel, under reduced pressure.

Distillation - Role of pressure on distillation, vapour - liquid equilibrium, flash distillation, batch distillation, types of equipments and accessories for distillation.

Crystallization - Role of stability. Types of crystallization - atmospheric cooling with stirring, agitated batch crystallization, sensors-Walker crystallization.

UNIT - 2 Water, Fuels and Industrial Gases

Water - water treatment for domestic and industrial purpose

Fuels - Calorific value, requirement of a fuel, type of fuels. Refining crude petroleum, octane number, anti- knocking compound-tetra ethyl lead.

Industrial gases - Coal gas, producer gas, water gas, semi water gas and LPG. Manufacture and industrial application. Bio gas, gobar gas, production, composition, calorific value, renewable nature.

UNIT - 3 Industrial application-1 Glass and Cement

Glass - Commercial glass, composition of glass, properties of glass, raw materials and methods of manufacturing of some special glasses.

Cement - Types, raw materials, manufacture and process of portland cement, setting and hardening of cement, Other cements, gypsum, calcium and magnesium compounds.

UNIT - 4 Industrial application-2 Oils, Soap & Detergents

Essential oils - isolation of essential oils from plants, production of natural perfumes - flower, fruit flavors and artificial flavors. Waxes – Classification, some common waxes - manufacture of candles. Soaps and detergents - manufacture of soap and detergents-action of soap and detergent

UNIT - 5 Fermentation Technology and sugar

Types of fermentation processes - Industrial preparation of alcohol from molasses, preparation of vinegar from alcohol. Composition of alcoholic beverages - spirits, wines and beers.

Sugar and Sugar based chemicals - manufacture of sugar from sugar cane. Sugar industry byproducts – acetic acid, ethyl acetate, oxalic acid, acetic anhydride, furfural from bagasse, citric acid by fermentation (manufacturing process & their industrial applications).

Text Books

1. W.L. Mc. Cab, J.C. Smith, **Unit Operations of Chemical Engineering**, Seventh Edition, 2017.
2. B.K. Sharma, **Industrial Chemistry**, Goel Publishing House Pvt Ltd, 1999.
3. M.G. Arora, M. Singh, **Industrial Chemistry**, Anmol Publications, First Edition, 1994.
4. G.N. Pandey, **A Textbook of Chemical Technology**, Vol. I & II, Vikas Publishing House Pvt Ltd, 1997.
5. John A Monick, **Alcohols, their chemistry, properties and manufacture**. New York, Reinhold Book Corp , 1968.
6. C.C. Furnas (Edition), **Roger's Manual of Industrial Chemistry**, Sixth Edition, Vol.I, D. Van Nostrand Company, Inc, 1948.
7. J.C. Kuriacose, J. Rajaram, **Chemistry in Engineering and Technology**, Vol.-II, Tata Mc. Graw Hill Publishing Company Ltd., New Delhi, 1984.

Reference Books

1. B.N. Chakrabarty, **Industrial Chemistry**, Oxford & IBH Publishing Co. Pvt Ltd, 1991.

2. V. Subrahmaniyan, S. Renganathan, K. Ganesan, S. Ganesh, **Applied Chemistry**, Scitech Publications, 1998.

3. J.E. Kuria Cose, J. Rajaram, **Chemistry in Engineering & Technology**, Vol. I & II, Tata Mc Graw Hill, 1984.

Mapping with Programme outcomes

COs	PO1	PO 2	PO 3	PO4	PO 5
CO1	S	S	S	M	S
CO2	M	S	M	S	M
CO3	S	M	S	M	S
CO4	M	S	M	S	S
CO5	S	M	S	M	M

S- Strong; **M**-Medium.

22UPCHE3S05 CHEMISTRY IN AGRICULTURE

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

1. To understand the basic concepts of soil nature and properties.
2. To learn the soil fertility and water management.
3. To learn about the fertilizers and its role in plants.
4. To acquire awareness about the preparation and uses of pests.
5. To get knowledge about the advantages of biofertilizers.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	know thorough knowledge about the basics of soil nature.	K2 & K3
CO2	understand the various types of soils and their properties.	K1, K2 & K3
CO3	learn how to solve the problems in nutrients deficiency in soil.	K2, K3 & K4
CO4	get clear idea about the Soil fertility and water management.	K3, K4 & K5
CO5	produce the various fertilizers used in different types of soil.	K2, K3 & K4

UNIT I - Soil nature and properties

Soil – types of soil, composition. Properties - physical properties - Soil texture, structure, particle density, bulk density, pore space, soil aeration, soil water holding capacity, soil temperature, soil moisture. Chemical properties - Soil clay minerals, soil colloids, cation exchange capacity, soil acidity, soil alkalinity, soil salinity, soil organic matter, soil nutrients.

UNIT II - Soil fertility and Water Management

Soil fertility problems, role of organic matter, important manures and fertilizers including biofertilizers and their application. Different soils behavior and fertilizer recommendation. Role of water in plant development and crop production. Different system of irrigation and drainage and rrigation requirement of different field crops.

UNIT III - Fertilizers and their Role in Plants

Criteria of essentiality of nutrients, Classification nutrients - primary, secondary and micro nutrients. Essential requirement of plant nutrients, effect of nitrogen, phosphorus and potassium on plant growth and development, nutrients deficiency symptoms, commercial method of preparation of urea, ammonium nitrate, triple superphosphate and potassium nitrate. Organic fertilizer - farmyard manure, composite, green manure, liming and vermicomposite, complex and mixed fertilizers-their manufacture and composition.

UNIT IV - Insecticides, Fungicides and Herbicides

Insecticides - Classification, types of insecticides and disadvantages of insecticides. Synthesis of insecticides – DDT, BHC, Boric acid and Organophosphate. Fungicides - Types, Sulphur compounds, Copper compounds, Bordeaux mixture and benefits of fungicides. Herbicides – Classification, based on mode of action, advantages and limitation of herbicide. Seed – Function of seed, Characteristic of good seed and preservation of seeds.

UNIT V- Biofertilizers

Biofertilizers-definition, classification, specification, methods of production and role in crop production, few examples are Rhizobium, Azotobacter, Azospirillum, Phosphate Solubilizing Bacteria and mycorrhiza.

Text Books

1. N.C. Brady, **The Nature and Properties of Soils**, Eurasia Publishing House, New Delhi, 1977.
2. V.S. Jones, **Fertilizers and Soil Fertility**, Prentice Hall of India, New Delhi, 1993.
3. D.E.H. Freer, **Chemistry of Pesticides**, D.Van Nostrand Co, Reinhold, 1969.
4. Krishnendu Acharya, Surjiit Sen, Manjula Rai, **Biofertilizers and Biopesticides**, Techno World, First Edition, 2019.
5. J.L. Havlin, S.L. Tisdale, W.L. Nelson, J.D. Beaton, **Soil Fertility & Fertilizers, Pearson Education India**, Eighth Edition, 2016.
6. Dr. Himadri Panda, **The Complete Technology Book on Pesticides, Insecticides, Fungicides and Herbicides**, Niir Project Consultancy Services, Second Revised Edition, 2022.

Reference books

1. U.D. Chavan, **Agriculture Chemistry and Soil Science**, Daya Publishing House, 2015.

2. Margarita Stoytcheva, Roumen Zlatev, **Agricultural Chemistry**, InTech, 2013.
3. Shalini Suri, **Biofertilizers and Biopesticides**, Aph Publishing Corporation, 2011.
4. Chamberlain Joseph Scudder, biblio life, **Organic Agricultural Chemistry**, Wentworth Press, 2016.
5. Hart Edwin Bret, **General Agricultural Chemistry**, Wentworth Press, 2016.
6. A. Mariakulamdai, T.S. Manickam, **Chemistry of Fertilizers and Manures**, Asia Publishing House1975.

Mapping with Programme Outcomes

COs	PO1	PO 2	PO 3	PO4	PO 5
CO1	M	S	S	S	S
CO2	S	M	M	S	M
CO3	S	S	S	M	M
CO4	M	S	M	S	S
CO5	S	M	S	M	M

S- Strong; **M**-Medium.

22UPCHE3S06 **CHEMISTRY IN DAILY LIFE**

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

1. To understand the food products, vitamins, fats and detergents.
2. To understand various pollution and pollutants.
3. To learn water purification and polymers.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	understand the food products and their additives.	K2 & K3
CO2	understand pollutants and their case study	K1, K2 & K3
CO3	learn the water purification techniques.	K2, K3 & K4
CO4	understand the importance of vitamins, fat and detergents	K3, K4 & K5
CO5	learn the concept of corrosion and importance of polymers.	K2, K3 & K4

UNIT - I Food Products and Additives

Dairy Products - Composition of milk and milk products, analysis of fat content and estimation of added water in milk. Beverages - Analysis of caffeine in coffee and tea. Estimation of methyl alcohol in alcoholic beverages. Food additives, adulterants and contaminants. Flavoring agents - Vanillin, alkyl esters (fruit flavours) and monosodium glutamate. Artificial food colorants - Coal tar dyes and non-permitted colours and metallic salts.

UNIT - II Pollutants

Air Pollution - Definition, classification, effects and control measure of air pollution. Green house effect, green house gases and acid rain, Ozone hole and CFC's, photochemical smog and PAN. Soil Pollution - Definition, classification, effects and control measure of soil pollution. Water pollution - Definition, classification, effects and

control measure of water pollution and sewage water treatment.

UNIT - III Water Purification

Water - Hydrologic cycle, water quality standards, public health significance and measurement of water quality parameters - Colour, turbidity, total solids, acidity, alkalinity, hardness, sulphate, fluoride, phosphate, nitrite, nitrate, BOD and COD. Water purification treatment for drinking and industrial purposes.

UNIT - IV Vitamins, Fat and Detergents

Vitamins – Definition, composition, classification, Sources and health effects. Structures of Vitamin A_1, Vitamin B_1, Vitamin C, Vitamin D, Vitamin E & Vitamin K_1. Oils and fats - Composition of edible oils, detection of purity, rancidity of fats and oil. Soaps & Detergents : Definition, classification, preparation and uses.

UNIT - V Corrosion and Polymers

Corrosion – Definition, effect of corrosion, causes of corrosion, classification- Dry and wet corrosion, corrosion control and its significances. Batteries – Definition, characteristic and limitation, Types -primary & secondary batteries. Fuel cell. Future energy storage - Solar energy and wind energy.

Polymers – Definition, classification, and general characteristics of polymers. Typical examples of polymers used as plastics, in textiles, in electronic and automobile components, in the medical and aerospace materials.

Text Books

1. B. K. Sharma, **Introduction to Industrial Chemistry**, Goel Publishing, Meerut, 1998.
2. Ashutosh Kar, **Medicinal Chemistry**, New Age International Publisher, Seventh Edition, 2018.
3. Titus A. M. Msagati, **Chemistry of food Additives and Preservatives**, Wiley-Blackwell, 2012.
4. Deanna M. Minich, **An A-Z Guide to Food Additives**, ReadHowYouWant, 2010.

5. N. Saradha, V. Dhulasi Birundha, Industrial Pollution: A Reference to small Scale Industries, Serials Publication, 2008.
6. Baboian, Robert, **NACE Corrosion Engineer's, NACE International**, Fourth Edition, 2016.
7. Pierre R. Roberge, **Handbook of Corrosion Engineering**, Second Edition, 2016.
8. Manas Chanda, **Introduction to Polymer Science and Chemistry**, CRC Press, Second Edition, 2013.
9. Charles E. Carraher Jr. **Introduction to polymer Chemistry**, CRC Press, 2017.

