PERIYAR UNIVERSITY

Salem – 636011, Tamil Nadu, India

State University - NAAC A++ Grade - NIRF Rank 94

State Public University Rank 40 – SDG Institutions Rank Band 11 - 50

M.Sc., DEGREE

[Choice Based Credit System (CBCS)]

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

Programme Code: CHE02

REGULATIONS AND SYLLABUS

[For the candidates admitted from the academic year 2026– 2027 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 Bioinorganic Chemistry, 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 consists of 90 working days.

VI - Course of Study

M.Sc. Chemistry - CBCS

Structure of the Programme

S. No	Paper code	Title of the Paper	Total Hours	L/ W	T/ W	P/ W	C
First Semester							
1.	26UPCHE1C01	Core Course 1 - Aromaticity and organic reaction mechanism	72	3	1	0	4
2.	26UPCHE1C02	Core Course 2 - Main group and Solid-State Chemistry	72	3	1	0	4
3.	26UPCHE1C03	Core Course 3 - Thermodynamics and Electrochemistry	72	3	1	0	4
4.	26UPCHE1E--	Elective course I - Discipline Centric	72	3	1	0	4
5.	26UPCHE1E--	Elective course II - Generic	72	3	1	0	4
6.	26UPCHE1C04	Core Course 4 - Organic Chemistry Practical	90	0	0	5	3
		Total	**450**	**15**	**5**	**5**	**23**
Second Semester							
7.	26UPCHE1C05	Core Course 5 - Organic reactions, reagents and stereochemistry	72	3	1	0	4
8.	26UPCHE1C06	Core Course 6 - Coordination Chemistry	72	3	1	0	4
9.	26UPCHE1C07	Core Course 7 – Chemical Dynamics and Surface Chemistry	72	3	1	0	4
10.	26UPCHE1E--	Elective Course III - Discipline Centric	72	3	1	0	4
11.	26UPCHE1E--	Elective Course IV - Generic	72	3	1	0	4
12.	26UPCHE1C08	Core Course 8 - Inorganic Chemistry Practical	90	0	0	5	3
13.	26UPPGC1H01	Compulsory Course - Human Rights-Duties	18	1	0	0	2
14.	26UPCHE1N01	SWAYAM (Non-Major Elective I)	Online				2

		Total	**468**	**16**	**5**	**5**	**27**
	INTERNSHIP-During Summer Vacation (4 to 6 weeks)						
Third Semester							
15.	26UPCHE1C09	Core Course 9 - Organic Synthesis and Natural Products	72	3	1	0	4
16.	26UPCHE1C10	Core Course 10 – Organometallic Chemistry and Inorganic Spectroscopy	72	3	1	0	4
17.	26UPCHE1C11	Core Course - 11 Quantum Chemistry and Group theory	72	3	1	0	4
18.	26UPCHE1E--	Elective Course V - Discipline Centric	72	3	1	0	4
19.	26UPCHE1E--	Elective Course VI - Generic	72	3	1	0	4
20.	26UPCHE1N--	Supportive course (Non-Major Elective II)	54	2	1	0	2
21.	26UPCHE1C12	Core Course 12 - Physical Chemistry Practical	72	0	0	4	3
22.	26UPGEN1V01	Value Added Course - Peace Education	54	2	1	0	2
23.	26UPCHE1I01	Internship Viva	-	-	-	-	2
		Total	**540**	**19**	**7**	**4**	**29**
Fourth Semester							
24.	26UPCHE1C13	Core Course 13 Project	306	--	--	17	8
25.	26UPCHE1E--	Elective Course VII - Industry / Entrepreneurship	72	1	0	3	3
26.	26UPCHE1E--	Elective Course VIII - Skill Enhancement course	72	3	1	0	3
27.	26UPCHE1X01	Extension Activity	-	-	-	-	1
28.	26UPCHE1V--	Value Added Course	-	-	-	-	-
		Total	**450**	**6**	**2**	**22**	**17**

Total Credits: 94

Elective Courses – Discipline Centric

1.	26UPCHE1E01	Bioinorganic Chemistry	72	3	1	0	4
2.	26UPCHE1E02	Polymer Chemistry	72	3	1	0	4
3.	26UPCHE1E03	Green Chemistry	72	3	1	0	4
4.	26UPCHE1E04	Medicinal Chemistry	72	3	1	0	4
5.	26UPCHE1E05	Environmental Chemistry	72	3	1	0	4
6.	26UPCHE1E06	Supramolecular Chemistry	72	3	1	0	4

Elective Courses – Generic

1.	26UPCHE1E07	Spectroscopy	72	3	1	0	4
2.	26UPCHE1E08	Nanomaterials and Nanotechnology	72	3	1	0	4
3.	26UPCHE1E09	Analytical and Instrumental Analysis	72	3	1	0	4
4.	26UPCHE1E10	Pharmaceutical Chemistry	72	3	1	0	4
5.	26UPCHE1E11	Phytochemistry and Pharmacognosy	72	3	1	0	4
6.	26UPCHE1E12	Research methodology	72	3	1	0	4

Elective - Industry / Entrepreneurship

1.	26UPCHE1E13	Cosmetic Chemistry	72	1	0	3	3
2.	26UPCHE1E14	Chemical Polishing of metals	72	1	0	3	3
3.	26UPCHE1E15	Preparation of Consumer Products	72	1	0	3	3

Elective - Skill Enhancement Courses

1.	26UPCHE1E16	Research Tools and Techniques	72	3	1	0	3
2.	26UPCHE1E17	Laboratory Safety and Hazard Management	72	3	1	0	3
3.	26UPCHE1E18	Computational Chemistry	72	3	1	0	3

Supportive Courses for other Departments (Non Major Elective)

1.	26UPCHE1N01	Chemistry and Health	54	2	1	0	2
2.	26UPCHE1N02	Applied Cosmetic Chemistry	54	2	1	0	2
3.	26UPCHE1N03	Water Chemistry	54	2	1	0	2
4.	26UPCHE1N04	Industrial Chemistry	54	2	1	0	2
5.	26UPCHE1N05	Chemistry in Agriculture	54	2	1	0	2
6.	26UPCHE1N06	Chemistry in Daily Life	54	2	1	0	2
7.	26UPCHE1N07	Pharmaceutics	54	2	1	0	2
8.	26UPCHE1N08	Fundamentals of Analytical Chemistry	54	2	1	0	2

Value Added Courses (Certificate course-Extra credits)

1.	26UPCHE1V01	Electro polishing of Metals	30	2	0	0	2
2.	26UPCHE1V02	Chemical Energy	30	2	0	0	2
3.	26UPCHE1V03	Water Analysis	30	2	0	0	2

Note:

1. Human Rights – Compulsory course for All P.G. students
2. Value Added Course - Peace Education - Compulsory course for All P.G. students
3. C – Core Courses, E – Elective Courses & N – Non Major Elective Courses; L – Lecture, T – Tutorial, P – Practical

Credits for Core Courses **53**

Credits for Elective Courses **30**

Credits for Supportive Course **02**

Credits for Swayam Course **02**

Credits for Human rights Course **02**

Credits for Value added Course **02**

Internship Viva **02**

Extension Activity **01**

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 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.	26UPCHE1C01	Core Course 1 - Aromaticity and organic reaction mechanism	3	25	75	100	4
2.	26UPCHE1C02	Core Course 2 - Main group and solid-state Chemistry	3	25	75	100	4
3.	26UPCHE1C03	Core Course 3 - Thermodynamics and Electrochemistry	3	25	75	100	4
4	26UPCHE1E--	Elective course I - Discipline Centric	3	25	75	100	4
5.	26UPCHE1E--	Elective course II - Generic	3	25	75	100	4
6.	26UPCHE1C04	Core Course 4 - Organic Chemistry Practical	6	40	60	100	3
Second Semester							
7.	26UPCHE1C05	Core Course 5 - Organic reactions, reagents and stereochemistry	3	25	75	100	4
8.	26UPCHE1C06	Core Course 6 - Coordination Chemistry	3	25	75	100	4
9.	26UPCHE1C07	Core Course 7 – Chemical Dynamics and Surface Chemistry	3	25	75	100	4
10.	26UPCHE1E--	Elective Course III - Discipline Centric	3	25	75	100	4
11.	26UPCHE1E--	Elective Course IV - Generic	3	25	75	100	4
12.	26UPCHE1C08	Core Course 8 - Inorganic Chemistry Practical	6	40	60	100	3
13.	26UPPGC1H01	Compulsory Course - Human Rights-Duties	3	25	75	100	2
14.	26UPCHE1N01	SWAYAM	Online				2
Third Semester							
15.	26UPCHE1C09	Core Course 9 - Organic Synthesis and	3	25	75	100	4

		Natural Products					
16.	26UPCHE1C10	Core Course 10 – Organometallic Chemistry and Inorganic spectroscopy	3	25	75	100	4
17.	26UPCHE1C11	Core Course - 11 Quantum Chemistry and Group theory	3	25	75	100	4
18.	26UPCHE1E--	Elective Course V - Discipline Centric	3	25	75	100	4
19.	26UPCHE1E--	Elective Course VI - Generic	3	25	75	100	4
20.	26UPCHE1N--	Supportive course	3	25	75	100	2
21.	26UPCHE1C12	Core Course 12 - Physical Chemistry Practical	6	40	60	100	3
22.	26UPGEN1V01	Value Added Course - Peace Education	3	25	75	100	2
23.	26UPCHE1I01	Internship Viva	-	-	-	-	2
Fourth Semester							
24.	26UPCHE1C13	Core Course 13 Project	-	50	150	200	8
25.	26UPCHE1E--	Elective Course VII - Industry / Entrepreneurship	3	25	75	100	4
26.	26UPCHE1E--	Elective Course VIII - Skill Enhancement course	3	25	75	100	4
27.	26UPCHE1X01	Extension Activity	-	-	-	-	1
28.	26UPCHE1V--	Value Added Course (certificate course)	-	-	-	-	-

X - Question Paper Pattern

Internal Examinations

Time: 2 Hours Max. Marks - 50

PART-A: 16x1=16

(Answer all questions)

PART-B: 2 x 5=10

(Answer any two out of three questions)

PART C: 3x8=24

(Answer all questions)

(either or type Maximum two Sub-Divisions only)

End Semester Examinations

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 out of five 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)

26. a) or b)

27. a) or b)

28. a) or b)

29. a) or b)

30. a) or b)

XI - Distribution of Marks Theory and Practical Examinations

Theory Marks

Internal Marks (Maximum 25)

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

External Marks (Maximum 75)

Marks distribution as per question paper pattern

Practical Marks

Internal marks (Maximum 40 marks)

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

External marks (Maximum 60 marks)

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

Inorganic Chemistry Practical	
Qualitative analysis	30 marks
Preparation	10 marks
Viva-voce in practical	10 marks

Record	10 marks
Total	**60 marks**

Physical Chemistry Practical	
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

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.

a) **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.

b) **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.

c) 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.

d) 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.

e) 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

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

A candidate shall be declared to have passed the examination if he/she secures a minimum of 50% marks in the External Examination (University Examination) and an overall aggregate of 50% in the Internal and External Examinations taken together.

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 2026-2027..i.e., for students who are to be admitted to the first year of the programme during the academic year 2026-2027 and thereafter.

XVII - Transitory Provision

Candidates admitted to the M.Sc. Degree Programme in Chemistry prior to the academic year 2026–2027 shall be permitted to appear for the examinations under the previous syllabus for a period of three years, i.e., up to and including the April/May 2029 examinations. Thereafter, they shall appear for the examinations only under the syllabus and regulations in force at that time.

XVIII - Syllabus

CORE COURSES

First Semester

26UPCHE1C01 AROMATICITY AND ORGANIC REACTION MECHANISM

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

1. To understand the structure and reactivity of chemically active centers
2. To understand the concept of aromaticity
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 Number	CO Statement	Knowledge Level
CO1	understand the basic reaction mechanism and its determination be familiar with the concepts of aromaticity	K1, K2 & K3
CO2	be familiar with the concepts of aromaticity	K2, K3 & K4
CO3	understand in detail about the mechanism of both aliphatic and aromatic nucleophilic substitution reactions.	K3, K4 & K5
CO4	understand the concepts of electrophilic substitution reactions in aromatic and aliphatic compounds.	K3, K4 & K5
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.	K3, K4 & K5

UNIT - I Reaction Intermediates and Determination of Reaction Mechanism

Reaction intermediates- Formation, stability and structure of carbenes and nitrenes. The transition state, Thermodynamic and kinetic requirements of reactions: Microscopic reversibility, Hammond postulate. 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 methods - relation of rate and mechanism. Effect of structure on reactivity: Hammett and Taft equations. Linear free energy relationship, partial rate factor, substituent and reaction constants.