Reference Books

1. Marcel Dekker, **Drugs and Pharmaceutical Sciences Series**, Vol. II, INC, New York
2. H.E. Cox, David Pearson, **Analysis of Foods**, **Chemical Analysis of Foods**, Chemical Publishing Co Inc.,U.S. 1962.
3. N. Shakuntala Many, S. Swamy, **Foods: Facts and Principles**, Fourth Edition, New Age International, 1998.
4. P. Atkins and J. de Paula- Physical Chemistry, Seventh Edition, 2002, Oxford University Press, 2002.
5. S. Swaminathan, Manish Goswamy, K.P. Sundaram, **Handbook on Feritilizer Technology**, Fertiliser Association of India, Sixth Edition, 2001,
6. I.L. Finar, **Organic Chemistry**, Vol. 1 & 2. Pearson Education India; Sixth Edition, 2002.
7. J. Fired, Polymer Science and Technology, Pearson Prentice Hall, Third Edition, 2014.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	M	M
CO2	M	S	S	S	M
CO3	S	M	S	S	M
CO4	M	M	S	S	S
CO5	M	S	M	M	S

S- Strong; **M**-Medium.

22UPCHE3S07 PHARMACEUTICAL CHEMISTRY

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

1. To study the basic terms used in pharmaceutical chemistry.
2. To study various types of antibiotics and sulpha drugs.
3. To learn different types of analgesics and antiseptics.
4. To study different types anaesthetics, tranquilisers and antineoplastics.
5. To learn about the drugs used in the gastrointestinal therapy and the uses of topical agents.

Course Outcomes

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

CO No.	CO Statement	Knowledge Level
CO1	know the basic terms used in pharma chemistry	K2 & K3
CO2	know the preparation and uses of antibiotics and sulpha drugs	K1, K2 & K3
CO3	understand various types of analgesics and antiseptics	K2, K3 & K4
CO4	understand the classification and role of anaesthetics, tranquilisers and antineoplastics	K3, K4 & K5
CO5	Know the importance of gastrointestinal drugs like antacids as well as the composition and uses of topical agents	K2, K3 & K4

UNIT - I Introduction

Important terminologies - pharmaceuticals, drugs, clinical trials, pharmacodynamics, Pharmacokinetics, pharmacopoea, metabolites, antimetabolites. Therapeutic index - LD_{50}, ED_{50} and their use in selective drugs.

UNIT - II Antibiotics and Antibacterial drugs

Antibiotics – Classification, synthesis, and uses of penicillin, chloramphenicol and tetracyclines. Antibacterials - Sulpha drugs - Classification, preparation and uses of - sulphanilamide, sulphadiazine, sulphapyridine, sulphathiazole and sulphafurazole.

UNIT - III Analgesics and Antiseptics

Analgesics – Definition, classification. Narcotic analgesics - isolation, pharmacological action and uses of morphine, heroin and codeine. Synthetic analgesics- pethidine and methadone. Antipyretic analgesics - synthesis, structure and action of methyl salicylate, aspirin, paracetamol and phenacetin. Chemicals used in sterilization - Types, Antiseptics – tincture, iodoform, hydrogen peroxide, potassium permanganate and soframycin, and disinfectants - Dettol, Chlorine, Hexachlorophene, Thymol, Amyl meta cresol and bithional and their significance.

UNIT - IV Anaesthetics, Tranquilisers and Antineoplastics

Anaesthetics – Classification - general, local and intravenous anaesthetics, chemistry of anaesthetic ether, nitrous oxide, halothane, chloroform, thiopental sodium methohexital, cocaine and benzocaine. Tranquilisers, hypnotics and sedatives; Antineoplastic drugs - causes and control of cancer. Hypoglycemic agents - cause and control of diabetes and oral hypoglycemic agents.

UNIT - V Gastrointestinal and Topical Agents

Acidifying agents - Dilute hydrochloric acid. Antacids - sodium bicarbonate, aluminum hydroxide gel, aluminum phosphate, calcium carbonate, magnesium carbonate, Magnesium trisilicate, Magnesium oxide, Combinations of antacid preparations. Purgatives and laxatives, Antidiarrohoeals, Emetics, Anti-emetics, Antispasmodics.

Topical Agents – Talc, Zinc Oxide, Calamine, Zinc stearate, Titanium dioxide, silicone polymers.

Text Books

1. T.C. Daniels, E.C. Jorgensen, **Text Book of Organic Medicinal and Pharmaceutical Chemistry**, J. B. Lippincott, Philadelphia, 1977.
2. Ashutosh Kar, **Medicinal Chemistry**, New Age International Publisher, Seventh Edition, 2018.
3. Graham L. Patrick, **An Introduction to Medicinal Chemistry**, Oxford, Fifth Edition, 1995.
4. Graham Patrick, **An Introduction to Medicinal Chemistry**, Oxford University Press, International Edition, 2018.
5. Joseph M. Ascenzi, **Hand Book of Disinfectants and Antiseptic**, CRC Press, 1995.

Reference Books

1. M. Gordon, **Psychopharmacological agents**, Academic press, New York, 1965
2. J.M. Ritchie, P.J. Cohen, **The Pharmacological Basis of Therapeutics**, Fifth Edition, Macmillan, New York, 1975.
3. D. Lednicer, L.A. Mitscher, **Organic Chemistry of Drug Synthesis**, John Wiley & Sons, New York, 1959.
4. J.E. Hoover, **Remington's Pharmaceutical Sciences**, Fifteenth Edition, Mack Publ.Company, Easton, 1975.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	M	S	M	S	M
CO2	S	S	M	S	M
CO3	S	M	S	S	M
CO4	S	M	S	S	S
CO5	S	S	M	M	M

S- Strong; **M**-Medium.

22UPCHE3S08 FUNDAMENTALS OF ANALYTICAL CHEMISTRY

Hours	L	T	P	C
75	3	1	0	4

Course Objectives

1. To study the definition and basic concepts of analytical data treatment and its evaluation.
2. To understand the theory and principles of titrimetric analysis and determination of methods.
3. To learn the concepts of sample preparation for solids, liquids and gas.
4. To acquire knowledge on the analysis of industrial samples.
5. To reveal the basic concepts and applications of water treatment.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	get in depth knowledge in analytical data treatment.	K1 &K2
CO2	develop an ability to understand the neutralization reactions based on the theory of acid-base titrations. And determine redox potentials.	K2 & K3
CO3	understand the sample preparation techniques to elucidate the effect of sampling uncertainties for analysis.	K3 & K4
CO4	obtain skill on the sample types and their dissolution behaviors.	K3 & K4
CO5	determine the Gaseous fuel properties through sampling procedure for industrial samples.	K3 & K4

UNIT- I Analytical Data Treatment and Evaluation:

Definition of Terms - Mean, median, precision, accuracy. Errors in chemical analysis - systematic errors and random errors. Treatment of data - Basic statistical concept, Frequency distribution, average and measure of dispersion. Significance of Gaussian distribution curves, confidence interval of mean and Criteria for rejection of data.

UNIT- II Titrimetric Analysis

Neutralization reactions - theory of acid-base titrations, titration curves and feasibility of reactions, Indicators-theory and choice, calculation of pH during titrations. Redox titrations - Redox potentials, theory and feasibility of redox titrations, redox indicators, their choice and applications.

UNIT- III Sampling Techniques I:

Preparing the sample for analysis - Effect of sampling uncertainties, gross sample, determination of the size of the sample, analytical sample. Sampling of solids: Preparation of laboratory sample from gross sample, moisture in the sample. Sampling of gases and liquids.

UNIT- IV Sampling Techniques II

Definition, types of sample, sampling plan, quality of sample, subsampling, Sampling of raw materials, intermediates and finished products. Sample preparations - dissolution technology and decomposition and storage of samples.

UNIT - V Analysis of Industrial samples

Gaseous fuels - sampling procedure, ultimate and proximate analysis, specific volatile index, ash content, calorific value by bomb colorimeter and Junker's calorimeter.

Text Books

1. D.A. Skoog, D.M. West, **Fundamentals of Analytical Chemistry**, Holt Rinehart and Winston Publications, Fourth Edition, 1982.
2. A.I. Vogel, **Text Book of Quantitative Inorganic Analysis**, ELBS, Third Edition, 1987.
3. A.I. Vogel, **Text Book of Quantitative Inorganic Analysis**, Pearson, Fifth Edition, 2001.
4. E. Prichard, **Quality in the Analytical Chemistry Laboratory**, John Wiley and sons, 1997.
5. W. Funk, V. Dammann, G. Donnevert**, Quality Assurance in Analytical Chemistry**, VCH Weinheim, 1995.
6. J.G. Dick, **Analytical Chemistry**, McGraw Hill Publishers, 1974.
7. T.S. Ma, V. Horak, **Microscale-Manipulations**, John Wiley and Sons, 1976.

Reference books

1. D.A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, **Fundamentals of Analytical Chemistry**, Eighth Edition, Thomson Brooks/Cole Publishers, 2004.
2. H.A. Stobel Addison, **Chemical Instrumentation**, Wesley Publishers Co., 1976.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	M	S	S	M
CO2	S	S	M	S	M
CO3	S	M	S	M	M

CO4	M	S	S	S	S
CO5	M	M	M	M	S

S- Strong; **M**-Medium.

Hours	L	T	P	C
72	3	1	0	4

Course Objective

1. To learn the chemical technology and unit operation processes.
2. To learn the synthesis of industrial products.
3. To learn industrial application of chemical compounds.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	know the types of various glasses, their manufacture and uses	K1 &K2
CO2	learn the water treatment for domestic and industrial purpose	K2 & K3
CO3	learn the industrial application of chemical compounds	K3 & K4
CO4	understand the various techniques of preparation and increase the yield of the synthesized compounds	K3 & K4
CO5	understand the raw materials involved in synthesizing industrially important products	K3 & K4

UNIT - 1 Glass and ceramics

1.1 Glasses - Types of glasses, Raw materials, manufacture and properties of glass. Some special glasses - fused silica glass, optical glass. photosensitive glass. Composition and uses

1.2 Ceramics**:** Definition, manufacture and applications

UNIT - 2 Cement

Cement-Types of cement, High alumina cement, slag cement, acid resisting cement, white cement and portland cement. Raw materials, manufacture, setting of cement, factors affecting quality of cement, Cement industries in Tamil Nadu.

UNIT - 3 Dyes and paints

3.1 Dyes – Classification, preparation and applications in medicine, chemical analysis, cosmetics, colouring agents, foods and beverages.

3.2 Paints - Constitution of paints, manufacture of paints, requirement of paint, setting of paints

UNIT - 4 Synthetic Fibres and Plastics

4.1Synthetic fibres – Characteristics, significance, difference between natural and synthetic fibres. Preparation and applications of synthetic fibres - Rayon, terylene, nylon and teflon

4.2 Plastics - types of plastics, domestic and industrial applications of plastics

UNIT - 5 Oils and Fats

Classification of oils and fats, distinction between oils and fats-Soaps-Manufacture of soap-toilet and transparent soaps, cleaning action of soap. Detergents-classification and uses.

Text Books

1. B.K. Sharma, **Industrial Chemistry**, Goel Publishing House Pvt Ltd, 1999.
2. M.G. Arora, M. Singh**, Industrial Chemistry**, Anmol Publications, First Edition, 1994.
3. G.N. Pandey, **A Textbook of Chemical Technology**, Vol. I & II, Vikas Publishing House Pvt Ltd, 1997.
4. John A Monick, **Alcohols**, **Their Chemistry**, **Properties and Manufacture**, First Edition, Reinhold Book Corporation, 1968.
5. C.C. Furnas (Edition), **Roger's Manual of Industrial Chemistry**, Sixth Edition, Vol. I, D. Van Nostrand Company, Inc. 1942.

Reference Books

1. B.N. Chakrabarty, **Industrial Chemistry**, Oxford & IBH Publishing Co. Pvt Ltd, 1991
2. V. Subrahmaniyan, S. Renganathan, K. Ganesan, S. Ganesh, Applied Chemistry, Scitech Publications, 1998.
3. J.E. Kuriacose and J. Rajaram, **Chemistry in Engineering & Technology**, Vol. I & II, Tata Mc Graw Hill, 1984.

Mapping with Programme outcomes

COs	PO1	PO 2	PO 3	PO4	PO 5
CO1	S	S	S	M	S
CO2	M	S	M	S	M
CO3	S	M	S	M	S
CO4	M	S	M	S	S
CO5	S	M	S	M	M

S- Strong; **M**-Medium.

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

1. To understand the basic concepts of soil nature and properties.
2. To learn the soil fertility and water management.
3. To learn about the fertilizers and its role in plants.
4. To acquire awareness about the preparation and uses of pests.
5. To get knowledge about the advantages of biofertilizers.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	know thorough knowledge about the basics of soil nature.	K1
CO2	Student will understand the various types of soils and its properties.	K2
CO3	learn how to solve the problems in nutrients deficiency in soil.	K3
CO4	get clear idea about the Soil fertility and water management.	K4
CO5	can create the various fertilizers used in different types soil.	K6

UNIT I - Soil nature and properties

Soil-types, composition, physical properties. Soil texture, structure, particle density, bulk density, pore space, soil aeration, soil water holding capacity, soil temperature, soil moisture, soil acidity, soil alkalinity, soil salinity, soil organic matter, soil nutrients.

UNIT II - Soil fertility and water management

Soil fertility and water management - Soil fertility problems - role of organic matter, Role of water in plant development and crop production; irrigation and drainage - irrigation requirement for different field crops.

UNIT III - Fertilizers and their role in plants

Criteria of essentiality of plant nutrients, effect of nitrogen, phosphorus and potassium on plant growth and development, Fertilizers-commercial method of preparation of urea and triple superphosphate. Farmyard manure, composite, green manure, vermicomposite and biofertilizers. Complex and mixed fertilizers-their manufacture, composition and uses

UNIT IV- Iinsecticides, fungicides and herbicides

Insecticides - Inorganic pesticides-borates. Organic pesticides - D.D.T. and BHC. Fungicides - Sulphur compounds, Copper compounds, Bordeaux mixture. Herbicides -

UNIT V- Biofertilizers

Biofertilizers- Classification- their role in crop production- methods of production, few examples are Rhizobium, Azotobacter, Azospirillum, Phosphate Solubilizing Bacteria and mycorrhiza.

Text Books

1. N.C. Brady, **The Nature and Properties of Soils, Eurasia Publishing House**, New Delhi, 1977.
2. V.S. Jones, **Fertilizers and Soil Fertility**, Prentice Hall of India, New Delhi, 1993.
3. D.E.H. Freer, **Chemistry of Pesticides**, D. Van Nostrand Co, Reinhold, 1969.

Reference Books

1. U. D. Chavan, **Agriculture Chemistry and Soil Science**, 2015.
2. Margarita Stoytcheva, Roumen Zlatev, **Agricultural Chemistry**, 2013.
3. Shalini Suri, **Biofertilizers and Biopesticides Book**, 2011.
4. Chamberlain Joseph Scudder, **Organic Agricultural Chemistry**, Biblio Life, 2012.
5. Hart Edwin Bret, **General Agricultural Chemistry**, Wentworth Press, 2016.
6. A. Mariakulamdai, T.S. Manickam, **Chemistry of Fertilizers and Manures**, 1975.

Mapping with Programme Outcomes

COs	PO1	PO 2	PO 3	PO4	PO 5
CO1	M	S	S	S	S
CO2	S	M	M	S	M
CO3	S	S	S	M	M
CO4	M	S	M	S	S
CO5	S	M	S	M	M

S- Strong; **M**-Medium.

VALUE ADDED COURSES

22UPCHE3V01 **CHEMICAL POLISHING OF METALS**

Hours	L	T	P	C
30	2	0	0	2

Course Objectives

1. To understand the principles of chemical polishing.
2. To study the importance and uses of chemical polishing.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	understand the principles of chemical polishing of metals	K1 & K2
CO2	study the importance and uses of chemical polishing of Al, Steel, Silver, Gold and Brass.	K1 & K2

UNIT - I Chemical Polishing of Al and Steel

Chemical polishing - Definition, need for polishing. Chemical polishing of Al - Requirements of polishing bath. Types of baths - Alkaline bath, acidic bath. Rate of metal removal. Factors affecting polishing - selection of polishing bath, temperature, time, surface preparation, nature and type of alloy, shape and size of articles. Cleaning materials and polishes for steel - Content of chemical substances in polishes for steel.

UNIT - II Chemical Polishing of Silver, Gold, and Copper/ Brass

` Cleaning materials and polishes for silver - All sizes of silver objects - Small objects-Cutlery, Content of chemical substances in polishes for silver objects-Liquid products, creamy products, Textile products. Cleaning materials and polishes for gold-Content of chemical substances in polishes for gold and jewels. Liquid products. Cleaning materials and polishes for copper/brass, Content of chemical substances in polishes for copper/brass, Creamy products for copper/brass.

Text Books

1. Eckart Uhlmann, Ioan D. Marinescu, Toshiro Doi, **Handbook Of Lapping And Polishing**, CRC Press, 2006.
2. R.K. Singh, R. Bajaj, M.Monpour, M. Meuris, **Chemical-Mechanical Polishing 2000 - Fundamentals and Materials**, Issues: Vol. 613, Cambridge University Press, 2000.
3. D. Marinescu, Toshiro Doi, Eckart Uhlmann, **Handbook of Ceramics Grinding and Polishing**, William Andrew, 2015.

4. Pawan Tyagi, Tobias Goulet, Nitt Chuenprateep, Robert Stephenson, Rudolph Knott, Antione Reddick, Devdas Shetty, Justin Schlitzer, Cordell Benton, Francisco Garcia-Moreno, **Chemical Polishing Based Surface Finishing of 3D Printed Steel Components**, ASME, 2019.
5. Hawkins Herbert James, **The Polishing and Plating of Metals; A Manual for The Electroplater, Giving Modern Methods Of Polishing, Plating, Buffing, Oxydizing and Lacquering Metals, For The Progressive Workman**, Read Books, 2012.
6. NIIR Board of Consultants & Engineers, **The Complete Technology Book on Electroplating, Phosphating, Powder Coating and Metal Finishing**, Asia Pacific Business Press inc, Second Revision, 2021.

Reference Books

1. H. J. Herbert, **The Polishing and Plating of Metals**, Forgotten Books, 1987.
2. Sheasby & Pinner, **The Surface Treatment and Finishing of Aluminum and its Alloys**, Finishing Publications / ASM, Sixth Edition, 2001.
3. R. H. Probert, **How to Aluminium anodizing, hard coating, and chromating of aluminum**, R. H. Probert, 2005.
4. Jack W. Dini, **Electrodeposition, the Materials Science of Coatings and Substrates**, 1993.
5. Lawrence J. Durney, **Electroplating Engineering Handbook**, 1984.
6. **Metal Finishing Guidebook and Directory**, Elsevier.
7. **Metals Handbook of Surface Engineering**, American Society for Metals, Vol. 5, Tenth Edition, 1994.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	M	M	S	M	M
CO2	M	S	M	S	M

S- Strong; **M**-Medium.

Hours	L	T	P	C
30	2	0	0	2

Course Objectives

3. To understand the principles , reaction and application of batteries.
4. To understand the principles and applications of fossil fuels and solar cells.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	understand the principles of batteries and fuel Cells	K1 & K2
CO2	understand the function of fossil fuels and solar cells	K1 & K2

UNIT - I Batteries and Fuel Cells

Electrochemical power sources - Primary cells - various types. Secondary cells - classification. Chemistry of the main secondary batteries. Batteries for electric vehicles.

Fuel cells - classification - chemistry of fuel cells, detailed description of hydrogen/oxygen fuel cells, methanol - molten carbonate, solid polymer electrolyte and biochemical fuel cells. Hydrogen as a fuel.

UNIT - II Fossil Fuels and Solar Cells

Fossil fuels - petroleum, natural gas and coal, Origin, processing and production of value added products, available current conversion technologies.

Solar energy conversion devices - photovoltaic cells, photoelectrochemical cells-semiconductor electrolyte junctions, photocatalytic modes for fuel conversion process-photo biochemical options.

Text Books

1. C. A. Vincent, **Modern Batteries**, Edward Arnold, 1984.
2. R. Narayanan, B. Viswanathan, **Chemical and Electrochemical Energy Systems**, Orient Longmans, 1997.
3. K. Sriram, **Basic Nuclear Engineering**, Wiley Eastern, 1990.

Reference Books

1. S. J.. Appleby, F. K. Foulkes, **Fuel Cell Hand Book**, Von Nostrand Reinhold, 1989.
2. D. Linden, **Hand Book of Batteries and Fuel cells**, McGraw Hill Book Company, 1984.
3. T. Ohta, **Solar Hydrogen Energy Systems**, Peragamon Press, 1979.

4. M. Gratzel, **Energy Resources Through Photochemistry and Catalysis**, Academic Press, 1983.
5. T. Ohta, **Energy Technology, Sources, Systems and Frontiers Conversions**, Pergamon, 1994.
6. J. G. Speight, **The Chemistry and Technology of Petroleum**, Marcel Dekker Inc. 1980.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	M	M	M	M	M
CO2	M	S	S	S	M

S- Strong; **M**-Medium.

22UPCHE3V03 CHEMICALS SAFETY AND HEALTH

Hours	L	T	P	C
30	2	0	0	2

Course Objectives

1. To understand the common chemical hazards at workplace and best safety practice in chemical storage, handling, transportation
2. To understand the GHS system , the process of chemical classification and hazards communication through use of labels and SDS according to requirements of GHS

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	understand the chemical hazards at workplace and best safety practice in chemical storage, handling and transportation	K1 & K2
CO2	understand the GHS system , use of labels and SDS according to requirements of GHS	K1 & K2

UNIT - I Workplace Safety and Health

Workplace safety and health Act and subsidiary regulations - Latest WSH Act and legal requirements. Personal responsibilities on workplace safety and health, Personal legal responsibilities and liabilities. Common chemical hazards at workplace, safety and health impacts of exposure, hazard of chemical through Safety Data Sheet and hazard identification using the data, classification and labelling of chemicals.