Tutorials: Problems on prediction of products.

UNIT - II Aromaticity

Aromaticity of benzenoid, heterocyclic and non-benzenoid compounds-Huckel rule and Craig's rule. Effect of aromaticity on bond lengths, resonance, resonance energies, homo isodesmic reactions and electronic absorption spectra. Aromatic systems with other than six π electrons, non-aromatic and anti-aromatic systems with more than 10 π electrons – annulenes, azulenes, tropolones, fulvenes and ferrocenes (synthesis not necessary). Homo-aromaticity.

Tutorials: Prediction of aromaticity of given compounds.

UNIT - III Nucleophilic Substitution Reactions

S_N1, S_N2, and SNi mechanism and evidences, Stereochemistry of S_N1 and S_N2 mechanisms, Reactivity - Effect of structure, leaving group, attacking nucleophile and solvent polarity. Neighbouring group participation and non-classical carbocations. Aliphatic nucleophilic substitutions at an allylic carbon, aliphatic trigonal carbon and vinyl carbon. Swain-Scott, Grunwald-Winstein relationship - Ambident nucleophiles.

Aromatic nucleophilic substitution: Mechanisms - S_NAr, S_N1 and Benzyne mechanisms - Evidences - Reactivity, Effect of structure, leaving group and attacking nucleophile. Reactions: Bucherer and Rosenmund reactions, von Richter, Sommelet- Hauser and Smiles rearrangements.

Tutorials: Problems on conversions and mechanism.

UNIT - IV Electrophilic Substitution Reactions

Aromatic electrophilic substitution - arenium ion mechanism, typical reactions like Friedel-Crafts alkylation, acylation, arylation and diazonium coupling. Orientation and reactivity - ortho, meta and para directing groups, ortho-para ratio. 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 E1cB mechanisms. Syn- and anti- eliminations. Orientation of the double bond - Hofmann and Saytzeff rules. Mechanism of pyrolytic eliminations, and Chugaev reaction.Addition to Carbon - Carbon and Carbon - Hetero atom Multiple bonds-Hydrogenation of double and triple bonds, 1,3-dipolar addition. hydrolysis of esters and amides. ammonolysis of esters.

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

Tutorials: 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. Arun Sarkar, **Advanced Organic Chemistry: Reactions and Mechanisms**, Indramani Pandey 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.

26UPCHE1C02 MAIN GROUP AND SOLID STATE CHEMISTRY

Hours	L	T	P	C
72	3	1	0	4

Objectives

1. To learn the structure and bonding in small molecules.
2. To understand the basic concepts and bonding in main group elements and inorganic polymers.
3. To gain fundamental knowledge on the structural aspects of ionic crystals.
4. To study the effect of point defects as well as line defects in ionic crystals and structural aspects of solids.
5. To familiarize various diffraction and microscopic techniques.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	Predict the geometry and bonding of main group compounds.	K2, K3 & K4
CO2	Understand the various types of inorganic polymers, heterocyclic ring systems and clusters.	K2, K3 & K4
CO3	Explain about the packing of ions in crystals and apply the radius ratio rule to predict the coordination number of cations.	K2, K3 & K4
CO4	Understand the various types of ionic crystal systems, analyze their structural features and band theory and defects in crystals.	K2, K3 & K4
CO5	Understand the principles of diffraction techniques and microscopic techniques.	K2, K3 & K4

UNIT - I 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. 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.

Tutorials - Problem solving exercises related to bonding and geometry of the molecules.

UNIT - II Rings, Cages and Clusters

Chemistry of boron –classification, structure and bonding of higher boranes, borazines, boron nitrides, hydroborate ions Lipscomb styx rule. Carboranes – nido, closo, arachno structure and bonding Chemistry of silicon – classification of silicates, siliconessiloxanes, silanes, higher silanes, silicon nitrides. P-N compounds-linear and cyclic phosphazenes, S-N compounds – structure and bonding of S4N4, polythiazyl (SN)x compounds. Poly acids – types, examples and structures. Cluster compounds – bi-, tri-, tetra- and hexa-nuclear clusters (Metal halides and oxides only), Wade and Mingo's rule, polyatomic Zintl anions and cations.

Tutorials: Problems on structure and bonding.

UNIT - III Solid State Chemistry – I

Ionic crystals: Packing of ions in simple, hexagonal and cubic close packing, voids in crystal lattice, Radius ratio, Crystal systems and Bravis lattices, Symmetry operations in crystals, glide planes and screw axis; point group and space group; Solid state energetics: Lattice energy – Born-Lande equation - Kapustinski equation, Madelung constant.

Tutorials: Problems on the above titles.

UNIT - III Solid State Chemistry – II

Structural features of the crystal systems: Rock salt, zinc blende & wurtzite, fluorite and anti-fluorite, rutile and anatase, cadmium iodide, nickel arsenide, perovskite structures. Crystal Growth methods: From melt and solution (hydrothermal, sol-gel methods) – principles and examples. Band theory – features and its application in conductors, insulators and semiconductors, Intrinsic and extrinsic semiconductors; Defects in crystals – point defects (Schottky, Frenkel, metal excess and metal deficient) and their effect on the electrical and optical properties; Laser and phosphors; Linear defects and their effects due to dislocations.

Tutorials: Problems on the above titles.

UNIT - V Techniques in Solid State Chemistry

X-ray diffraction technique: Bragg's law, Powder diffraction method – Principle and Instrumentation; Interpretation of XRD data – JCPDS files, Phase purity, Scherrer formula, lattice constants calculation; Systematic absence of reflections; Electron diffraction technique – principle, instrumentation and application. Electron microscopy – difference between optical and electron microscopy, theory, principle, instrumentation, sampling methods and applications.

Tutorials: Problems on the above titles.

Text Books

1. J.E. Huheey, E.A. Keiter, R.L. Keiter, O.K. Medhi **Inorganic Chemistry: Principles of Structure and Reactivity**, Pearson India Publishers, 5th Edition, 2022.
2. J. D. Lee, Concise Inorganic Chemistry, Wiley India, 5th Edition, 2021.
3. F. A. Cotton and G. Wilkinson, C. A. Murillo, M. Bochmann, **Advanced Inorganic Chemistry, An Indian Adaptation**, Wiley India, 6th Edition, 2021.
4. Ajai Kumar, **Chemistry of The Main Group Elements**, Aaryush Education, 1st Edition, 2021
5. S. K. Agarwala, Keemti Lal, **Advanced in Inorganic Chemistry**, Pragathi Pragasam, 2022.
6. F. Liebau, **Structural Chemistry of Silicates: Structure, Bonding, and Classification**, Springer, 1st Edition, 2012.
7. A. R. West, **Solid State Chemistry and its Applications**, John Wiley & Sons, 2nd Edition (Students Edition), 2014.
8. A. K. Bhagi and G. R. Chatwal, **A Textbook of Inorganic Polymers**, Himalaya Publishing House, 2001.
9. L. Smart, E. Moore, **Solid State Chemistry – An Introduction**, 4th Edition, CRC Press, 2012.
10. K. F. Purcell and J. C. Kotz, **Inorganic Chemistry**, 2nd Edition, Cengage Learning, 2012.

Reference Books

1. G. L. Miessler, P.J. Fischer D. A. Tarr, Inorganic Chemistry, 5th Edition, Pearson, 2025.
2. M. Weller, T. Overton, **Inorganic Chemistry**, Seventh International Edition, 2018
3. P. Atkins, T. Overton, J. Rourke, M. Weller, F. Armstrong, M. Hagerman, Shriver & Atkins' Inorganic Chemistry, 5th edition, W. H. Freeman and Company, New York, 2010.
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, 3rd Edition, 2010.
6. A.F. Wells, **Structural Inorganic Chemistry**, Oxford University Press, 5th Edition (Reprint), 2012.
7. L. Smart, E. Moore, **Solid State Chemistry - An Introduction**, Chapman & Hall, 2005.
8. H. V. Keer, **Principles of the Solid State**, New Age International Publishers, 2nd Edition,

2017.

9. D. E. Douglas, D.H. McDaniel and J. J. Alexander, **Concepts and Models in Inorganic Chemistry**, Wiley, 3rd Edition, 1994.
10. R. J. D. Tilley, **Understanding Solids - The Science of Materials**, 2ndEdition, Wiley Publication, 2013.
11. C. N. R. Rao and J Gopalakrishnan, **New Directions in Solid State Chemistry**, 2nd Edition, Cambridge University Press, 1997.
12. T. Moeller, **Inorganic Chemistry, A Modern Introduction**; John Wiley, 2nd Edition, 1982.

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.

26UPCHE1C03 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 concepts of chemical and phase equilibria.
3. To understand the concepts of statistical thermodynamics.
4. To understand the conductometric and potentiometric titrations.
5. To understand the Electrode-electrolyte interface 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 the conductometric and potentiometric titrations.	K2, K3 & K4
CO5	Understand the Electrode-electrolyte interfaces and elucidate the structures of electrical double layers.	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.

Tutorials: Problems related to Thermodynamic functions and their relationships

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.

Tutorials: 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, Heat capacities of solids – Einstein and Debye Theories.

Tutorials: 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.

Tutorials : 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 - Electrokinetic 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.

Tutorials : Problems in Electrode-electrolyte interface and Electrokinetic phenomina.

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

26UPCHE1C04 ORGANIC CHEMISTRY PRACTICAL

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 double stage preparation of organic compounds.
3. To be familiarise with estimation of organic compounds.
4. 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	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**
CO4	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 (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)

v. Acetyl salicylic acid from methyl salicylate (Ester hydrolysis)

III. 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

IV. 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**, Cambridge Soft 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.

SECOND SEMESTER

26UPCHE1C05 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, to 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 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.	K3, K4 & K5

UNIT - I Organic Photochemistry

Organic photochemistry - Introductory theory of light absorption. Characteristics of

photochemical reactions. Photophysical processes - Jablonski diagram and energy transfer. Photochemical reactions 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.

Tutorials: 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.

Tutorials: 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, Baker-Venkataraman, Baeyer-Villiger, Wolff, Stevens, Von-Richter, Lossen, Schmidt, Sommelet-Hauser, Smiles, Dakins, and [1,2]-Wittig and [2,3]-Wittig rearrangements (a few examples in each rearrangement are to be studied).

Tutorials: Problems on prediction of products, reagents, conditions, mechanism and name of the reaction.

UNIT - IV Oxidation and Reduction Reactions

Mechanisms: Direct electron transfer, hydride transfer, hydrogen transfer, displacement,

addition-elimination, oxidative and reductive coupling reactions. Mechanism of oxidation reactions: Dehydrogenation by quinones, selenium dioxide, ferricyanide, mercuric acetate, lead tetraacetate, permanganate, manganese dioxide and osmium tetroxide. Oxidation of saturated hydrocarbons, alkyl groups, alcohols, halides and amines. Reactions involving cleavage of C-C bonds - cleavage of double bonds, oxidative decarboxylation, allylic oxidation, oxidation by chromium trioxide-pyridine, DMSO-Oxalyl chloride (Swern oxidation) and Corey-Kim oxidation, dimethyl sulphoxide- dicyclohexyl carbodiimide (DMSO-DCCD).

Mechanism of reduction reactions: Rosenmund, reduction with trialkyl and triphenyltin hydrides, McFadyen-Steven's reduction, Homogeneous hydrogenation, Hydroboration with cyclic systems and Bouveault-Blanc reduction.

Tutorials: 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. Optical purity, Asymmetric synthesis - using chiral reagents, optical isomerism due to asymmetric and dissymmetric molecules with C, N, S based chiral centers. Racemic modification: Racemization by thermal, anion, reversible formation, epimerization, mutarotation.

Conformation and reactivity of acyclic systems-intramolecular rearrangements, Curtin-Hammett Principle. Stability of five and six-membered rings: mono-, di- and polysubstituted cyclohexanes, conformation and reactivity in cyclohexane systems. Fused rings: bicyclic, poly cyclic systems – decalins and perhydrophenanthrenes. Bridged rings – bicyclo [2.2.1] heptane and Bredt's rule.

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.

Tutorials: 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.
11. I.L. Finar, Organic Chemistry, Volume 2, Stereochemistry and Chemistry of Natural Products, Fifth Edition, Pearson, 2002.

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.