UNIT – II Evaluation and Control of Chemicals

Evaluation and control of chemicals including storage, handling, transportation, disposal and emergency response. Best safety practice in chemical storage, handling, transportation. Understand the GHS system, the process of chemical classification and hazards communication through use of labels. Response to any chemical mishaps or incident. Risk assessment principles - survey of risks associated with chemical use. Overview of personnel protection equipment. Chemical emergency response procedures.

Text Books

1. T.S.S. Dikshith, **Handbook of Chemicals and Safety**, First Edition, CRC Press, 2017.

2. M. N. Vyas, **Safety and Hazards Management in Chemical Industries**, Atlantic Publishers & Distributors Pvt Ltd., 2013.
3. T.S.S. Dikshith, **Hazardous Chemicals: Safety Management and Global Regulations**, T&F India, 2019.

Reference Books

1. **Occupational Safety, Health And Working Conditions and Labour Laws**, Professional Book Publishers, 2020.
2. **NIOSH Pocket Guide to Chemical Hazards**, Books Express Publishing, 2012.
3. Robert Tisser, Rodney Young, **Essential Oil Safety: A Guide for Health Care Professionals**, Elsevier, 2013.
4. M.H. Fulekar, **Industrial Hygiene and Chemical Safety**, Dreamtech Press, 2020

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	M	S	M	M	S
CO2	M	S	M	S	M

S- Strong; **M**-Medium.

XIX Model Question Papers

(For the candidates admitted from 2022-2023 onwards)

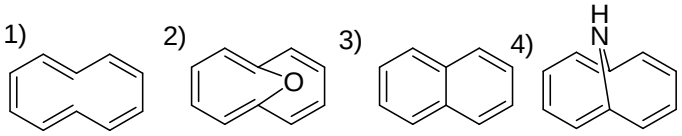
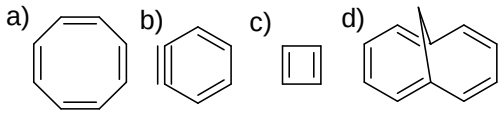
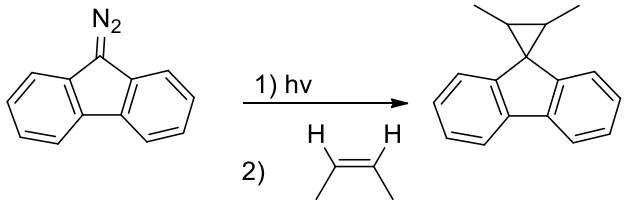
M. Sc. DEGREE EXAMINATION

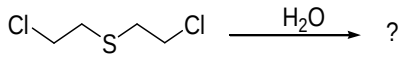
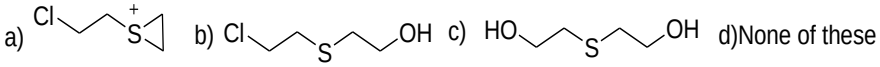
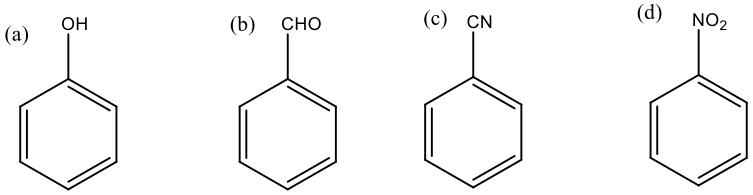
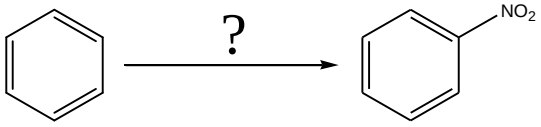
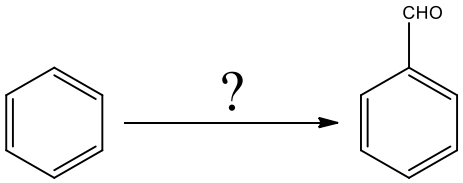
22UPCHE3C01 AROMATICITY AND ORGANIC REACTION MECHANISM

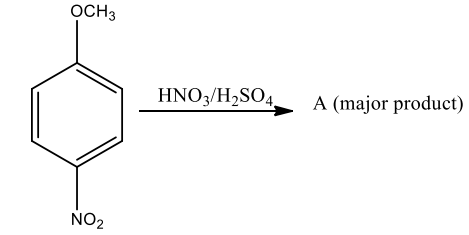
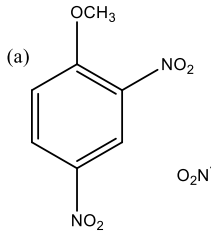
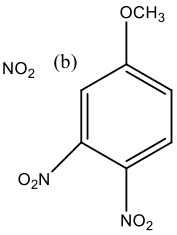
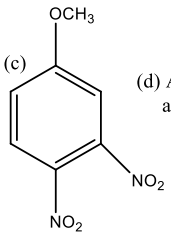
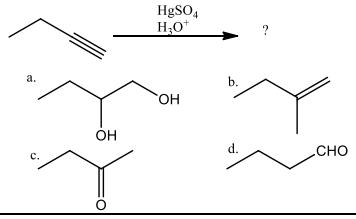
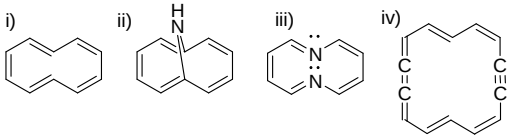
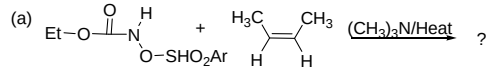
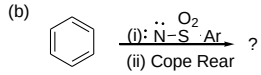
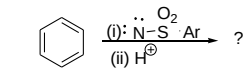
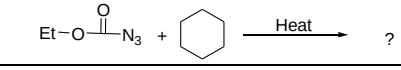
Time : Three Hours **Total marks = 75**

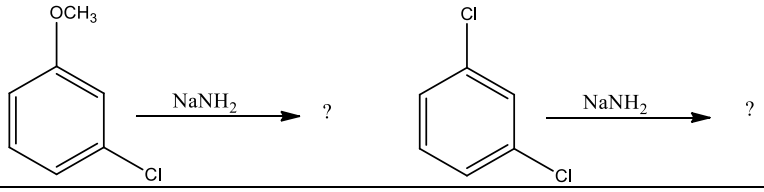
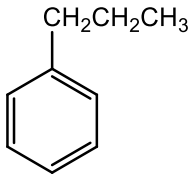
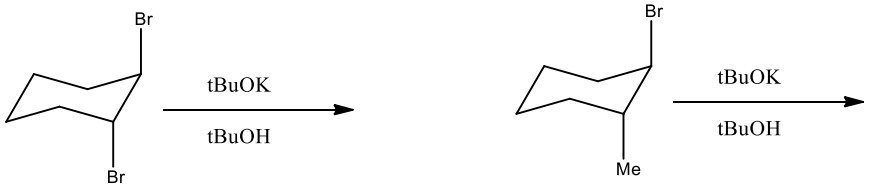
Part A (1X20) =20

Answer all the questions

Q. No.	Questions	Cognitive Level	Course Outcome
	PART A (20X1=20Marks) (Answer ALL the questions)		
1	Among 1-4, the aromatic compounds are  a) 1 only b) 2, 3 and 4 c) 3 and 4 d) 1, 2 and 4	K2	CO1
2	Consider the following statements for [18]-annulene 1) It is aromatic 2) The inner proton resonate at δ9.28 in its ^{1}H spectrum 3) There are six protons in the shielded zone. The correct statements are a) 1, 2 and 3 b) 1 and 2 only c) 2 and 3 d) 1 and 3 only	K3	CO1
3	Among the following compounds, the one that is non-aromatic is 	K2	CO1
4	The compound azulene is a) aromatic and has high dipole moment b) aromatic and has no high dipole moment c) non-aromatic and has high dipole moment d) anti-aromatic and has no high dipole moment	K3	CO1
5	The intermediate involved in the reaction given below is  a) Free radical b) Carbocation c) Carbanion d) Carbene	K3	CO2
6	Hammett equation was applicable for only reaction involving benzoic acid derivatives with substituent in position of _____? a)Ortho and Para b) Para and Meta c) Meta and Ortho d) all of the above	K3	CO2
7	In hammett substituent constant σis positive the substitueted benzoic acid is _____ than benzoic acid itself? a) More acidic b) Neutral c) More basic d) Less acidic	K3	CO2
8	In which rearrangement, reaction intermediate is carbene? a) Pinacol-Pinacolone b) Stevens c) Wolff d) Wagner-Meerwein	K2	CO2

9	In which of the following is the strongest nucleophile (a). NH_2^- (b). CH_3 (c). OH^- (d). F^-	K2	CO3
10	What will be the product in the following reaction   	K3	CO3
11	The name of the intermediate in the SNAr mechanism of aromatic nucleophilic mechanism is, (a) arenium ion (b) radical anion (c) Meisenheimer salt (d) benzyne	K3	CO3
12	Which of the following compounds will easily undergo aromaticnucleophilicsubstitution by benzyne mechanism? (a) all aromatic compounds (b) aryl halides without any activating groups (c) aryl halides with electron withdrawing substituents (d) aryl halides with electron releasing substituents	K3	CO3
13	Which of the following is most readily undergo electrophilic attack?  	K4	CO4
14	How would you perform the following reaction?  (a) conc. HNO_3 + conc. H_2SO_4(b) conc. HNO_3 (c) anhydrous $AlCl_3$ + Ph-NO_2(d) conc. H_2SO_4 + Oleum	K4	CO4
15	Which of the following reactants can be used to carry out following reaction?  (a)conc. HNO_3 + conc. H_2SO_4(b) HCl + CO + $AlCl_3$ (c) anhydrous $AlCl_3$ + Ph-NO_2(d) conc. H_2SO_4 + Oleum	K4	CO4

16	 (a)  (b)  (c)  (d) All the three in equal amounts	K4	CO4
17	Which of the following statements regarding the E2 mechanism is wrong? (a) Reactions by the E2 mechanism are always bimolecular (b) Reactions by the E2 mechanism are generally second order (c) Reactions by the E2 mechanism usually occur in one step (d) Reactions by the E2 mechanism usually occur in two steps	K3	CO5
18	Reaction intermediate of E1CB mechanism is : (a) Free radical (b) carbanion (c) carbocation (d) carbene	K2	CO5
19	Addition of bromine to trans-2-butene gives (a) dl-2,3-dibromobutane (b) meso-2,3-dibromobutane (c) 1-bromopropane (d) 2-bromopropane	K3	CO5
20	Give the product of the following reaction 	K4	CO5
	PART B (3X5=15 Marks) **(Answer Any THREE Questions)**		
21	Classify each of the following molecules and ions as aromatic, antiaromatic and nonaromatic and give reason. 	K3	CO1
22	Complete the following reaction: (a)  (b)  (c)  (d) 	K4	CO2

23	What will be the major products in the following reactions? Explain with mechanism. 	K4	CO3
24	How can you prepare the following compound from benzene? 	K3	CO4
25	What will be the products in the following reactions? 	K3	CO5
	PARTC (5X8=40Marks) **(Answer ALL the questions)**		
26	(a) (i) What is called homoaromatic compound? Give an example and discuss its structure. (ii) Explain the aromaticity and dipole moment of tropone and fulvene. (OR) (b) Discuss aromaticity of azulenes, fulvenes and ferrocenes using suitable example.	K3	CO1
27	(a) Illustrate with suitable examples the following techniques for determining mechanisms of reactions: (i) Isotopic labelling (ii) Study of intermediates (iii) Stereochemical studies (iv) Cross over experiments.(8) (OR) (b) Derive Hammett equation and give the significance of σ.	K2	CO2
28	(a) (i) Write a note on neighbouring group participation by π and σ bonds. (6 marks) (ii) Explain why 1-bromotriptycene is inert to nucleophilic substitution by both the S_N1 and S_N2 mechanism. (2 marks) (OR) (b) (i) Write a note on Williamson and Von Braun reaction with suitable reaction. (3+3 marks) (ii) Discuss the stereochemistry of S_N2 reaction. (2 marks)	K4	CO3
29	(a) Write an account on orientation and reactivity in mono and disubstituted benzene. (OR) (b) i. Explain with mechanisms, the Vilsmeiyer and Reimer-Tiemann reactions. (2+2 marks). ii With suitable example explain the mechanism of electrophilic substitution accompanied by double bond shifts. (4 marks)	K3	CO4

30	(a) (i) Explain with each one examples the Hofmann and Saytzeff rules. (4 marks) ii. Explain the mechanism of Chugaev reaction and Cope elimination. (4 marks) (OR) (b) Give the mechanism of Mannich, Stobbe, Darzen and Glycidic ester condensation reactions.	K3	CO5

Cognitive Level	Total Marks	Percentage(%)
Remember(K1)	-	-
Understand (K2)	23	27
Apply (K3)	39	46
Analyze (K4)	23	27
Evaluate (K5)	-	-
Create (K6)	-	-

(For the candidates admitted from 2022-2023 onwards)

M. Sc. DEGREE EXAMINATION

22UPCHE3C02 BONDING IN MAIN GROUP ELEMENTS, SOLID STATE AND NUCLEAR CHEMISTRY

Time : Three Hours **Total marks = 75**

Part A (1X20) =20

Answer all the questions

Q. No.	Questions	Cognitive Level	Course Outcome
	PART A (20X1=20Marks) **(Answer ALL the questions)**		
1	In diborane, the number of electrons that accounts for bananabonds is a) Six b) two c) four d) three	K2	CO1
2	Which one of the following is isolobal to CH_3^+ is a) $Fe(CO)_5$ b) $Mn(CO)_5$ c) $Cr(CO)_5$ d) $[Ni(CO)_3]^+$	K4	CO1
3	$Cp_4Ni_4B_4H_4$ is a a) Closo b) Nido c) Arachno d) None of these	K2	CO1
4	The number of metal – metal bond in $Re_2(CO)_8Cl_2$ a) 2 b) 1 c) 0 d) 4	K2	CO1
5	The correct shape of $[TeF_5]^-$ ion on the basis of VSEPR theory is a) Trigonal bipyramidal b) Square pyramidal c) Pentagonal planar d) See-saw	K3	CO2
6	Which shows the highest lattice energy? a) RbF b) CsF c) NaF d) KF	K3	CO2
7	The bond order of NO_2 molecule is a) 2 b) 2.5 c) 3 d) 3.5	K3	CO2
8	According to bents rule, the lone pair occupy		

	a) Axial position b) Equatorial position c) Either axial or equatorial position d) All the above	K3	CO2
9	The bonds present in borazine or inorganic benzene are: a) 12σ, 3π b) 9σ, 6π c) 6σ, 6π d) 9σ, 9π	K3	CO3
10	Which of the following minerals is composed of sheeted tetrahedra? a) Micas b) Feldspar c) Quartz d)Pyroxene	K3	CO3
11	The basic unit of three dimensional silicates a) SiO_2 b) $Si_2O_7^{6-}$ c) Si_2O_5 d) $(SiO_3)_n$	K3	CO3
12	Which of the statement about silicates in not correct? a) Silicon is 4-coordinated to oxygen atoms b) Asbestos is an amphibole silicate c)Talc and mica are examples of silicates with chain structures d) Zeolites are aluminosilicates	K3	CO3
13	Which one of the following statements is incorrect? a) Frenckel defect is a cation vacancy and a cation interstitial. b) Frenckel defect is a anion vacancy and a cation interstitial. c) Density of a solid remains unchanged in case of Frenkel defects. d) Density of a solid decrease in case of Schottky defects.	K3	CO4
14	Which one is Normal Spinel's? a) Fe_3O_4 b) $CoFe_2O_4$ c) Mn_3O_4 d) $K_4[Fe_2O_4]$	K6	CO4
15	In the precipitation method for the growth of the crystal, the solventmelts are often known as_____ a) Electrolyte b) fluxes c) electrode d) all the above	K3	CO4
16	The co-ordination number of Titanium ion in calcium titanate a) 6 b) 4 c) 12 d) 8	K6	CO4
17	Among the following radioactive isotopes which one is used in the treatment of cancer? a) Cu-62 b) Co-60 c) Au-198 d) F-18	K3	CO5
18	The radioisotopes used for smoke detection is a) Californium-252 b) Americium-241 c) Iridium-192 d) Iodine-131	K3	CO5
19	If there are 60 grams of Np -240 present, how much Np -240 willremain after 4 hours? (Np -240 has a half-life of 1 hour) a) 4.15 b) 3.75 c) 4.25 d) 3.15	K4	CO5
20	Hydrogen bomb is based on the phenomenon of a) Nuclear explosion b) Chemical reaction c) Nuclear fusion d) Nuclear fission	K2	CO5
	PART B (3X5=15 Marks) **(Answer Any THREE questions**		
21	According to wades rule the correct structural types of a) $[Co(\eta_5\text{-}C_5H_5)B_4H_8]$ b) $[Mn(\eta_3\text{-}B_3H_8)(CO)_4]$	K4	CO1
22	Find out the hybridization, electron geometry, lone pairs and Stericnumber of ClF_3 molecule.	K2	CO2
23	What is Zeolities How is it useful for water softening process?	K3	CO3
24	What is Perovskite? Discuss its structure and bonding.	K3	CO4
25	Calculate Q-Value of the following nuclear reaction $_3Li^7 + _1H^1 \longrightarrow 2\ _2He^4$ Check whether the reaction is exoergic or endoergic		

	Given that The exact mass of $_3Li^7$ isotope = 7.01601 a.m.u. and that of $_1H^1$ = 1.00738 a.m.u. The exact mass of $_2He^4$ = 4.00260 a.m.u.	K4	CO5
	PARTC (5X8=40Marks) **(Answer ALL the questions)**		
26	a) i) Give the preparation properties structure and bonding in $B_{10}H_{14}$. ii) How many skeletal electrons in the following boranes and carboranes? a) $C_2B_{10}H_{12}$ b) CB_4H_8 c) B_5H_{11} d) B_6H_{12} OR b) i) What is meant by metal cluster? How is $[Re_2Cl_8]^{2-}$ prepared? Discuss its structure and bonding. ii) What is STYX number? Calculate STYX number for B_5H_9	K4	CO1
27	a) i) The C-Cl bond distance in CH_3Cl and CF_3Cl are 1.78Å and 1.75Å respectively. Comment on this difference with the help of Bent's rule? ii) Draw a molecular orbital diagram of CO_2 molecule. Discuss its bond order and magnetic properties OR b) i) Use the kapustinskii equation to estimate the lattice energy for MgO. Given that r^+ and r^- are the radius of the cation and anion,are 72 pm and 140 pm respectively, d=0.345 ii) Using VSEPER theory write the shapes of the following simple molecules a) XeF_6 b) $TeCl_6^{2-}$ c) $SbCl_6$	K4	CO3
28	a) i) What are Polythiazyl? How is it prepared? Which propertiesis important for industrial application ii) Discuss the structure of any one isopoly acids of chromium OR b) i) Discuss about the structure and bonding of trimeric phosphazenes. Does trimeric phosphazes show aromaticity? If yes justify your answer. ii) Discuss the structure of any one heteropolyacids of molybdenum.	K3	CO3
29	a) i) What are spinels? How are they classified? Give one example for each type.Discuss the spinel structure using CFSE values. ii) Explain the band theory of solides. OR b) i) Elaborate the method of single crystal growth using chemical vapour transport. ii) Discuss the preparation of solids using Sol-Gel and hydrothermal methods.	K3	CO4
30	a) i) How does the meson theory of exchange forces. Explain thenucleus stability. ii) Complete the following nuclear reactions (a) $^{14}_{11}N + ^{1}_{1}H \rightarrow ^{14}_{6}C + ...$ (b) $^{27}_{13}Al + ^{1}_{0}n \rightarrow ^{27}_{12}Mg +$ ..... (c) $^{55}_{25}Mn + ^{1}_{1}H \rightarrow ^{55}_{26}Fe + ...$ (d) $^{226}_{88}Ra \rightarrow ^{222}_{86}Rn + ...$		

	b) i) What are Transuranic elements? How is Plutonium Synthesized? ii) What are Radioisotopes? Mention the important radioisotopes used in various discipline?	K4	CO5

Cognitive Level	Total Marks	Percentage (%)
Remember (k1)	00	00
Understand (k2)	09	11
Apply (k3)	38	45
Analyze (k4)	36	42
Evaluate (k5)	-	-
Create (k6)	2	2

(For the candidates admitted from 2022-2023 onwards)

M. Sc. DEGREE EXAMINATION

22UPCHE3C04 Analytical Chemistry Time : Three Hours

Total marks = 75

Part A (1X20) =20

Answer all the questions

Q. No.	Questions	Cognitive Level	Course Outcome
	PART A (20X1=20Marks)		
1	Number of significant figures in 4.5578 a. Two b. Four c. Three d. Five	K1	CO1
2	Mean deviation is= a. $\sum(Mn-m)/n$ b. $\sum Mn/n$ c. $[\sum(Mn-m)/n-1]^2$ d. $[\sum(Mn-m)/n]^2$	K1	CO1
3	Which statement is correct about the standard error of a statistic? a. The standard error can never be a negative number b. The standard error increases as the sample size(s) increases. c. The standard error is the estimated standard deviation of the sampling distribution for the statistic d. All of the above.	K2	CO1
4	In a measurement, what is the term used to specify the closeness of two or more measurements? a. Accuracy b. Threshold c. Precision d. Fidelity	K1	CO1
5	Sampling is the process of: a. Extracting an amount of material b. Extracting a small quantity of material c. Extracting a large quantity of material d. a, b and c	K1	CO2
6	_____ is protecting contamination-sensitive materials from ambient conditions? a. Glove boxes b. Dry box and glove box c. isolation glove box d. none of the above	K1	CO2
7	Common analytical methods used for trace metal analysis is a. ICP-OES& ICP-MS b. AAS c. ICP-OES, ICP-MS & AAS d. ICP-	K3	CO2