26UPCHE1C06 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 electronic spectra in the structural elucidation of coordination compounds.
3. To understand and analyze the geometry and isomerism 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, K3, K4
CO2	Learn various theories to explain the structure and properties of coordination compounds.	K2, K3, K4
CO3	Understand about the reaction mechanism of transition metal complexes.	K2, K3, K4
CO4	Apply Crystal Field Theory to understand the electronic spectra and the magnetic properties of complexes	K3, K4
CO5	Explain the various geometries exhibited by coordination compounds and predict the possible geometrical as well as optical isomers for given coordination complexes	K3, K4

Unit - I Coordination Chemistry- Principles

HSAP principle, 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.

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

Tutorials: Problems related to factors affecting stability.

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.

Tutorials: Problems related to theories of coordination compounds.

Unit - III Reactions

Substitution reactions in Octahedral complexes: Inert and labile complexes - Associative, dissociative and SN_I mechanistic pathways for substitution reactions, Acid and base hydrolysis of octahedral complexes. Substitution reactions in square planar complexes: the rate law for nucleophilic substitution in a square planar complex. Trans effect - theories and applications of trans effect in synthesis of square planar complexes; Kurnakov test - Mechanisms of redox reactions. Outer sphere mechanisms - excited state outer sphere electron transfer reactions. Inner sphere mechanisms - mixed valence complexes.

Tutorials: Problems related to substitution and redox reactions.

Unit - IV Electronic Spectra and Magnetism

Microstates, Term states for d ions, 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. Spectral and magnetic properties of lanthanides.

Tutorials: Problems related to electronic spectra and magnetism of coordination compounds.

Unit - V Coordination numbers and isomerism of Coordination compounds

Structure of coordination compounds with reference to the existence of various coordination numbers - complexes with coordination number two - complexes with coordination number three - complexes with coordination number four - tetrahedral and square planar complexes – complexes with coordination number five - regular trigonal bipyramidal and square pyramidal - site preference in trigonal bipyramidal complexes - site preference in square planar complexes – complexes with coordination number six - distortion from perfect octahedral symmerty - coordination number seven and eight.

Stereochemical aspects - stereoisomerism in inorganic complexes, isomerism arising out of ligand distribution and ligand conformation and chirality (Coordination no. 4 and 6 only).

Tutorials: Problems related to coordination numbers and isomerism of coordination compounds.

Text Books

1. J.E. Huheey, E.A. Keiter, R.L. Keiter, O.K. Medhi **Inorganic Chemistry: Principles of Structure and Reactivity**, Pearson India Publishers, 5th Edition, 2022.
2. F. A. Cotton and G. Wilkinson, C. A. Murillo, M. Bochmann, **Advanced Inorganic Chemistry, An Indian Adaptation**, Wiley India, 6th Edition, 2021.
3. J. D. Lee, **Concise Inorganic Chemistry**, Wiley India Pvt. Ltd, 5th Edition, 2021.
4. W.U. Malik, G.D. Tuli, R.D. Madan, **Selected Topics in Inorganic Chemistry**, S. Chand & Co., 8th Edition, 2020.
5. B.R. Puri, L.R. Sharma, K.C. Kalia, **Principles of Inorganic Chemistry**, Vishal Publishing Co., 55th Edition, 2020.
6. P. Atkins, T. Overton, J. Rourke, M. Weller, F. Armstrong, M. Hagerman, **Shriver & Atkins' Inorganic Chemistry**, 5th edition, W. H. Freeman and Company, New York, 2010.

Reference Books

1. J. Lewis, R. G. Wilkins, **Modern Coordination Chemistry**, Wiley Interscience, 1960.
2. K. Nakamoto, **Infrared and Raman Spectra of Inorganic and Coordination Compounds**, Part A & Part B, 6th Edition, Wiley, 2009.
3. G. L. Miessler, P.J. Fischer D. A. Tarr, **Inorganic Chemistry**, 5th Edition, Pearson, 2025.
4. J. E. House, **Inorganic Chemistry**, 4th Edition, Academic Press, 2025.
5. C. E. Housecroft, A. G. Sharpe, **Inorganic Chemistry**, 5th Edition, Pearson, 2018.
6. K. F. Purcell and J. C. Kotz, **Inorganic Chemistry**, 2nd Edition, Cengage Learning, 2012.

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.

26UPCHE1C07 CHEMICAL DYNAMICS AND SURFACE CHEMISTRY

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 understand the fast reactions.
3. To understand the kinetics of catalysis.
4. To study the theory and mechanism of catalytic and surface reactions.
5. 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 - Steady state approximation - Theories of reaction rates - Hard sphere collision theory, Transition state theory, Eyring equation - Kinetics of Elementary, parallel, opposing and consecutive reactions, Rice Herzfeld mechanism - Determination of reaction mechanisms - 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. Diffusion controlled reactions in solution, Debye-Smoluchowski equation.

Tutorials: 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; Study of fast reactions-relaxation methods-temperature and pressure jump methods, electric and magnetic field jump methods, stopped flow, flash photolysis and pulse radiolysis methods. Kinetics of polymerization-free radical, cationic and anionic polymerization - Polycondensation.

UNIT III Catalysis

Concepts of catalysis - pH and temperature dependence of rate constants of catalysed reactions; Homogeneous catalysis – Acid base catalysis - Theories, Protolytic and prototropic mechanisms, kinetics, affecting factors; Enzyme catalysis – Mechanism, kinetics, factors affecting 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 area and its determination. Colloids - Preparation of lyophobic colloidal solutions – Dispersion and condensation 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. S. Berry, S. A. Rice, J. Ross, **Physical Chemistry**, Second Edition, Oxford University Press, Oxford, 2007.
3. K.J. Laidler, **Chemical Kinetics**, Third Edition, Harper & Row, New York, 2003.
4. K. Rohatgi – Mukherjee, **Fundamentals of Photochemistry**, New Age International Pvt. Ltd.; Third Edition, New Delhi, 2014.

5. I.Steindeld, J. S. Francisco, W. L. Hase, **Chemical Kinetics and Dynamics**, Second Edition, Prentice Hall International Inc., New York, 1989.
6. J. Rajaram, J.C. Kuriacose, **Kinetics and Mechanism of Chemical Transformations**, Macmillan India Ltd., 1993.

Reference Books

1. R.G. Frost, Pearson, **Kinetics and Mechanism**, Wiley New York, 1961
2. G.M. Harris, D.C. Health, **Chemical Kinetics**, 1966.
3. A.W. Anderson, **Physical Chemistry of Surfaces**, Wiley - Interscience, Newyork, 1990.
4. 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.

26UPCHE1C08 INORGANIC CHEMISTRY PRACTICAL

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.
3. To determine the amount of metal ions in a solution by complexometric titration.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	analysis a mixture of salts and familiarize the test involving identification of special elements.	K3, K4 & K5
CO2	know the various techniques of preparation and the techniques involving drying and recrystallization of synthesized complexes.	K4 & K5
CO3	understand complexometric titrations 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. Complexometric Titrations involving the Estimation of Ca, Mg, Ni, Zn and hardness of water.

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, 3rd Edition, 1988.
2. R. Mukhopadhyay, P. Chatterjee, **Advanced Practical Chemistry**, Book & Allied, Private Ltd, 2007.

Reference Books

1. Vogel's **Text Book of Quantitative Inorganic Analysis**, 6th Edition, Pearson Education 2009.
2. G. Svehla, B. Sivasankar, **Vogel's Qualitative Inorganic Analysis**, 7th Edition, Pearson Education, 2012.
3. I.M. Koltoff, E.B. Sandell, **Text Book of Quantitative Inorganic Analysis**, 3rd 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

Third Semester

26UPCHE1C09 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.

Tutorials: 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 interconversions

involving C=O, CHO, OH, C=C, NH_2, COOH, C-Cl and C-Br functional groups.

Tutorials: 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).

Use of acetylenes and aliphatic nitro compounds in organic synthesis.

Reagents and their uses - trimethylsilyl iodide, trimethylsilyl chloride, 1,3-dithiane (umpolung), osmium tetroxide, DDQ, selenium dioxide, *meta*-chloroperbenzoic acid (m-CPBA), $NaIO_4$, phase transfer catalysts, crown ethers and baker's yeast. Lithium diisopropylamine (LDA), sodium cyanoborohydride ($NaBH_3CN$), diazobicyclo[5.4.0]undec-7-ene (DBU), diisopropylazodicarboxylate (DIAD) and diethylazodicarboxylate (DEAD).

Tutorials: 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, oxeranes, thieranes, azetidines, oxetanes and thietanes. Preparation, chemical reactions and properties of benzo fused heterocycles - benzofurans, benzothiophenes, carbazoles, chromones, flavanones and isoflavones. Preparation, chemical reactions and properties O, N, and S containing five membered and N-containing 6-membered heterocycles.

Tutorials: 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.

Tutorials: 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.

12. Paul Wyatt and S. Warren, **Organic Synthesis: Strategy and Control,** John Wiley and Sons, England, 2007.

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.

26UPCHE1C10 ORGANOMETALLIC CHEMISTRY AND INORGANIC SPECTROSCOPY

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 bonding in metal carbene complexes and their applications.
4. To identify the structural identification of coordination compounds using spectroscopic tools.
5. To apply EPR and Mössbauer spectroscopic techniques for structural elucidation and analysis of inorganic compounds.

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.	K2, K3, K4
CO2	know reaction mechanism in organometallic catalysis.	K2, K3. K4
CO3	learn the role of carbenes in organometallic chemistry.	K2, K3. K4
CO4	understand the structural elucidation of coordination complexes using IR and NMR spectroscopies.	K3, K4
CO5	know the structure and bonding in coordination compounds using EPR and Mössbauer spectroscopy.	K2, K3, K4

UNIT - I Chemistry of organometallic compounds

Classification of organometallic compounds based on M-C bond – 18 and 16 electron rule; Metal – carbonyl complexes: MO diagram of CO; Structure and bonding − bonding modes, MO approach of M-CO bonding, π-acceptor, nature of carbonyl group, synergistic effect (stabilization of lower oxidation states of metals). Bonding in metal – olefin complexes (example: Ziese's salt), metal-acetylene and metal-allyl complexes; Metal-cyclopentadienyl complexes – Examples. MO approach to bonding in metallocenes; fluxional isomerism.

Tutorials: Problems on bonding of organometallic compounds.

UNIT - II Reactions and catalysis of organometallic compounds

Oxidative addition, reductive elimination (α and β eliminations), migratory insertion reaction and metathesis reaction. Organometallic catalysis: Hydrogenation of olefins

(Wilkinson's catalyst), hydroformylation of olefins using cobalt and rhodium catalysts (oxo process), oxidation of olefin (Wacker process), olefin isomerisation, water gas shift reaction, cyclo-oligomerisation of acetylenes using Reppe's catalysts, Monsonto process.

Tutorials: Problems on reaction mechanism of catalytic reactions.

UNIT – III Carbenes

Introduction to transition metal carbene complexes, Classification of carbene complexes. Fisher carbene complexes – structure, bonding, chemical reactions (Nucleophilic attack and substitution reaction only), Schrock carbenes complexes – structure, bonding, reactions (Formation of Tebbes reagent only). N-heterocyclic carbene complexes - Difference between complexes with carbene ligands and phosphine ligands, NHCs as Ligands in Palladium Catalysed Cross-coupling, Grubbs Catalyst for metathesis reaction. Carbyne complexes – structure and bonding.

Tutorials: Problems related to bonding of carbene complexes.

UNIT - IV Inorganic spectroscopy -I

IR spectroscopy: Effect of coordination on the stretching frequency-sulphato, carbonato, sulphito, aqua, nitro, thiocyanato, cyano, thiourea and DMSO complexes; IR spectroscopy of carbonyl compounds. NMR spectroscopy- Introduction, applications of ^{1}H, ^{19}F, ^{31}P-NMR spectroscopy in structural identification of inorganic complexes (HPF_2, PF_5, PCl_2F_3, P_4S_3, TiF_4, BrF_5, SF_4, SF_6, XeF_4O, SiF_6^{2-}, $B_3H_8^-$, NF_3, $P_3N_3Cl_4F_2$, ClF_5, ClF_3, phosphorous and hypophosphorous acid systems, $HP(O)F_2$, HOP(O)FH - use of lanthanide compounds as shift reagents.

Tutorials: Problems on structural identification of inorganic complexes using IR and NMR spectroscopies.