	MS & AAS		
8	When a chemical splashes in the eye rinse for _____? a. 5 minutes b. 15 minutes c. 30 minutes d. 15 seconds	K1	CO2
9	Calculate the pH of a 5.0 x 10^{-2} M solution of sodium hydroxyapatite a. 10 b) 10.5 c) 13 d) 13.5	K3	CO3
10	MnO_4^- + HSO_3^- = MnO_4^{2-} + SO_4^{2-} For the above reaction , the oxidizing agent is _____ and the reducing agent is _____ a. HSO_3^-, OH^- b. MnO_4^-, HSO_3^- c.MnO_4^-, HSO_3^- d. MnO_4^-, OH^-	K2	CO3
11	What is the product of H_3O^- ion and OH^- ion concentrations in water? a. 10^{-28} b. 10^{-14} c. 10^{-7} d. 55.4	K1	CO3
12	If there is an excess of one ion over the other, the concentration of the other is suppressed and the solubility of the precipitation is a. Increased b. decreased and increased c. decreased d. increased and increased	K2	CO3
13	The complexmetric titration curve which is usually a plot of a.pM= $^-$log [M] b. Pm = $^-$log [M] c. . pM= log [M] $^{1/2}$ d. pM= log [M]	K2	CO4
14	EDTA and other similar chelating agents are called Sequestering agents because of_____ a. Ability to form ions b. Ability to active metal ions c. Ability to ability to add metal ions d. Ability to remove and inactive metal ions	K2	CO4
15	Addition of acid to indicator will shift equilibrium towards a. Up b. Right c. Down d. Left	K2	CO4
16	The complexometric titration curve which is usually a plot of a. pM = -log [M] $^{1/2}$ b. pM= -log [M] c. pM=log [M] $^{1/2}$ d. pM=log [M]	K2	CO4
17	Stationary phase and mobile phase a. Solid (or) Gas and Liquid (or) Gas b. Liquid (or) Gas and Liquid (or) Solid c. Liquid (or) Solid and Liquid (or) Gas d. Liquid (or) Solid and Solid (or) Gas	K2	CO5
18	In which of the following type of paper, chromatography does the mobile phase move horizontally over a circular sheet of paper? a. Ascending paper chromatography b. Descending paper chromatography c. Ascending – descending chromatography d. Radial paper chromatography	K2	CO5
19	Two main branches of planar chromatography is--------- a. Gel permeation chromatography& Paper chromatography b. Thin layer & ion-exchange chromatography c. Thin layer chromatography & Paper chromatography d. Thin layer chromatography & Gel permeation chromatography\	K2	CO5
20	Hydrophilic porous packing is prepared by polymerization ---------- a. 2-hydroxyethyl methacrylate b. Ethylene dimethacrylate c. c. 2-Hydroxyethyl methacrylate with Ethylene dimethycrylate d. None	K2	CO5
	PART B (3X5=15 Marks) **(Answer Any THREE questions**		
21	What is meant by the term error? Explain the classification of errors.	K2	CO1
22	Explain about samples and sampling techniques.	K2	CO2
23	Explain the theory of acid base titrations	K2	CO3
24	How Masking and Demasking agent can be used to enhance the selectivity of EDTA titration.	K2	CO4
25	Factors affecting ion exchange chromatography?.	K1	CO5

	PARTC (5X8=40Marks) (Answer ALL the questions)		
26	a) What do you meant by F-test and Q-test? How it is employed in statistical analysis. (Or) b) Explain: i. One tailed test and two tailed test in statistical hypothesis. ii. F-test.	K2	CO1
27	a) Briefly Explain the followings: (i) Types of sample (ii) Quality of sample (iii) Transfer and storage sample (Or) b) Write the important sources of contamination in trace analysis	K2	CO2
28	a) Describe the principle and procedure for the determination of chloride by Volhard method (Or) b) Write an essay on neutralization reaction	K2	CO3
29	a) Describe the basic requirements for a metal ion indicator used in complexometric titration method (Or) b) Why is small amount of magnesium salt added to the EDTA solution used for the titration of calcium with an Eriochrome Black- T indicator?	K2	CO4
30	a) Describe the development of chromatogram; (i) Accending (ii) Descending (iii) Radial (OR) b) i) Write notes on factors influencing gel permeation chromatography (ii) Application of GPC	K3	CO5

Cognitive Level	Total Marks	Percentage (%)
Remember(K1)	12	14
Understand (K2)	63	74
Apply (K3)	10	12
Analyze (K4)	-	-
Evaluate (K5)	-	-
Create (K6)	-	-

(For the candidates admitted from 2022-2023 onwards)

M. Sc. DEGREE EXAMINATION

22UPCHE3C13 Organometallic and Bioinorganic Chemistry

Time : Three Hours **Total marks = 75**

Part A (1X20) =20

Answer all the questions

Q. No.	Questions	Cognitive Level	Course Outcome
	PART A (20X1=20Marks) (Answer ALL the questions)		
1	Which of the following complex has highest ν_{CO} stretching frequency? (a) $Fe(CO)_4^-$ (b) $Fe(CO)_4^{2-}$ (c) $Fe(CO)_4$ (d) $Fe(CO)_4^+$	K3	CO1
2	The number of metal-metal bonds in $Ir_4(CO)_{12}$ is (a) 4 (b) 6 (c) 10 (d) 12	K2	CO1
3	How to predict the presence of metal carbon multiple bond in metal carbonyl a) CO stretching frequency is lower when compared to free carbonyl b) CO stretching frequency is higher when compared to free carbonyl c) no change in CO stretching frequency when compared to free carbonyl d) none	K3	CO1
4	$V(CO)_6^-$ is a) diamagnetic b) paramagnetic c) ferromagnetic d) antiferromagnetic	K3	CO1
5	In metal-olefin interaction, the extent of increase in metal olefin π back-donation would (a) lead to a decrease in C = C bond length (b) change the formal oxidation state of the metal (c) change the hybridisation of the olefin carbon from sp^2 to sp^3 (d) increase with the presence of electron donating substituents on the olefin	K4	CO2
6	The formulae of the Wilkinson catalyst is a) $[RhCl(PPh_3)_3]$ b) $[RuCl(PPh_3)_3]$ c) $[RhHCl(PPh_3)_2]$ d) $[RuHCl(PPh_3)_2]$	K3	CO2
7	The catalyst used in the conversion of ethylene to acetaldehyde using Wacker process is (a) $HCo(CO)_4$ (b) $[PdCl_4]^{2-}$ (c) V_2O_5 (d) $TiCl_4Al(C_2H_5)_3$	K4	CO2
8	$Co_2(CO)_8$is used as a catalyst is in the synthesis of (a) Butanoic acid (b) Butanal (c) 2-butanon (d)Methylpropanoate	K4	CO2
9	Ferrocene most readily undergoes Friedel-Crafts acylation gives, (a) Acylation at one ring (b) Acylation at both rings (c) Acylation at one ring with different isomers	K4	CO3
10	The haptacity of ligand cyclopentadienyl in cobaltoceneis (a) Two (b) Three (c) Four (d) Five	K4	CO3
11	Which one of the following is an example of non-aromatic oganometallic compounds? (a) $[Cr(\eta^6\text{-}C_6H_6)_2]$ (b) $Fe(\eta^5\text{-}C_5H_5)_2$ (c) $[PtCl_3(C_2H_4)]$ (d) all of these	K3	CO3
12	Ferrocene can be prepared from the reaction of sodiumcyclopentadienide ion in THF with (a) $FeCl_3$ (b) $[Fe(NH_3)_6]$ (c) $FeCl_2$ (d) $Fe(F)_6$	K4	CO3
13	The metal present in vitamin B_{12} is: (a) Fe (b) Co (c) Mg (d) Cu	K2	CO4

14	Oxidation state of iron in heamoglobin: (a) One (b) Two (c) Three (d) Four	K2	CO4
15	Iron-sulphur clusters in biological systems are involved in (a) proton transfer (b) atom transfer (c) group transfer (d) electron transfer	K3	CO4
16	Mg^{2+} is preferred in photosynthesis by chlorphyll because (a) it has strong spin-orbit coupling (b) it has weak spin-orbit coupling (c) it is a heavy metal (d) it binds strongly with chlorophyll	K3	CO4
17	In the mental health treatment, Lithium is used in the form of (a) Lithium sulphate (b) Lithium nitrate(c) Lithium acetate (d) Lithium carbonate	K2	CO5
18	The deficiency disease of cupper in our body is (a) Anaemia (b) Osteoporosis (c) Wilsons disease (d) Hypotension	K2	CO5
19	Minamata disease is due to (a) Mercury (b) Cadmium (c) Zinc (d) Lead	K3	CO5
20	Example of anticancer drug is (a) Tetracycline (b) Fluconazole (c) cis-platin (d) idoxuridine	K3	CO5
	PART B (3X5=15 Marks) **(Answer Any THREE questions**		
21	Discuss the bonding in metal nitrogen complexes.	K3	CO1
22	Explain the mechanism of hydrosilation reaction.	K4	CO2
23	Write short notes on how Cp_2Fe/Cp_2Fe^+ couple act as a biosensors.	K4	CO3
24	Write the name of enzyme used in nitrogen fixation. Discuss its role.	K3	CO4
25	Discuss the role in lithium in mental disorder.	K3	CO5
	PARTC (5X8=40Marks) **(Answer ALL the questions)**		
26	a) How is IR spectroscopy is used in the structural elucidation of metal carbonyl? (OR) b) Discuss the synthesis and bonding in alkylidene complexes.	K2	CO1
27	a) Explain the role of Wilkinson's catalyst in hydrogenation reaction. (OR) b) Explain the catalytic mechanism of Ziegler-Natta catalyst for the polymerization reaction.	K4	CO2
28	a) Discuss the structure and bonding in ferrocene using MOT. (OR) b) Explain howcyclopentadieneacts as a non-spectator ligand?	K4	CO3
29	a) What are cytochromes? Explain their biological significance. (OR) b) Discuss the mechanism of oxygen transport by Hemoglobin.	K3	CO4
30	a) Discuss the role of Gd complexes in MRI. (OR) b) Write the disadvantages of cisplatin complex in the cancer treatment. Write the name of the new metal complexes which are used to replace Pt complexes.	K3	CO5

Cognitive Level	Total Marks	Percentage (%)
Remember(K1)	-	-
Understand (K2)	13	15
Apply (K3)	40	47

Analyze (K4)	32	38
Evaluate (K5)	-	-
Create (K6)	-	-

(For the candidates admitted from 2022-2023 onwards)

M. Sc. DEGREE EXAMINATION

22UPCHE3C14 Quantum Chemistry and Group theory

Time : Three Hours **Total marks = 75**

Part A (1X20) =20

Answer all the questions

Q. No.	Questions	Cognitive Level	Course Outcome
	PART A (20X1=20Marks) (Answer ALL the questions)		
1	Which of the following is not linked to the solution of the atomic Schrodinger equation? (a). Spherical polar coordinates (b). Laguerre polynomials (c). Hermite polynomial (d). Legendre polynomials.	K3	CO1
2	What is the energy,E_1 and degeneracy, g for the j = 2 level of a rigid rotor with rotational Constant B? (a). E = 3B, g = 3 (b). E = B 6B, g = 7 (c). E = 12, g = 7 (d). E = 6B, g = 5.	K2	CO1
3	Which of the following statement is correct? (a). Only charged particle in motion are accompanied by matter waves (b). No particle in motion whether charged or uncharged is accompanied by matter waves (c). No particle whether rest or in motion is ever accompanied by matter waves (d). Only sub- atomic particles in motion are accompanied by matter waves.	K3	CO1
4	For a particle of mass m in a one-dimensional box of length l, What is the average of momentum p_x for the ground state? (a). Zero (b). h/(2l) (c). h/l (d). h / (2πl).	K3	CO1
5	In HMO- Theory overlap of integral is (a). $S_{ij} = 0$ (b). $S_{ij} = 1$ (c). $S_{ij} = 2$ (d). $S_{ij} = -1$	K4	CO2
6	If the perturbation H' =ax, where a is a constant, is added to infinite square well potential V(x) = { 0 for 0≤ x ≤ π and α otherwise the correction to the ground state energy to first order in a is (a). aπ/2 **(b)**. aπ (c). aπ/4 (d). aπ/8	K3	CO2
7	A particle has the wave function $\Psi(x,t) = A [\exp (i\omega t) \cos kx]$ Which one of the following is correct , (a) This is an eigen state of both energy and momentum (b) This is an eigen state of momentum only (c) This is an eigen state of energy only (d) This is not an eigen state for energy and momentum	K4	CO2
8	The energy separation between two successive states for a infinite potential well is given by (a). ΔE α (2n + 1) (b). ΔE α n (c). ΔE α (2n - 1) (d). ΔE α 2n	K4	CO2
9	The point group symmetry of the molecule CH2Cl2 is a). C_{2h} . b) C_{2v} . c) D_{2h} d) D_{2d}	K4	CO3
10	The point group symmetries of isosceles and equilateral triangles respectively are a). C3v and D2d b). D3h and D2d c). D3h and	K4	CO3