UNIT-V Inorganic spectroscopy-II

EPR spectroscopy - Theory of EPR spectroscopy, hyperfine splitting of radicals such as CH_3, C_5H_5, C_6H_5, C_6H_5 (anion), naphthalene negative ion, *p*-benzosemiquinone, and spin density. McConnell relationship, g value and factors affecting the magnitude of g and A tensors in metal complexes, Zero-field splitting, Kramers degeneracy. Spectra of VO(IV), Mn(II), Fe(II), Co(II), Ni(II) and Cu(II) complexes including $[(NH_3)_5Co\text{-}O_2\text{-}Co(NH_3)_5]^{5+}$ and bis (salicylaldimine)copper(II).

Mossbauer spectroscopy – Mossbauer effect, Recoil energy, Mossbauer active nuclei, Doppler

shift, Isomer shift, quadrupole splitting and magnetic interactions. Applications of Mössbauer spectra to Fe and Sn compounds.

Tutorials: Problems on structural elucidation by EPR and Mossbauer spectroscopies.

Text books

1. Robert H. Crabtree, The Organometallic Chemistry of the Transition Metals. 3rd Edition, John Wiley, New York, 2000.
2. P. Gütlich, E. Bill and A.X. Trautwein, Mossbauer Spectroscopy and Transition Metal Chemistry: Fundamentals and Applications, 1st Edition, Springer-Verlag Berlin Heidelberg, 2011.
3. B. Douglas, D. McDaniel, J. Alexander, Concepts and Models of Inorganic Chemistry, 3rd Edition, Wiley, 1994.
4. K. F. Purcell and J. C. Kotz, Inorganic Chemistry, 2nd Edition, Cengage Learning, 2012.
5. R.S. Drago, PhysicaI Methods in Chemistry, Saunders, 1992.
6. B.D. Gupta and A.K. Elias, Basic Organometallic Chemistry: Concepts, Syntheses and Applications, University Press, 2013.

Reference Books

1. G.O. Spessard, G. L. Miessler, **Organometallic Chemistry**, Second Edition, Oxford University Press, 2009.
2. J. Haiduc, J.J. Zuckerman, **Basic Organometallic Chemistry**, Walter de Gruyter, Brelin, 1985.
3. Bockmann, **Organometallics 1, Complexes with Transition Metal-Carbon Bonds**, Oxford science publications, Oxford, 1996.
4. Bockmann, **Organometallics 2, Complexes with Transition Metal-Carbon Bonds**, Oxford Science Publications, Oxford, 1996.
5. C. Elschenbroich, **Organometallics**, Third Edition, Wiley VCH, 2006.
6. Indrajit Kumar, **Organometallic Compounds**, Pragati Prakashan publication, 2018.
7. J.E. Huheey, E.A. Keiter, R.L. Keiter, O.K. Medhi Inorganic Chemistry: Principles of Structure and Reactivity, Pearson India Publishers, 5th Edition, 2022.
8. G. L. Miessler, P.J. Fischer D. A. Tarr, Inorganic Chemistry, 5th Edition, Pearson, 2025.
9. D. Banerjea, **Co-ordination Chemistry**, Asian Books, 2009.
10. F. A. Cotton and G. Wilkinson, C. A. Murillo, M. Bochmann, **Advanced Inorganic**

Chemistry, An Indian Adaptation, Wiley India, 6th Edition, 2021.

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.

26UPCHE1C11 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 Introduction to quantum mechanics

Black body radiation, wave particle duality, uncertainty principle, photoelectric effect, hydrogen spectrum. Need for quantum mechanics, postulates of quantum mechanics. Particle wave and Schrodinger wave equation-Time independent and time dependent. Wave function, properties of wave function- Normalized, orthogonal, orthonormal, Eigen values and Eigen function: Hermitian properties of operators.

UNIT II Applications to particles, quantum models and hydrogen atom

Application of Schrodinger wave equation to particle in a box-(1D, 2D and 3D).Degeneracy,free particles. Harmonic Oscillator-wave equation and solution, anharmonicity, force constant and its significance. Rigid Rotor-wave equation and solution, calculation of rotational constants and bond length of diatomic molecules. Hydrogen atom and hydrogen like

ions, Hamiltonian-wave equation and solutions, radial and angular functions, representation of radial distribution functions.

UNIT III Applications to polyelectron atoms

Approximation methods: variation methods- trial wave function, variation integral and application to particle in 1D box. Perturbation method - first order applications. Hartree-Fock self-consistent field method, Helium atom-electron spin, Pauli's exclusion principle and Slater determinant.Hohenberg-Kohn theorem and Kohn-Sham equation.Molecular orbital theory and Heitler London (VB) treatment, Energy level diagrams. Hydrogen molecule ion; Use of linear variation function and LCAO methods. Electronic conjugated system: Huckel method to Ethylene butadiene, cyclopropenyl, cyclo butadiene and Benzene

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.

Tutorials : 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

Tutorials : 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.

26UPCHE1C12 PHYSICAL CHEMISTRY PRACTICAL

Hours	L	T	P	C
90	0	0	5	3

Course Objectives

1. To learn some determinations of physical properties of a solution.
2. To learn various experiments related to colorimetry, pH metry, potentiometric, and conductivity measurements.
3. To learn various experiments related to chemical kinetics, phase rule and adsorption,

Course Outcomes

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	K3, K4 & K5
CO3	evaluate the kinetics of a reaction, construction of phase diagram of binary systems and adsorption properties.	K3, K4 & K5

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.

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.

Conductivity Experiments

iii) Determination of equivalent conductance of a strong electrolyte & the verification of DHO equation

iv) Verification of Ostwald's Dilution Law & Determination of pKa of a weak acid and

Acid-base titration (strong acid and weak acid vs NaOH).

v) Study of the saponification of ethylacetate by sodium hydroxide conductometrically and determine the order of the reaction.

Potentiometric titration

vi) Determination of the strength of a given solution of KCl using differential potentiometric titration technique.

vii) Determination of solubility and solubility products by emf method.

viii) Determination of the activity coefficient of an electrolyte at different molalities by emf measurements.

ix) Determination of the formation constant of silver ammonia complex and stoichiometry of the complex potentiometrically.

Colorimetry

x) Determination of the pH of the given solutions with the help of the indicators using buffer solutions by colorimetric method.

xi) Verification of Beer's law and calculation of molar absorption coefficient using $CuSO_4$ and $KMnO_4$ solutions

pH Metry

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

Kinetics

xiii) Study the kinetics of acid hydrolysis of an ester, determine the temperature coefficient and also the activation energy of the reaction.

xiv) 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.

xv) Study the primary salt effect on the kinetics of ionic reactions and test the Bronsted relationship (iodide ion is oxidized by persulphate ion.

Phase diagram

Construction of phase diagram for a simple binary system

xvi) Naphthalene-phenanthrene.

xvii) Benzophenone- diphenyl amine.

Adsorption

xviii) Adsorption of oxalic acid on charcoal & determination of surface area

(Freundlich isotherm only).

Text Books

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

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.

ELECTIVE COURSES - Discipline centric

26UPCHE1E01 BIOINORGANIC CHEMISTRY

Hours	L	T	P	C
90	3	1	0	4

Course Objectives

1. To understand the role of trace elements and enzymes in biological system.
2. To understand the significance of transport proteins in biological system.
3. To understand the concepts and mechanism of nitrogen fixation.
4. To know the metal toxicity and role of metal complexes in medicines
5. To understand the role of complexes in bioenergetics and photosynthesis.

Course Learning Outcomes

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

CO Number	CO Statement	Knowledge level
CO1	know the role of trace elements and enzymes in biological system.	K2, K3, K4
CO2	understand the role of transport protein in biological system.	K2, K3, K4
CO3	learn about the concept and mechanism of nitrogen fixation.	K2, K3, K4
CO4	know the role of metal complexes in medicine.	K1, K2, K3, K4
CO5	understand the bioenergetics in biological system and role of complexes in photosynthesis.	K2, K3, K4

UNIT-I Essential trace elements

Selective transport and storage of metal ions: Ferritin, transferrin and sidorphores, Sodium and potassium transport, Calcium signaling proteins. Metalloenzymes: Zinc enzymes–carboxypeptidase and carbonic anhydrase. Iron enzymes–catalase, peroxidase. Copper enzymes – superoxide dismutase, plastocyanin, ceruloplasmin and tyrosinase. Coenzymes - Vitamin-B12 coenzymes.

UNIT-II Transport Proteins

Oxygen carriers: Haemoglobin and myoglobin - Structure and oxygenation, Bohr Effect, Binding of CO, NO, CN to myoglobin and haemoglobin. Biological redox systems: Cytochromes-Classification, cytochrome a, b and c, Cytochrome P-450. Non-heme oxygen

carriers-Hemerythrin and hemocyanin. Iron-sulphur proteins- Rubredoxin and Ferredoxin-Structure and classification.

UNIT-III Nitrogen fixation

Introduction, types of nitrogen fixing microorganisms. Nitrogenase enzyme - Metal clusters in nitrogenase- redox property. Dinitrogen complexes-Transition metal complexes of dinitrogen. Nitrogen fixation via nitride formation and reduction of dinitrogen to ammonia. Biological nitrogen fixation using molybdenum nitrogenase- spectroscopic and other evidences, other nitrogenase model systems. Nickel and Molybdenum containing Enzymes Structure and functions of Urease, Hydrogenases.

UNIT-IV Metals in medicine

Toxicity of metals - Hg, Cd, Zn, Pb, As and Sb. Therapeutic compounds: Vanadium-based diabetes drugs, Platinum-containing anticancer agents. Chelation therapy and cancer treatment. Diagnostic agents: Technetium imaging agents, Gadolinium MRI imaging agents. Temperature and critical magnetic field.

UNIT-V Bioenergetics

Bioenergetics and ATP Cycle Features of ATP, phosphate group transfer potential of various phosphate compounds, glycolysis (glucose to pyruvate conversion) and glucose storage as glycogen. Photosynthesis: structural features of chlorophylls, role of Mg(II), Pigments involved in Photosystems I and II (PS I and II), cleavage of water using PS-I and PS-II in photosynthesis (Zscheme), Oxygen evolving complex (OEC) and its involvement in oxidation of water to O2.

Text Books

1. D.R. Williams, Introduction to Bioinorganic Chemistry. Thomas, 1976.
2. F.M. Fiabre and D.R. Williams, The Principles of Bioinorganic Chemistry, Royol Society of Chemistry, Monograph for Teachers-31, 1977.
3. K.F. Purcell and Kotz, Inorganic chemistry, WB Saunders Co., USA.1977.
4. G.N. Mugherjea and Arabinda Das, Elements of Bioinorganic Chemistry, U.N.Dhur, 1993.
5. R. Gopalan, V. Ramalingam, Concise Coordination Chemistry, S. Chand, 2001.

Reference Books

1. M. Satake and Y. Mido, Bioinorganic Chemistry, Discovery Publishing House, New Delhi, 1996.

2. M.N. Hughes, The Inorganic Chemistry of Biological Processes, 2nd Edition, Wiley London, 1982.
3. R. W. Hay, Bio Inorganic Chemistry, Ellis Horwood, 1987.
4. R. M. Roat-Malone, Bio Inorganic Chemistry, John Wiley, 2002.
5. T. M. Loehr, Iron Carriers and Iron Proteins, VCH, 1989.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5
CO 1	S	S	S	S	M
CO 2	M	S	S	S	S
CO 3	S	S	M	S	S
CO 4	M	S	S	S	S
CO 5	M	S	M	S	S

S – Strong, M– Medium, L - Low

26UPCHE1E02 POLYMER CHEMISTRY

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

1. To learn the basic concepts and bonding in polymers.
2. To understand various types of polymerization reactions and kinetics.
3. To understand the polymerization techniques and polymer degradation.
4. To understand some important Industrial polymers.
5. To understand various Polymer processing techniques.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	Understand the basic concepts and bonding in polymers.	K1, K2 & K3
CO2	Understand the various polymerization reactions and kinetics.	K1, K2 & K3
CO3	Conceive the polymerization techniques and polymer degradation.	K2, K3 & K4
CO4	Learn the preparation of some important Industrial polymers.	K2, K3 & K4
CO5	Understand various Polymer processing techniques.	K2, K3 & K4

UNIT-I: Characterization, Molecular Weight and its determination:

Primary and secondary bond forces in polymers; cohesive energy, molecular structure, chemical tests, thermal methods, Tg, molecular distribution, stability. Determination of Molecular mass of polymers: Number Average molecular mass (Mn)and Weight average molecular mass (Mw) of polymers. Molecular weight determination of high polymers by physical and chemical methods.

UNIT-II: Mechanism and Kinetics of polymerization:

Chain growth polymerization: Cationic, anionic, free radical polymerization, Stereo regular polymers: Ziegler Natta polymerization. Reaction kinetics. Step growth polymerization,

Degree of polymerization.