	C2vd). C3v and C2v		
11	The number of faces and edges in IF7 polyhedron are, respectively a). 15 and 15 b). 10 and 15 c). 10 and 10 d). 15 and 10	K3	CO3
12	4. The interplanar distance of (111) planes in fcc lattice is a). a/√6 b) a/√8 c).a/√3 d).a/√12	K4	CO3
13	If all the elements of the group may be expressed by the powers of a single element, the group is called a) Cyclic group b) Sub-group c) Non-abelian group d) permutation	K2	CO4
14	A planar AB_4 molecule with aD_{4h} point group has $\Gamma = A_{1g}+B_{1g}+E_u$. The possible orbital combinations are *a) dsp^3, d^3p b) d^3p, d^3s^1 c) dsp^2, d^2p^2 d) sp^3, s^2p^2*	K2	CO4
15	Given the character table for the point group C3v, the number of irreducible representation present in ΓR is C3v E 2C3 3σv A1 1 1 1 A2 1 1 -1 E 2 -1 0 ΓR 6 3 0 a) E+2A1+2A2 b) 2E+A1+A2 c) 3A1+3A2 d) E2+2A1	K3	CO4
16	An Oh XY6 molecule exhibits two T1u, IR active modes. Which statement is true? a) Each T1u mode is triply degenerate, and each gives rise to one absorption in the IR spectrum of XY6 b) Each T1u mode is triply degenerate, and each gives rise to three absorptions in the IR spectrum of XY6 c) Each T1u mode is non-degenerate, and gives rise to one absorption in the IR spectrum of XY6 d) One of the T1u modes is the symmetric stretching mode of XY6	K3	CO4
17	The parameters of an orthorhombic unit cell are a = 50 pm, b = 100 pm, c = 150 pm. The spacing between the (123) planes will be a) 50 pm b) 29 pm c) 19 pm d) 76 pm	K2	CO5
18	For a first order Bragg reflection, if the Bragg angle of incidence is 30^o, then d_{hkl} is equal to a) 2 b) 1 c) 1/2 d) ¼	K2	CO5
19	X-ray diffraction patterns are used for studying crystal structure of solids because a) They have very high energy, hence they can penetrate through solids b) They are electromagnetic radiation, and hence do not interact with matter (crystals) c) Their wavelengths are comparable to inter-atomic distances d) Their high frequency enables rapid analysis	K3	CO5
20	In the powder method of XRD, the intensities of various bright lines are compared to determine the crystal structure. For simple cubic lattice the ratio of intensities at first two maxima are:	K3	CO5

	a) 1⁄2 b) 3⁄4 c) 1⁄2 d) None of the mentioned		
	PART B (3X5=15 Marks) **(Answer Any THREE questions**		
21	Determine the zero-point energy of a cricket ball of mass 100g confined in three-dimensional box of length 10cm.	K3	CO1
22	Write the iterative procedure of Hartree-Fock self-consistent field method.	K4	CO2
23	Write the matrix representations of C_2, σ_v and i operations	K4	CO3
24	State and explain great Orthogonality theorem.	K3	CO4
25	A beam of X-rays of wavelength 0.071 nm is diffracted by (110) plane of rock salt with lattice constant of 0.28 nm. Find the glancing angle for the second-order diffraction.	K3	CO5
	PARTC (5X8=40Marks) **(Answer ALL the questions)**		
26	a) Solve the Schrodinger wave equation for simple harmonic oscillator (Or) b) Write notes on quantum mechanical tunneling and spin-orbit interaction.	K2	CO1
27	a) Determine the energy of hydrogen molecule using by VB theory. (Or) b) Calculate the energy and wave function of benzene using Huckel pi-electron theory.	K4	CO2
28	a) How will you determine the point group of a molecule? (Or) (b) Determine the vibrational modes of ammonia molecule? Which of them are IR and Raman active. Why?	K4	CO3
29	a) How will you determine point group for a molecule (Or) b) Construct the character table for C_3V point group	K3	CO4
30	a) Find the IR and Raman active modes of vibration of NH_3. (Or) b) i)Differentiate reducible and irreducible representations? ii) How will you reduce a reducible representation to irreducible representation with an example?	K3	CO5

Cognitive Level	Total Marks	Percentage (%)
Remember (k1)	00	00
Understand (k2)	09	11
Apply (k3)	38	45
Analyze (k4)	36	42
Evaluate (k5)	-	-
Create (k6)	2	2

(For the candidates admitted from 2022-2023 onwards)

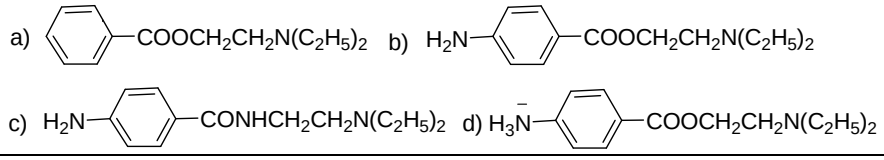
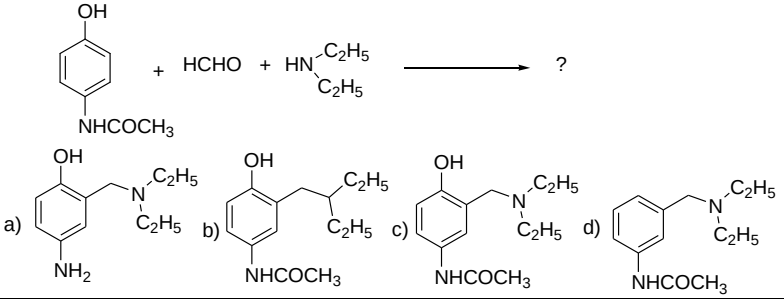
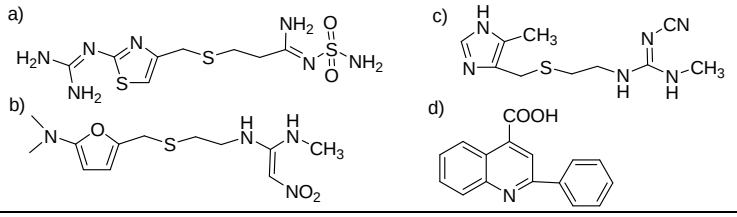
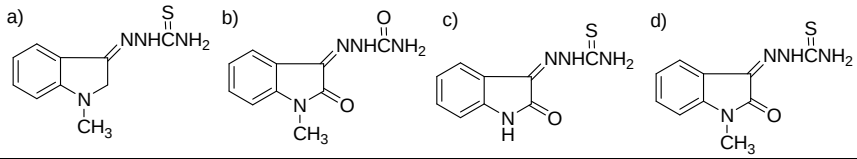
M. Sc. DEGREE EXAMINATION

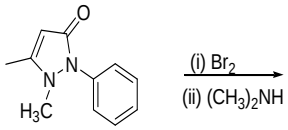
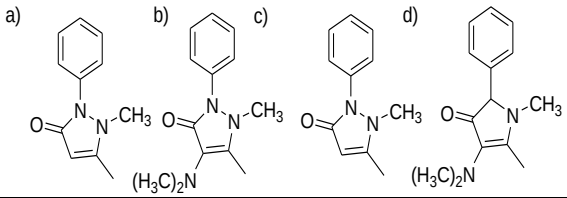
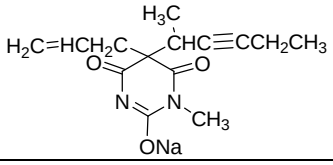
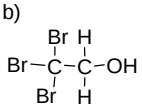
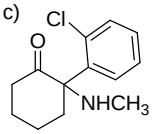
22UPCHE3E01 MEDICINAL CHEMISTRY

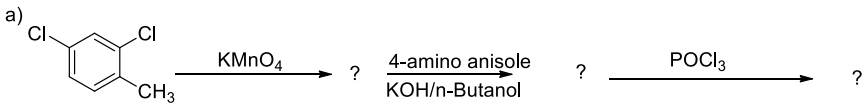
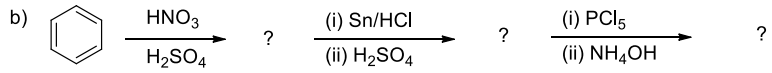
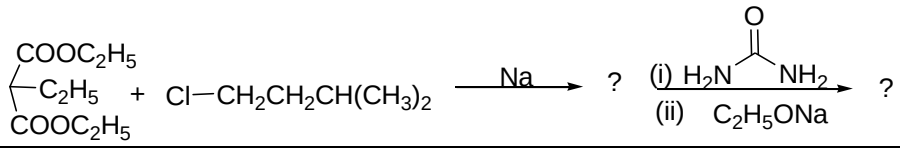
Time : Three Hours **Total marks = 75**