UNIT-III: Techniques of polymerization and polymer degradation:

Bulk, Solution, Emulsion, Suspension, solid, interfacial and gas phase polymerization. Types of Polymer Degradation, Thermal degradation, mechanical degradation, photodegradation, Photo stabilizers, Solid and gas phase polymerization.

UNIT-IV: Industrial polymers:

Preparation of fibre forming polymers, elastomeric material. Thermoplastics: polyethylene, polypropylene, polystyrene, polyacrylonitrile, polyvinyl Chloride, Poly tetrafluoro ethylene, nylon and polyester. Thermosetting Plastics: Phenolic and epoxy resin. Elastomers: Natural rubber and synthetic rubber - Buna - N, Buna-S and neoprene. Conducting Polymers: Elementary ideas; examples: poly sulphur nitriles, polyphenylene, polypyrrole and polyacetylene. Polymethylmethacrylate, polyimides, polyamides, polyurethanes, polyureas, polyethylene and polypropylene glycols.

UNIT-V: Polymer processing:

Compounding: Polymer Additives: Fillers, Plasticizers, antioxidants, thermal stabilizers, fire retardants and colourants. Processing Techniques: Calendaring, die casting, compression moulding, injection moulding, blow moulding and reinforcing. Film casting, Thermofoaming, Foaming.

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.

26UPCHE1E03 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 Number	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 microwave and ultra sound assisted reactions as greener approaches	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 - 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, Rakesh K. Sharma, **An Introductory Text on Green Chemistry**, Wiley, 2020.
3. V. Kumar, **An Introduction to Green Chemistry**, Third Edition, Vishal Publishing Co, 2022.
4. P.T. Anastas, T.C. Williamson (Eds.), **Green Chemistry: Frontiers in Chemical Synthesis and Processes**, First Edition, Oxford University Press, Oxford, 1998.

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**, Oxford University 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.

26UPCHE1E04 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

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.

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 interaction, Charge-Transfer interaction and Van der Waals forces. G protein-coupled receptors. Drug metabolism - Phase I and Phase II reactions. Prodrugs - classification and application.

UNIT - II Antiviral, Antimalarial, Antiulcer and Antibacterial Drugs:

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

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

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

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

UNIT - III Antipyretic Analgesics, Antiallergic and Other Agents

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

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

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

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

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.

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

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

Anticancer drug - Pt, Ru and other metal complexes.

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

26UPCHE1E05 ENVIRONMENTAL CHEMISTRY

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

1. To understand the fundamentals of environmental chemistry.
2. To understand the water pollutants and purification techniques.
3. To learn the structure and composition of atmosphere.
4. To study the impact of chemical components & pollutants in soil.
5. To learn the detailed issues of hazardous chemicals in environmental.

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	Learn the structure and composition of atmosphere.	K2, K3 & K4
CO4	Learn the impact of chemical components & pollutants in soil.	K2, K3 & K4
CO5	Learn 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.

26UPCHE1E06 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 Number.	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.

ELECTIVE COURSES - GENERIC

26UPCHE1E07 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 Number	CO Statement	Knowledge Level
CO1	understand the theory and uses of UV-Vis and FT-IR spectroscopy for the structure elucidation of organic molecules	K1, K2 & K3
CO2	understand the theory and principles of NMR and use the 1H NMR for structure elucidation.	K2, K3 & K4
CO3	characterize the compounds using the 13C NMR and mass spectral techniques.	K2, K3 & K4
CO4	Understand the theory and uses of photoelectron spectroscopy	K2, K3 & K4
CO5	elucidate the structures of the compounds applying various spectral data provided	K2, K3 & K4

UNIT I UV-Visible and IR Spectroscopy

UV-Visible Spectroscopy - Theory of electronic excitations – types of transitions – Chromophores and auxochromes – absorption and intensity shifts – solvent effects – conjugated systems – extended conjugation – aromatic systems – Woodward Fisher rules for calculating adsorption maximum in dienes and enones.

FT-IR spectra- vibrational frequency- factors influencing vibrational frequency – characteristic group frequencies-finger print region; Interpretation of vibrational spectra; Applications to organic compounds.

UNIT – II ^{1}H NMR Spectroscopy

^{1}H NMR spectroscopy - theory and principles, instrumentation, Zeeman effect, chemical shift and the factors affecting it - electronegativity and electrostatic effects. Mechanism of

shielding and deshielding. Spin-spin coupling-theory and factors affecting coupling constant. Simplification of complex NMR spectra - spin decoupling, double resonance and shift reagents. Homonuclear coupling interactions - AX, AX2, AMX and AB types. Vicinal, germinal and long-range coupling-spin decoupling.

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

^{13}C-NMR Spectroscopy**:** Instrumentation, Decoupled spectra - ^{1}H decoupling, noise decoupling, broadband decoupling, off resonance and spin tickling. Spin systems: First order and second order coupling of AB systems, Nuclear Overhauser effect. 2D NMR, CIDNP, INDOR (Basic idea only). Introduction to ^{31}P, ^{19}F NMR.

Mass spectra – Theory and instrumentation, isotopic abundance, molecular ions, meta stable ions, fragmentation processes associated with functional groups of organic molecules, Ortho effect and McLafferty rearrangement.

UNIT – IV Photoelecron Spectroscopy

X-ray absorption spectroscopy (XAS) and Extended X-ray absorption fine structure (EXAFS) – Applications of X-ray absorption spectroscopy. X-ray Absorption Edges - X-ray Fluorescence - Measurement of X-ray Absorption Spectra -Theoretical Description of EXAFS Spectra - Single scattering, Multiple scattering – Data reduction and analysis - Applications: structure determination, Resolution of crystallographic disorder, Oxidation state, prediction of molecular symmetry, determinations of atoms present in the first coordination sphere (Edge and EXAFS analysis) – Structure of Metal clusters.

UNIT - V Combined problems

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

Text books

1. C.N.R. Rao, J.R. Ferraro, **Spectroscopy in Inorganic Chemistry**, Methven Co., London, 2012.
2. William Kemp, **Organic Spectroscopy**, Third Edition, Palgrave Macmillan, 1991.
3. C.F. Banwell, **Fundamentals of Molecular Spectroscopy**, Seventh Edition, 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**, Fourteenth Edition, S. Chand, 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**, Fifth Edition, 2025.
9. Kazuo Nakamoto, **IR and Raman Spectra of Coordination compounds**, Sixth Edition, Wiley, 2009.
10. P.S. Kalsi, **Spectroscopy of Organic Compounds,** Tenth Edition, New Age International Private Limited, 2024.

Reference books

1. A.Carrigton and A.D. McLachlan, **Introduction to Magnetic Resonance**, Harper and Row, New York, 1967.
2. William Kemp, **Organic Spectroscopy**, Third Edition, Palgrave Macmillan, 1991.
3. Raymond Chang, **Basic Principles of Spectroscopy,** Mc Graw Hill Ltd., New York, 1993.
4. R.S. Drago, **Physical Methods in Chemistry**, Second Edition, Saunders College Pub, 1992.

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

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

26UPCHE1E08 NANOMATERIALS AND NANOTECHNOLOGY

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

1. To understand the concept, definitions, significance of nanoscience and classifications of nanomaterials.
2. To study the various fabrication techniques of nanomaterials.
3. To learn practical competence in principles and functions of nanomaterials using different characterization devices.
4. To understand the physical, chemical and surface properties of the nanomaterials.
5. To understand the applications of nanomaterials and various fields.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	To explain fundamentals of nanoscience and nanomaterials.	K1, K2 & K3
CO2	To explain methods of fabricating nanostructures.	K2, K3 & K4
CO3	To describe tools for the identification of nanostructures.	K2, K3 & K4
CO4	To learn about the properties of nanomaterials.	K2, K3 & K4
CO5	To understand the applications of various fields.	K2, K3 & K4

UNIT-I 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.

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. Electrical properties, Conductivity and Resistivity, Classification of Materials based on Conductivity.

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 sun barrier products. Application of nanoparticles in photostat, printing, solar cell, batteries. Information storage, 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.

26UPCHE1E09 Analytical and Instrumental Analysis

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

1. To understand the basic theory, selection rules and instrumentation of rotational spectroscopy in atoms and molecular level.
2. To learn the fundamental concepts, principles and instrumentation of vibrational spectroscopy.
3. To understand the classical theory, quantum theory of the Raman effect. Raman spectra of linear and asymmetric top molecules. Polarization of Raman scattered photons.
4. To acquire knowledge of the principles, Elementary theory and instrumentation of atomic absorption and emission spectroscopy.
5. To describe the theory, principles and instrumentation of Voltammetric and Amperometric techniques. Explain the types of titration curves, indicator electrodes and applications.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	The student can interpret rotational spectra of diatomic and polyatomic molecules.	K1, K2 & K3
CO2	To apply the vibrational spectra to study molecular energy levels.	K2, K3 & K4
CO3	To understand the theory of raman effect, strokes, anti-stokes lines, selection rule for Raman scattering, rotational fine structure-O and S branches.	K2, K3 & K4
CO4	To learn the principles, instrumentations, applications of AAS and AES.	K2, K3 & K4
CO5	To develop the knowledge on principle, instrumentation and applications of Voltammetric and Amperometric Techniques.	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.

UNIT-II Vibrational spectroscopy

Vibrational spectra of diatomic molecules – Theory, Instrumentation, Zero-point energy, Anharmonicity. Vibration - Rotation spectroscopy - Selection rules, Born-Oppenheimer approximation, overtones, combination and hot bands, Factors influencing vibrational frequencies.Fermi resonance energy of diatomic molecule- simple harmonic and anharmonic oscillator. Rotational character of vibration spectra- Theory and applications of Vibrational spectroscopy.

UNIT-III Raman spectroscopy

Techniques, instrumentation and basic principles of Raman spectroscopy. Classical theory of the Raman effect, polarizability, quantum theory of the Raman effect, Pure rotational Raman spectra of linear and asymmetric top molecules, Stokes and anti-Stokes lines. Vibrational Raman spectra, Raman activity of vibrations, rule of mutual exclusion, general selection rule for Raman scattering, overtone and combination vibrations, rotational fine structure-O and S branches. Polarization of Raman scattered photons.

UNIT-IV Atomic Absorption and Emission 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. Atomic emission spectroscopy (AES)– Principles, theory, instrumentation, advantage and disadvantage of AES, origin of spectra, measurement of light intensity.

UNIT-V Voltammetric and Amperometric Techniques

Principles, theory and instrumentation of voltammetric techniques. Polarography-Theory, apparatus, DME, diffusion kinetic catalytic currents, current voltage curves for

reversible and irreversible systems, qualitative and quantitative applications to inorganic system. Linear Potential Sweep (dc) Voltammetry, Potential Step Methods, Cyclic Potential Sweep Voltammetry, and Stripping Voltammetry. Amperometric titrations- Theory, apparatus, types of titration curves, successive titrations and two indicator electrodes, applications.

Text books

1. C.N. Banwell and E.M. McCash, Fundamentals of Molecular Spectroscopy, 4thEdition, Tata McGraw Hill, New Delhi, 2000.
2. W. Kemp, Applications of Spectroscopy, English Language Book Society, 1987.
3. G.M. Barrow, Introduction to Molecular Spectroscopy, Mc Graw Hill, New York, 1962.
4. I.N. Levine, Molecular Spectroscopy, John Wiley & Sons, New York, 1974.
5. D.H. Williams and I. Fleming, Spectroscopic Methods in Organic Chemistry, 4thEdition, Tata McGraw-Hill Publishing Company, New Delhi, 1988.
6. Donald Pavia, George Kriz, Gary Lampman, James Vyvyan, Introduction to Spectroscopy, Fifth Edition, 2014.
7. G.R. Chatwal, Sham Anand, Instrumental Methods of Chemical Analysis, 2011.
8. H. Kaur, Instrumental Methods of Chemical Analysis, Pragati Prakashan Meerut, Tenth Edition, 2014.

Reference books

1. P.W. Atkins and J. de Paula, Physical Chemistry, 7thEdition, Oxford University Press, Oxford, 2002.
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. G. D. Christian, J. O. E. Reilly, Instrumental Analysis, Allyn and Bacon Inc, Second Edition, 1986.
4. Raymond Chang, Basic Principles of Spectroscopy, Mc Graw Hill Ltd., New York, 1993.
5. Willard, Merit, Dean, Settle, Instrumental Methods of Analysis, CBS Publishers and Distributors, Fourth Edition, 1989.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5
CO 1	S	S	S	S	M

CO 2	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**M**	**S**	**S**
CO 4	**M**	**S**	**S**	**S**	**S**
CO 5	**M**	**S**	**M**	**S**	**S**

S-Strong, M-Medium, L-Low

26UPCHE1E10 PHARMACEUTICAL CHEMISTRY

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

To understand the advanced concepts of pharmaceutical chemistry.

To recall the principle and biological functions of various drugs.

To train the students to know the importance as well the consequences of various drugs.

To have knowledge on various analysis and techniques.

To familiarize on the drug dosage and its structural activities.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	identify the suitable drugs for various diseases.	K1, K2 & K3
CO2	apply the principles of various drug action and drug design.	K2, K3 & K4
CO3	acquire the knowledge on product development based on SAR.	K2, K3 & K4
CO4	apply the knowledge on applications of computers in chemistry.	K2, K3 & K4
CO5	synthesize new drugs after understanding the concepts SAR.	K3, K4 & K5

UNIT-I Physical properties in pharmaceuticals

Physical properties of drug molecule: Refractive index- Definition, explanation, formula, importance, determination. Specific & molar refraction. Optical activity rotation- Monochromatic & polychromatic light, optical activity, angle of rotation, specific rotation examples, Measurement of optical activity. Dielectric constant. Induced polarization- Dielectric constant -Explanation & determination. Rheology of pharmaceutical systems - Introduction, definition, applications and concept of viscosity. Newton's law of flow, Kinematic, Relative, Specific, Reduced &intrinsic viscosity. Newtonian system, non-Newtonian system- Plastic flow, Pseudoplastic flow. Dilatent flow. Viscosity measurements- Selection of viscometer for Newtonian and non-Newtonian systems.

UNIT-II Isotopic dilution analysis

Principles and applications. Neutron activation analysis: Principle, advantages and limitations, Scintillation counters: Body scanning. Introduction to radiopharmaceuticals. Properties of various types of radiopharmaceuticals, Radiopharmaceuticals as diagnostics, as therapeutics for research and sterilization. Physicochemical Properties and drug action. Physicochemical properties of drugs (a) Partition coefficient, (b) solubility (c) surface activity, (d) degree of ionization.

UNIT-III Drug dosage and product development

Introduction to drug dosage forms &drug. Delivery system – Definition of Common terms. Drug Regulation and control, Pharmacopoeias and formularies. Sources of drug - Drug nomenclature, routes of administration of drugs products. Need for a dosage form and classification of dosage forms. Drug dosage and product development.

UNIT-IV Development of new drugs

Introduction, procedure followed in drug design, the research for lead compounds and molecular modification of lead compounds. Structure-Activity Relationship (SAR): Factors effecting bioactivity, resonance, inductive effect, isoterism, bioisosterism and spatial considerations. Biological properties of simple functional groups -Theories of drug activity, occupancy theory, rate theory, induced-fit theory. Quantitative structure activity relationship (QSAR): Development of QSAR, drug receptor interactions and the additivity of group contributions, Physicochemical parameters, lipophilicity parameters, electronic parameter, ionization constants, steric parameters, chelation parameters, redox potential, indicator and

variables.

UNIT-V Computers in Pharmaceutical Chemistry

Need of computers for chemistry. Computers for analytical chemists-Introduction to computers: Organization of computers, CPU, Computer memory, I/O devices, information storage, software components. Application of computers in chemistry: Programming in high level language (C+) to handle various numerical methods in chemistry – least square fit, solution to simultaneous equations, interpolation, extrapolation, data smoothing, numerical differentiation and integrations.

Text books

1. Bahl & Tuli, **Physical Chemistry**, Twenty Eighth Edition, S. Chand & company Ltd, 2019.
2. C.V.S. Subramanyam, **Text Book of Physical Pharmaceutics**, Second Edition, Vallabh Prakashan, 2000.
3. G.R Chatwal, **Medicinal Chemistry (Organic Pharmaceutical Chemistry)**, Second Edition, Himalaya Publishing house, 2017.
4. Hubert H, Willard, **Instrumental method of Analysis**, Seventh Edition, Wadsworth, 1988.
5. Jayshree Ghosh, **Textbook of Pharmaceutical Chemistry**, Third Edition, S. Chand & company Ltd, 2003.
6. Dr. S. Lakshmi, **Pharmaceutical Chemistry**, Third Edition, Sultan Chand& Sons, 2004.

Reference books

1. K.V. Raman, **Computers in chemistry**, Tata McGraw-Hill, 1993.
2. S.K Pundir, Anshu Bansal, **Computers for Chemists**, Second Edition, New age international (P) limited, New Delhi, 2010.
3. Martins, Patrick J. Sinko, **Physical Pharmacy and Pharmaceutical Sciences**, Eight Edition, Lippincott. William and Wilkins, 2023.
4. S.J. Carter, **Cooper and Gunn's Tutorial Pharmacy**, Sixth Edition, CBS Publisher Ltd, 2021.
5. Allen, Popvich, Ansel, **Ansels pharmaceutical Dosage forms and Drug Delivery System**, Sixth Edition, Williams & Wilkins, 1995.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5
CO 1	S	S	S	S	M

CO 2	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**M**	**S**	**S**
CO 4	**M**	**S**	**S**	**S**	**S**
CO 5	**M**	**S**	**M**	**S**	**S**

S-Strong, M-Medium, L-Low

26UPCHE1E11 PHYTOCHEMISTRY AND PHARMOCOGNOSY

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

To develop the knowledge of natural products, biological functions and pharmacological uses.

To develop knowledge on primary and secondary metabolites and their sources.

To understand the concepts of isolation methods and separation of bioactive compounds.

To provide the knowledge on selected glycosides and marine drugs.

To familiarize the guidelines of WHO and different sampling techniques.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	To recall the sources of natural medicines and analysis of crude drugs.	K1, K2 & K3
CO2	To understand the methods of evaluation based on various parameters.	K2, K3 & K4
CO3	To analyze the isolated drugs-preparation and applications	K2, K3 & K4
CO4	To apply various techniques to discover new alternative medicines.	K2, K3 & K4
CO5	To analyze the isolated drugs from plants and marines for various pharmacological activities.	K3, K4 & K5

UNIT-I: Pharmacognosy and standardization of herbal drugs

Introduction, definition, development classification and source of drugs: Biological, mineral, marine, and plant tissue cultures. Study of pharmacognostic of a crude drug. Biosynthesis: Shikimic acid pathway and acetate pathway. Systematic analysis of crude drugs. Standardization of herbal drugs. WHO guidelines - Sampling of crude drug, Methods of drug evaluation. Determination of foreign matter, moisture and ash value. Phytochemical investigations-General chemical tests.

UNIT-II: Extraction Techniques

General methods of extraction, types – Maceration, decoction, percolation, immersion and soxhlet extraction.

Advanced techniques- Counter current, steam distillation, supercritical gases, sonication, micro waves assisted extraction. Factors affecting the choice of extraction process.

UNIT-III: Drugs containing terpenoids and volatile oils

Terpenoids: Classification - Isoprene rule, isolation and separation techniques. General properties of camphor, menthol, eucalyptol. Volatile oils or essential oils: Method of Preparations, Classifications of Volatile oils. Camphor oil, Geranium oil and Citral – Structure and uses. Pentacyclic triterpenoids: Amyrines; taraxasterol: Structure and pharmacological applications.

UNIT-IV: Drugs containing alkaloids

Occurrence, function of alkaloids in plants, Pharmaceutical applications. Isolation - Preliminary qualitative tests and general properties. General methods of structural elucidation. Morphine, reserpine and papaverine - Chemical properties, structure and uses.

UNIT-V: Plant Glycosides and Marine drugs

Glycosides: Basic ring systems. Classification - isolation, properties, qualitative analysis and pharmacological activity of Senna glycosides, Cardiac glycosides-Digoxin, digitoxin, Steroidal saponins glycosides- Diosgenin, hecogenin. Plant pigments: Occurrence and general methods of structure determination, isolation and synthesis of quercetin and cyanidin chloride. Marine drugs -Selected drug molecules: Cardiovascular active substances, Cytotoxic compounds, antimicrobial compounds, antibiotic compounds, anti-inflammatory agents and marine toxins.

Text books

1. Gurdeep R Chatwal (2016), Organic chemistry of Natural products, Volume I&II, 5thEdition, Himalaya publishing House.
2. S. V .Bhat, B.A. Nagasampagi, M. Sivakumar (2014), Chemistry of Natural Products, Revised edition, Narosa Publishers.

Reference books

1. Jeffrey B. Harborne (2012), Phytochemical methods: A Guide to Modern Techniques of Plant Analysis, 4thEdition, Indian reprint, Springer.
2. Ashutoshkar (2007), Pharmacognosy and Pharmacobiotechnology, 2ndEdition, New age international (P) limited, New Delhi.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5
CO 1	S	S	S	S	M
CO 2	M	S	S	S	S
CO 3	S	S	M	S	S
CO 4	M	S	S	S	S
CO 5	M	S	M	S	S

S-Strong, M-Medium, L-Low

26UPCHE1E12 RESEARCH METHODOLOGY

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

1. To use literature and online databases for chemical research
2. To write scientific documents and prepare research proposals
3. To follow good laboratory practices and safety protocols
4. To manage projects effectively from planning to closure
5. To understand patents and intellectual property in research

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	gain knowledge of scientific literature sources, databases, and online research tools	K1, K2
CO2	develop skills in scientific writing, manuscript preparation, and research proposal drafting	K3, K4, K5
CO3	apply good laboratory practices and safety protocols in chemical research	K3, K4
CO4	analyze and managing research projects with effective planning and execution	K4, K5
CO5	understand patents, intellectual property rights, and procedures for protecting research	K1, K2

UNIT I Literature Survey

Sources of information – Primary, Secondary, Tertiary sources –Journals – Journal abbreviations – Reviews, Monographs – Textbooks – Current contents – Introduction to Chemical Abstract – Subject index, Author index, Formula index. Web resources – E- Journal access – TOC alerts – Hot Articles – Citation index - Impact factor – h-Index - E-Consortium – E-Books – Search engines: Scirus, Google Scholar, ChemIndustry – Databases: ScienceDirect, SciFinder, Scopus, Web of Science.

UNIT II Methodology of Science Document Writing

Introduction of technical writing – type of report –title and abstract – the text – writing dissertation and thesis – report of research work, laboratory observation – records preparation of

manuscript and posters – writingreview article and book reviews – preparing research proposals for grants – ethics in scientific publication – formats of some national and international journals. Document preparation using Microsoft office, chemdraw.

UNIT III Good laboratory practices and safety

Introduction: history, definition, principles, good laboratory practices (GLP). GLP training: resources, Rules, characterization, documentation, quality assurance, resources, facilities: equipment, GLP, FDA, European Union, non-member countries. Safe working procedure and protective environment, emergency procedure and first aid, laboratory ventilation, safe storage and use of hazardous chemicals, flammable or explosive hazards, procedures for working with gases at pressure above or below atmospheric – safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals and incineration.

UNIT-IV Project Management

Need for project management, project management approaches, project development stages, work breakdown structure. Time, cost, quality and risk management, tools and techniques for project management, cost estimation and budgeting, monitoring controlling and closure, continual improvement.

UNIT-V Patents

Definition and interpretation, criteria for patenting, types of inventions not patentable, patent application procedure, types of patent documents: provisional and complete specifications, opposition proceeding to grant of patent, patent office and its establishment, patent agents.

Text books

1. J. March, Advanced organic chemistry; Reaction, Mechanism and Structure 6th Ed.,Wiley-Interscience, 2007.
2. http:/www.inflibnet.ac.in; http:/www.springerlink.com; http:/www.rsc.org; http:/www.pubs.acs.org
3. M. Coghill and L. R. Gardson, The ACS Style Guide – Effective Communication of Scientific information, 3rd Ed, Oxford University Press, 2006.
4. H. Beall and J. Trimbur, A short Guide of Writing about chemistry, 2nd Ed., Longman, 2001.
5. Handbook Good Laboratory Practice (GLP) Quality Practices for Regulated Non-Clinical, Research Development, 2nd Ed., 2008.

6. Good Laboratory Practice Standards: Application for Field and Laboratory Studies W. Y. Garner, M. S. Barge, and James. P., University Press, 1992.