Part A (1X20) =20

Answer all the questions

Q. No.	Questions	Cognitive Level	Course Outcome
	PART A (20X1=20Marks) (Answer ALL the questions)		
1	Which of the following has a poor oral absorption? a) Progesterone b) Pentobarbitone c)Medroxyprogesterone d) Thiobarbital	K3	CO1
2	In which of the following hypothesis states that, "the higher the partition ratio P, the higher the pharmacological a) Henderson-Hasselbach equation b) Overton-Meyer hypothesis c) Ferguson hypothesis d) Hammett's equation	K2	CO1
3	Among the following, which is not a prodrug a) Omeprazole b) Valacyclovir c) Alprazolam d) Propranonol	K3	CO1
4	Find the correct structure of procaine 	K3	CO1
5	What will be product in the following reaction? 	K4	CO2
6	Pyrimethamine is a a) Antipyretic b) Antimalarial c) anaesthetic d) sulpha drug	K3	CO2
7	Which one the following is not act as a anti-ulcer drug, 	K4	CO2
8	The correct structure of the drug Methisazone is, 	K4	CO2
9	Which of the following gives Cinchophen on excess aq. ammonia	K4	CO3

	a) Isatin and acetophenone b) Aldehyde and acetophenone c) Salicyclic acid and acetophenone d) None of these		
10	Find out the suitable product in the following reaction,  a) b) c) d) 	K4	CO3
11	Which of the following is used as an antiallergic agents a) amobarbital b) pyrilamine maleate c) Halothan d) phenazone c) Sulphapyridine & Ranitidine d) None of the above	K3	CO3
12	Which one the following is not act as a anaesthetic, a)  b)  c)  d) All the above	K4	CO3
13	Arsenites are easily soluble in ..... a) Water b) Toluene c) Dichloromethane d) All the above	K2	CO4
14	Which inorganic compound is used as treatment of cardiovascular disease? a) Magnesium disodium EDTA b) Histidine c) Calcium disodium EDTA d) Lanthanum carbonate	K2	CO4
15	ZnO is used for ..... a) Skin ointment b) Anti-allergic agent c) Antidiabetic d) Antiseptic	K3	CO4
16	. ..... is known as Paris green. a) Arsenious oxide b) Monosodium arsenite c) Copper acetoarsenite d) dimethyl arsenic acid	K3	CO4
17	..... is one of the leading metal –based drugs widely used in the treatment of testicular cancer. a)Carboplatin b) Oxaliplatin c) Cis-platin d) Silver sulphadiazine	K2	CO5
18	Cis-amminedichloro (2-methylpyridine) platinum (II) is called ..... a)ZD 0001 b) ZD 0473 c) ZD 3465 d) ZD 3400	K2	CO5
19	Chronic osteoarthrosis affecting fingers, toes and long bones is found in children aged between ..... years. a) 5 and 12 b) 6 and 10 c) 2 and 5 d) 5 and 8	K3	CO5
20	..... compound (2% aqueous solution) is used as a topical antiseptic. a) Mercurochrome b) Hemochrome c) Both a and b d) none of the all	K3	CO5
	PART B (3X5=15 Marks) **(Answer Any THREE questions**		
21	Write a note on accidental drug discovery.	K3	CO1
22	What will be the drug product formed in the following reactions,	K4	CO2

	a)  b) 		
23	What will be the drug product formed in the following reaction, 	K4	CO3
24	Write a short note on chemical forms of arsenic metal and the environmental fate.	K3	CO4
25	Write a short note on neurological agents and give few examples.	K3	CO5
	PARTC (5X8=40Marks) **(Answer ALL the questions)**		
26	(a) (i) Write a note on Ferguson principle. (ii) What is pKa? Why is it an important property for a drug? Explain with example. (OR) (b) Define drug metabolism. Explain phase I and II reactions.	K2	CO1
27	(a) Discuss the synthesis of chloroquine phosphate. (OR) (b) Explain the synthesis of Ranitidine, Nizatidine and its uses	K4	CO2
28	(a) Describe the synthesis of pyrilamine maleate and antazoline hydrochloride and its uses. (OR) (b) What are intravenous and basal anaesthetics? Describe the synthesis of following: Methohexital sodium and Tribromoethanol.	K4	CO3
29	(a) Write about metal activation of organic drugs and magnetic resonance imaging contrast agents. (OR) (b) Explain about radiodiagnostic agents and photochemotherapeutic metallodrugs.	K3	CO4
30	(a) What are anticancer agents? Why many ruthenium compounds are used as very promising anticancer activity in recent years? (OR) (b) Explain about the uses of the following compounds a) Silver sulphadiazine b) N-methylglucamine antimonate and draw their structures.	K3	CO5

Cognitive Level	Total Marks	Percentage (%)
Remember(K1)	-	-
Understand (K2)	13	15
Apply (K3)	40	47
Analyze (K4)	32	38
Evaluate (K5)	-	-
Create (K6)	-	-

(For the candidates admitted from 2022-2023 onwards)

M. Sc. DEGREE EXAMINATION

22UPCHE3E03 NANOMATERIALS CHEMISTRY

Time : Three Hours **Total marks = 75**

Part A (1X20) =20

Answer all the questions

Q. No.	Questions	Cognitive Level	Course Outcome
	PART A (20X1=20Marks) (Answer ALL the questions)		
1	The metal ion used in Zeigler-Natta catalysis is A) Rh B) Ir C) Ni D) Ti	K3	CO1
2	Caprolactum is the monomer of A) Nylon-6 B) PVC C) Backelite D) Teflon	K2	CO1
3	The monomer which undergoes polymerization to form Teflon is A) $CH_2=CH_2$ B) CH_2-CHCl C) $CH_2=CHCN$ D) $CF_2=CF_2$	K3	CO1
4	Inorganic benzene is A) BH_3NH_3 B) $B_3N_3H_6$ C) B_2H_6 D) BH_3	K3	CO1
5	Textile fibers are prepared from A) Terglene B) Teflon C) PVC D) Nylon-6,6	K4	CO2
6	The copolymers which is used as cationic exchange resins is A) Styrene-acrylonitrile B) Nitrated styrene C) Halogenater styrene D) Sulphonated styrene	K3	CO2
7	The polymer which is used in adhesives and protective coating is A) Polystyrene B) Poly vinyl chloride C) Polyethylene D) Polyester	K4	CO2
8	Identify the biocompotability polymer A) PVC B) Teflon C) Nylon-6,10 D) PLLA	K4	CO2
9	The ratio between phenol and formaldehyde in phenol-formaldehyde resin is A) 1:5 B) 1:3 C) 1:1.5 D) 1:10	K4	CO3
10	Identify the polymers is used fabrication of artificial blood vessels A) PVC B) Teflon C) Fluoroalkoxy substituted phosphonitrillic polymers D) Polyesters	K4	CO3
11	Silicon has a stable A) Three dimensional structure B) Linear structure C) Two dimensional structure D) None of these	K3	CO3
12	Identify the polymer is used for injection moulded A) Polystyrene B) Styrene-acrylonitrile polymer C) Acrylonitrile-butadiene-styrene polymer D) Polyethylene	K4	CO3
13	Silicon is A) Copolymers B) Cross linked polymers C) Linear polymers D) Addition polymers	K2	CO4
14	1 bar is equal to ---------- psi A) 14.5038 B) 14.5138 C) 14.6036 D) 14.5234	K2	CO4
15	Identify the chemical method for the deposition of thin films A) ALD B) E-beam evaporation C) PVD D) Sputtering	K3	CO4
16	What is 0D material? A) CNTs B) Graphene C) Graphite D) GQDs	K3	CO4

17	How to measure the surface roughness of thin film A) AFM B) TEM C) SEM D) XPS	K2	CO5
18	Unit of specific energy density A) mWh/cm^3 B) F/g C) cm^3 D) mW/cm^3	K2	CO5
19	Choose the best potocatalytic material for organic dye degradation A) TiO_2 B) MgO C) PEDOT D) Na	K3	CO5
20	Photochromic materials undergoes reversible colour change in presence of A) Heat B) Light C) Stress D) Pressure	K3	CO5
	PART B (3X5=15 Marks) **(Answer Any THREE questions**		
21	If average degree of polymerization of polypropylene was 2×10^4, calculate the weight average molecular weight of the polymer	K3	CO1
22	A polymer has the following composition: 100 molecules of molecular mass 1000 g/mol, 200 molecules of molecular mass 2000 g/mol and 500 molecules of molecular mass 5000 g/mol. Calcualte the number and weight of average molecular weight and the polydispersity index	K4	CO2
23	When 52 g of styrene was polymerized, average degree of polymerization was found to be 1.5×10^5. Calculate the number of styrene molecules in the original sample and number of molecules of polystyrene produced	K4	CO3
24	Determine the approximate interaction present for a single polyethylene chain of 1500 repeat units within a liquid hexane solution (assuming that the interaction was about 2 kcal/mol repeat methylene unit)	K3	CO4
25	Calculate the relative viscosity, specific viscosity, reduced viscosity and inherent viscosity of a 0.5 %) made by dissolving 0.25g of polymer in 50 mL of solvent) solution where the time for solvent flow between the two appropriate marks was 60s and the time of flow for the solution was 80s	K3	CO5
	PARTC (5X8=40Marks) **(Answer ALL the questions)**		
26	(A) Detailed explanation of copolymerization (8) (OR) (B) Detailed dissuasion on addition polymerization (8)	K2	CO1
27	(A) Discuss the followings (i) Plastic elastomers (ii) Fibres (4+4=8) (OR) (B) Explain the followings (i) Die casting (ii) Fibre spinning (4+4=8)	K4	CO2
28	(A) Synthesis and chemical structure of the followings (i) Polyethylene (ii) Polyaminde (iii) Polyester (iv) Silicone polymers (2+2+2+2=8) (OR) (B) Write a short note on biomedical and synthetic polymers (with two suitable examples and their structures) (4+4=8)	K4	CO3
29	(A) Detailed discuss on the followings: (i) 0D (ii) 1D (iii) 2 D (iv) 3D (2+2+2+2=8) (OR) (B) (i) Explain theory and instrumentation of PVD and CVD	K3	CO4

	techniques (4+4=8)		
30	(A) List out the types of fuel cells and provides the detailed explanation of any two types of fuel cells (8) (OR) (B) List out the types of batteries and provides the detailed explanation of any two types of batteries (8)	K3	CO5

Cognitive Level	Total Marks	Percentage (%)
Remember(K1)	-	-
Understand (K2)	13	15
Apply (K3)	40	47
Analyze (K4)	32	38
Evaluate (K5)	-	-
Create (K6)	-	-

XX. List of Question paper setters / Examiners

From Periyar University & Affiliated Colleges		Outside Periyar University	
S. No.	**Name and Address**	**S. No.**	**Name and Address**
1.	Dr. V. Raj Professor and Head Department of Chemistry Periyar University, Salem – 636 011	1.	Dr.A. Ponnusamy Professor and Head , Department of Organic Chemistry Madurai Kamaraj University, Madurai 625 021
2.	Dr. P. Viswanathamurthi Professor Department of Chemistry Periyar University, Salem – 636 011	2.	Dr. A.Ilangovan Professor of Chemistry School of Chemistry Bharathidasan University, Tituchirapalli – 24
3.	Dr. D. Gopi Professor Department of Chemistry Periyar University, Salem – 636 011	3.	Dr. M.G.Sethuraman. Professor and Head Department of Chemistry Gandhigram Rural University Gandhigram - 624 302, Dindigul District
4.	Dr. A. Lalitha Associate Professor Department of Chemistry Periyar University, Salem – 636 011	4.	Dr. K.P.Elango Professor Department of Chemistry School of Chemistry Madurai Kamaraj University, Madurai 625 021
5.	Dr. R. Rajavel Associate Professor Department of Chemistry Periyar University, Salem – 636 011	5.	Dr. R. Karvembu Professor Department of Chemistry National Institute of Technology Tiruchirapalli
6.	Dr. V. Sujatha Assistant Professor Department of Chemistry Periyar University, Salem – 636 011	6	Dr. R.Ramesh Professor of Chemistry School of Chemistry Bharathidasan University, Tituchirapalli – 24
7.	Dr. K. Shanmuga Bharathi Assistant Professor Department of Chemistry Periyar University, Salem – 636 011	7.	Dr. T. M. Sridhar Head, Department of Analytical Chemistry University of Madras, Guindy Campus, Chennai-600 025
8.	Dr. Umarani Associate Professor and Head Department of Chemistry Govt. Arts College, Salem – 636 007.	8.	Dr. K. Krishnasamy Associate Professor Department of Chemistry Annamalai University, Annamalai Nagar, Chidambaram
9.	Mrs. S.Geetha Associate professor and Head Department of Chemistry Sarada college for women Salem – 636 016	9.	Dr. S. Abraham John Professor Department of Chemistry Gandhigram Rural University Gandhigram - 624 302 ,Dindigul

			District