Reference books

1. Chemical safety matters-IUPAC –IPCS, Cambridge University Press, 1992.
2. James P Lewis, Fundamentals of Project Management, 3rd Ed., AMACOM, 2006.
3. K. Arora, Ed., The Patents act, 1970 as amended by the patents Act 2005, Professional book publishers, 2005.
4. Manual of patent practice and procedure, Patent office, India, 2008; http:www.Patent office.nic.in/ipr/pa

	PO1	PO2	PO3	PO4	PO5
CO 1	S	S	S	S	M
CO 2	M	S	S	S	S
CO 3	S	S	M	S	S
CO 4	M	S	S	S	S
CO 5	M	S	M	S	S

S-Strong, M-Medium, L-Low

Elective Courses– (Industry/Entrepreneurship)

26UPCHE1E13 COSMETIC CHEMISTRY

Hours	L	T	P	C
72	3	1	0	4

Objectives of the course

1. To familiarize 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.
4. To learn about the properties of cosmetic products
5. To understand the influence of cosmetic problems.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	To understand the basic concepts of cosmeceutical and Hair Care products.	K1, K2
CO2	To understand the skin care products.	K3, K4, K5
CO3	To understand the impact of oral care products.	K3, K4
CO4	To learn about the properties of cosmetic products	K4, K5
CO5	To understand the influence of cosmetic problems.	K1, K2

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-phenylene 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 cosmeceuticals. Sun protection, Classification of Sunscreens and SPF. Aloe and turmeric. Analytical cosmetics: BIS specification and analytical methods for skin-creamand 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.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5
CO 1	S	S	S	S	M
CO 2	M	S	S	S	S
CO 3	S	S	M	S	S
CO 4	M	S	S	S	S
CO 5	M	S	M	S	S

S-Strong, M-Medium, L-Low

26UPCHE1E14 CHEMICAL POLISHING OF METALS

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

1. To understand the basic principles of electrochemistry.
2. To study about Corrosion Inhibitors.
3. To study about Electrodes used in different electrochemical industries.
4. To understand the principles of chemical polishing.
5. To study the importance and uses of chemical polishing.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	To understand the basic principles of electrochemistry.	K2, K3, K4
CO2	To study about Corrosion inhibitors.	K2, K3, K4
CO3	To study about Electrodes used in different electrochemical industries.	K2, K3, K4
CO4	To understand the principles of chemical polishing.	K2, K3, K4
CO5	To study the importance and uses of chemical polishing.	K2, K3, K4

UNIT - I Electrochemistry

Principles of Electrochemistry, electrode potential, reference electrode, half-cell reaction, Nernst's equation, Application of Thermodynamics to Feasibility of corrosion of metals & alloys in various environments, Pourbaix diagram of common metals, electrolytes, potentiometric and conductometric titration

UNIT – II Corrosion inhibitors

Principle of prevention and protection of corrosion, Anodic protection, cathodic protection, application of inhibitors, organic coating & paints, metallic coating, anodizing , phosphating, chromate coating,

UNIT – III Electrodes used in different electrochemical industries

Metals, graphite, lead dioxide, titanium substrate insoluble electrodes, iron oxide, semi conducting type etc., metal finishing: Electro deposition, electro refining, electro forming, electro polishing, anodizing, selective solar coatings, cell design

UNIT - IV 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 - V Chemical polishing of dilver, 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.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5
CO 1	**S**	**S**	**S**	**S**	**M**
CO 2	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**M**	**S**	**S**
CO 4	**M**	**S**	**S**	**S**	**S**
CO 5	**M**	**S**	**M**	**S**	**S**

S-Strong, M-Medium, L-Low

26UPCHE1E15 PREPARATION OF CONSUMER PRODUCTS

Hours	L	T	P	C
72	1	0	3	4

Objectives of the course

1. To train the student to prepare various consumer products
2. To analyze various chemical present in the consumer products

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	Prepare various consumer products by determination and estimation	K1, K2
CO2	To identify the adulteration and presence of various constituents in industrial and food products.	K3, K4, K5

UNIT-I: Determination and Estimation

Determination of active contents (SLS, SLES, LABS) in a detergent; Determination of nitrogen by Kjeldhal method; Estimation of iodine value and saponification value of an oil; Estimation of hardness of water; Estimation of iron(III) by colorimetric method in water; Estimation of ascorbic acid by iodimetric method; Estimation of glucose by Benedict's method. Estimation of sugar by refractometric method; Estimation of purity of soda ash; Estimation of phenol by Winkler's method; Estimation of available chlorine in bleaching powder or bleach liquor.

UNIT-II: Detection and Adulteration

Detection of food adulteration including milk; Microbiological examination of food products. RWC of phenol; Detection of adulteration in petrol / diesel; Analysis of essential oils by gas chromatographic method; Isolation of lactose from milk. Caffeine from tea leaves, Ginger oleoresin from Ginger; Detection of alkaloids, terpenes, flavanoids, anthocyanins, proteins, amino acids; Hydrocarbons in the natural product extracts.

Text books

1. S.Gobala Rao, Outlines of chemical technology, Affiliated East West press,1998

Reference books

1. Kafaro, Wasteless, Chemical Processing, Mir Publishers, 1995.

2. W. Sawyer, Experimental Cosmetics, Dover Publishers, New York, 2000.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5
CO 1	S	S	L	M	S
CO 2	S	S	S	S	S

S – Strong, M – Medium, L - Low

Elective Courses - Skill Enhancement Courses

26UPCHE1E16 RESEARCH TOOLS AND TECHNIQUES

Course Objectives

1. To learn the principle, instrumentation, characterization and applications of analysis techniques
2. To study the principle, instrumentation, characterization and applications of chromatographic and thermal analysis techniques.

Course Outcomes

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

CO Number	CO Statement
CO1	To learn the principle, instrumentation, characterization and applications of analysis techniques
CO2	To study the principle, instrumentation, characterization and applications of chromatographic and thermal analysis techniques.

UNIT-I

Principle, instrumentation, characterization and applications of X-Ray Photoelectron spectroscopy, Powder X-ray diffraction - Single crystal X-ray diffraction techniques, Scanning electron microscopy (SEM), Energy-dispersive X-ray analysis (EDAX), Transmission electron microscopy (TEM), Atomic force microscopy (AFM).

UNIT-II

Principle, instrumentation, characterization and applications of Gas liquid chromatography (GLC), High performance liquid chromatography (HPLC), Gas Chromatograph- Mass Spectrometer (GC-MS), Thermogravimetry (TGA), Differential thermal analysis (DTA) and Differential Scanning Calorimetry (DSC).

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, An 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.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5
CO 1	S	S	L	M	S
CO 2	S	S	S	S	S

S – Strong, M – Medium, L - Low

26UPCHE1E17 LABORATORY SAFETY AND HAZARD MANAGEMENT

Course objectives

1. To train the student how to work safely in the lab and protect others
2. To state the role of MSDS and universal precautions for disposal and handling of hazardous chemicals

Course outcomes

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

CO Number	CO Statement
CO1	To work in a lab safely and prevent human accidents
CO2	To get best lab practices and handling of harmful chemicals

UNIT-I

Chemistry lab layout and safety procedures practiced in the Chemical laboratory that pertain to general laboratory safety and awareness including eye shower to fume hoods. Safety kits, devices, uses and storage. SOP for personal safety.

UNIT-II

Material Safety Data Sheet (MSDS), chemical, radiation, fire, electrical and gas safety; Clean room facility Universal Precautions and its importance in the handling of hazardous chemicals in the lab; handling of radioactive materials and biohazardous materials.

Text books

1. Anthony Fuscaldo, Laboratory Safety Theory and Practice, 1st Edition, December 1980.

2. Stephen R. Rayburn, The Foundations of Laboratory Safety, 1990 Springer-Verlag, New York.

Reference books

1. Prudent practices in the laboratory: handling and management of chemical hazards, updated version. National Academies Press, 25-Mar-2011 - Science - 360 pages.

2. Guidelines for Chemical Laboratory Safety in Academic Institutions American Chemical Society Washington, DC 2016.

3. Guidelines for Laboratory Design: Health, Safety, and Environmental Considerations, Fourth Edition Louis 15 March 2013 John Wiley & Sons, Inc.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5
CO 1	S	S	L	M	S
CO 2	S	S	S	S	S

S – Strong, M – Medium, L - Low

26UPCHE1E18 COMPUTATIONAL CHEMISTRY

Course Objectives

1. To study the various computational methods.
2. To study the various applications of computational methods to chemical structures.

Course Outcomes

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

CO Number	CO Statement
CO1	learn various computational methods.
CO2	use various applications of computational methods to chemical structures.

UNIT-I: Computational Analysis

Geometry optimization, calculation of thermodynamic parameters, vibrational frequencies and intensities, NMR and ESR parameters using elementary examples and a few representative molecules using Gaussian 16. Writing a Z - matrix - basis sets and types - vibrational analysis - Finding TS, NMR analysis software's used in computation, Natural Bond Orbital analysis - current trends in computational chemistry, Output analysis.

UNIT-II:Applications

Combined QM/MM methods: Implications of the choice of QM and MM methods; Application of QM/MM methods in organic, inorganic and organometallic systems. Quantitative structure activity relation (QSAR): Early approaches, topological indices, fragmental models; quantum mechanical descriptors. Application to Benzenoid and Non-Benzenoid Aromatic compounds.

Text books

1. D. Frenkel and B. Smit, Understanding Molecular Simulations, Second Edition, Elsevier, 2001.
2. M. P. Allen and D. J. Tildesley, Computer Simulation of Liquids, Second edition, Oxford University Press, 2017.
3. J. B. Foresman and Aeleen Frisch, Exploring Chemistry with Electronic Structure Methods, Gaussian Inc., 2015
4. W. Koch & M. C. Holthausen,A Chemists' Guide to Density Functional Theory, Wiley-VCH, 2001.

Reference books

1. F. Jensen (1999). Introduction to Computational Chemistry. England: John Wiley and Sons Ltd.
2. D.Young ,Computational Chemistry , Wiley-Interscience, 2001
3. J. March, Advanced Organic Chemistry
4. F.Jensen, Introduction to Computational Chemistry, Third edition, Wiley, 2017.
5. , A. Szabo & N. S. Ostlund,Modern Quantum Chemistry McGraw-Hill, 1961 edition reprinted by Dover Publications, 1989.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5
CO 1	S	S	L	M	S
CO 2	S	S	S	S	S

S – Strong, M – Medium, L - Low

SUPPORTIVE COURSES

26UPCHE1N01 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.

26UPCHE1N02 **APPLIED COSMETIC CHEMISTRY**

Hours	L	T	P	C
72	3	1	0	4

Objectives of the course

1. To familiarize with the basic concepts of cosmetics.
2. To know the theoretical aspect of hair basic formulations
3. To know the commonly used additives in skin cosmetic formulations.
4. To learn about the properties of perfume products
5. To understand the influence of beauty treatments.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	To understand the basic concepts of skin care products.	K1, K2
CO2	To understand the cosmeceutical and Hair Care and oral care products.	K3, K4, K5
CO3	To understand the impact of make-up products.	K3, K4
CO4	To learn about the properties of perfume products	K4, K5
CO5	To understand the influence of beauty treatments.	K1, K2

UNIT I

Skin care Nutrition of the skin, skin care and cleansing of the skin; face powder – ingredients; creams and lotions – cleansing, moisturizing all purpose, shaving and sunscreen (formulation only); Gels – formulation and advantages; astringent and skin tonics – key ingredients, skin lightness, depilatories.

UNIT II

Hair care Shampoos – types – powder, cream, liquid, gel – ingredients; conditioner – types – ingredients. Dental care Tooth pastes – ingredients – mouth wash

UNIT III

Make up Base – foundation – types – ingredients; lipstick, eyeliner, mascara, eyeshadow, concealers, rouge

UNIT IV

Perfumes Classification - Natural – plant origin – parts of the plant used, chief constituents; animal origin – amber gries from whale, civetone from civet cat, musk from musk deer; synthetic –classification emphasizing- characteristics – esters – alcohols – aldehydes – ketones

UNIT V

Beauty treatments Facials - types – advantages – disadvantages; face masks – types; bleach -types – advantages– disadvantages; shaping the brows; eyelash tinting; perming – types; hair colouring and dyeing, permanent waving – hair straightening; wax types – waxing; pedicure, manicure - advantages – disadvantages Recommended text: 1. Thankamma Jacob, (1997) Foods, drugs and cosmetics – A consumer guide, Macmillan publication, London.

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. Wilkinson J B E and Moore R J, (1997) Harry's cosmeticology, 7th ed., Chemical Publishers, London.

2. George Howard, (1987) Principles and practice of perfumes and cosmetics, Stanley Therones, Chettenham

3. A. O. Barel, M. Paye and H. I. Maibach, (2009). Handbook of Cosmetic Science and Technology, 3rd edition, Informa Health Care USA.

4. K.R. Kirtikar, B.D.Basu, Archeological Survey, Medicinal Plants, Herbs, Plant, Analysis, 1963.

5. A.P. Purohit, C.K. Kokate, S.B. Gokhale, A Text Book Of Pharmacognosy, Nlrali Prakashan.

6. Marc Avram, Sandy Tsao, Zeina Tannous, Matthew Avram, Color Atlas of Cosmetic Dermatology: A Medical and Surgical, McGraw-Hill Medical, First Edition, 2007.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5
CO 1	S	S	S	S	M
CO 2	M	S	S	S	S
CO 3	S	S	M	S	S
CO 4	M	S	S	S	S
CO 5	M	S	M	S	S

S-Strong, M-Medium, L-Low

26UPCHE1N03 WATER CHEMISTRY

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

1. To learn the analysis and uses of water.
2. To understand the water sampling techniques.
3. To get an insight about the waste water treatment.
4. To get knowledge on industrial waste water treatment and removal of particular organic matters.
5. To understand about sludge treatment and disposal.

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 treatment and disposal.	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 - 1

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 Water Treatment - 2

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.

26UPCHE1N04 INDUSTRIAL CHEMISTRY

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

1. To learn the unit operation processes.
2. To learn the water treatment, fuels and industrial gases.
3. To learn the industrial applications of glass and cement.
4. To learn the industrial applications of oil, soap and detergents.
5. To learn the fermentation technologies and sugars.

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, fuels and industrial gases.	K2 & K3
CO3	Learn the industrial applications of glass and cement.	K2, K3 & K4
CO4	Learn the industrial applications of oil, soap and detergents.	K3 & K4
CO5	Learn the fermentation technologies and sugars.	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.

26UPCHE1N05 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 Insecticides, Fungicides and Herbicides.
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	Get clear idea about the Soil fertility and water management.	K1, K2 & K3
CO3	Learn various fertilizers and their role in plants.	K2, K3 & K4
CO4	Acquire awareness about the preparation and uses of Insecticides, Fungicides and Herbicides.	K3, K4 & K5
CO5	Get knowledge about the advantages of biofertilizers.	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.

26UPCHE1N06 CHEMISTRY IN DAILY LIFE

Hours	L	T	P	C
72	3	1	0	4

Course Objectives

1. To understand the nature of food products, vitamins, fats and detergents.
2. To understand various pollution and pollutants.
3. To learn water purification methods 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 constituents 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	K2, K3 & K4
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**, Twenty second Edition, Goel Publishing, Meerut, 2019.
2. Ashutosh Kar, **Medicinal Chemistry**, Eighth Edition, New Age International Publisher, 2023.
3. Titus A. M. Msagati, **Chemistry of food Additives and Preservatives**, First Edition, Wiley-Blackwell, 2012.
4. Deanna M. Minich, **An A-Z Guide to Food Additives**, Read How You Want, 2010.
5. N. Saradha, V. Dhulasi Birundha, **Industrial Pollution: A Reference to small Scale Industries,** First Edition, Serials Publication, 2008.
6. Baboian, Robert, **NACE Corrosion Engineer's, NACE International**, Fourth Edition, 2022.
7. Pierre R. Roberge, **Handbook of Corrosion Engineering**, Third Edition, 2019.
8. Manas Chanda, **Introduction to Polymer Science and Chemistry**, Second Edition, CRC Press, 2013.
9. Charles E. Carraher Jr., **Introduction to polymer Chemistry**, Fourth Edition, CRC Press,

2017.

Reference books

1. Marcel Dekker, **Drugs and Pharmaceutical Sciences Series**, Fifth Edition, Vol. II, INC, New York, 2009.
2. H.E. Cox, David Pearson, **Analysis of Foods**, **Chemical Analysis of Foods**, Seventh Edition, Chemical Publishing Co Inc., U.S, 1976.
3. N. Shakuntala Many, S. Swamy, **Foods: Facts and Principles**, Sixth Edition, New Age International, 2026.
4. P. Atkins and J. de Paula, **Physical Chemistry**, Seventh Edition, Oxford University Press, 2002.
5. S. Swaminathan, Manish Goswamy, K.P. Sundaram, **Handbook on Fertilizer Technology**, Sixth Edition, Fertilizer Association of India, 2001.
6. I.L. Finar, **Organic Chemistry**, Sixth Edition, Vol. 1 & 2, Pearson Education India, 2002.
7. J. Fired, **Polymer Science and Technology**, Third Edition, Pearson Prentice Hall, 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.

26UPCHE1N07 PHARMACEUTICS

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 pharmaceutical 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**, Seventh edition, J. B. Lippincott, Philadelphi, 1977.
2. Ashutosh Kar, **Medicinal Chemistry**, Eighth Edition, New Age International Publisher, 2022.
3. Graham L. Patrick, **An Introduction to Medicinal Chemistry**, Seventh Edition, Oxford, 2023.
4. Joseph M. Ascenzi, **Hand Book of Disinfectants and Antiseptic**, First Edition, CRC Press, 1995.

Reference books

1. M. Gordon, **Psychopharmacological agents**, Fourth Volume, Academic press, New York,

2012.

2. J.M. Ritchie, P.J. Cohen, **The Pharmacological Basis of Therapeutics**, Fourteenth edition, Macmillan, New York, 2023.
3. D. Lednicer, L.A. Mitscher, **Organic Chemistry of Drug Synthesis**, Seventh Volume, John Wiley & Sons, New York, 2007.
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.

26UPCHE1N08 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 understand the basic principles of solvent, gel, paper, and ion-exchange chromatography.
5. To acquire knowledge on the analysis of separation, identification, quantification of volatile and semi volatile compounds.

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 gas chromatography techniques used for separating volatile compounds	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

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 Separation Techniques

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.

UNIT - V Analysis of Industrial samples

Gas chromatography - principle, instrumentation, theory and applications of separating volatile compounds. Gas liquid and Gas solid chromatography, carrier gases, injections techniques, packed and capillary columns and common detectors.

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.

VALUE ADDED COURSES

26UPCHE1V01 ELECTRO 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.

26UPCHE1V02 CHEMICAL ENERGY

Hours	L	T	P	C
30	2	0	0	2

Course Objectives

1. To understand the principles, reaction and application of batteries.
2. 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.

26UPCHE1V03 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)

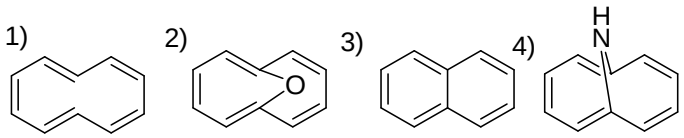
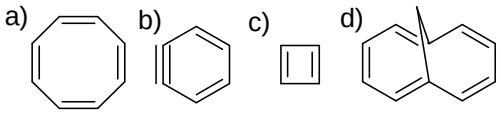
M. Sc. DEGREE EXAMINATION

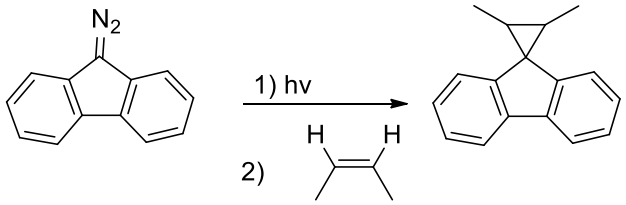
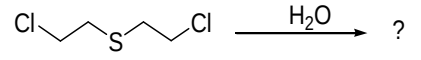
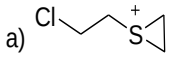
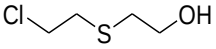
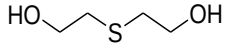
22UPCHE3C01 AROMATICITY AND ORGANIC REACTION MECHANISM

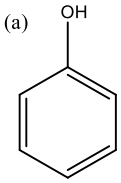
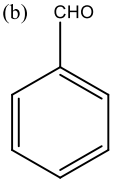
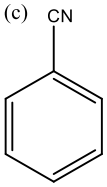
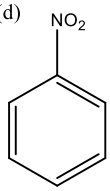
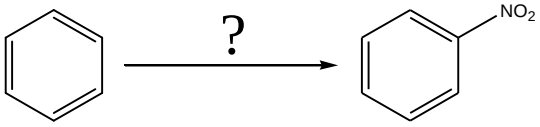
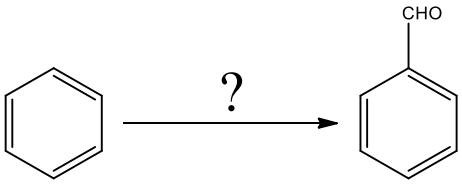
Time : Three Hours **Total marks = 75**

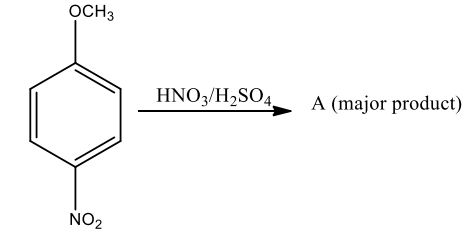
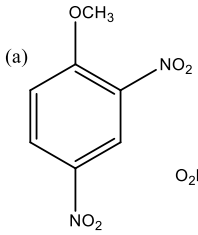
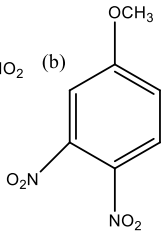
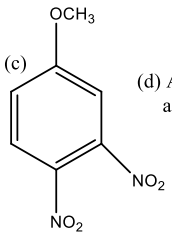
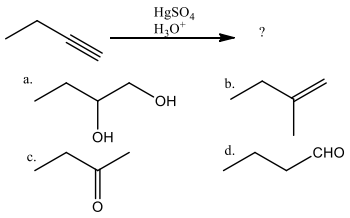
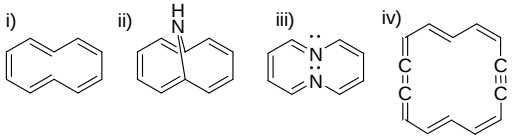
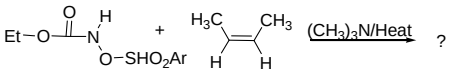
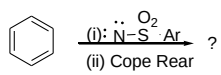
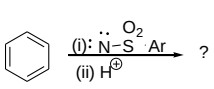
Part A (1X20) =20

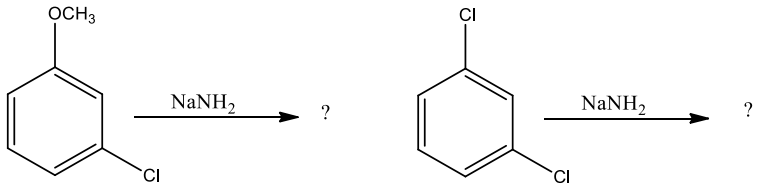
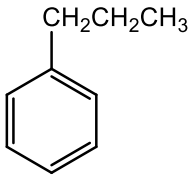
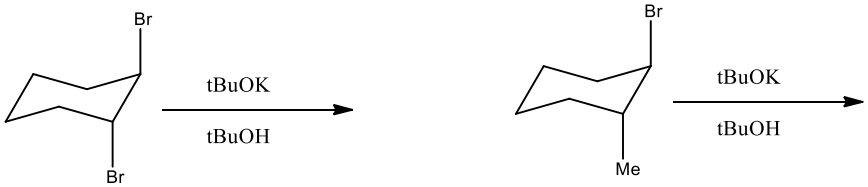
Answer all the questions

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	K3	CO2

	 a) Free radical b) Carbocation c) Carbanion d) Carbene		
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). $\dot{C}H_3$ (c). $O\bar{H}$ (d). F^-	K2	CO3
10	What will be the product in the following reaction  a)  b)  c)  d)None of these	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)	K3	CO3

	aryl halides with electron releasing substituents		
13	Which of the following is most readily undergo electrophilic attack? (a)  (b)  (c)  (d) 	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) 	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

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 reatment 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 $_3Li^7 + _1H^1$ ———> $2\ _2He^4$ 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	K4	CO3

	simple molecules a) XeF_6 b) $TeCl_6^{2-}$ c) $SbCl_6$		
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) $^{14}_{6}C + {}^{1}_{1}H \rightarrow {}^{11}_{5}B + ...$ (b) $^{27}_{12}Mg + {}^{1}_{0}n \rightarrow {}^{27}_{11}Na + ...$ (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	K1	CO1

	two or more measurements? a. Accuracy b. Threshold c. Precision d. Fidelity		
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-MS & AAS	K3	CO2
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_____	K2	CO4

	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		
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	K2	CO4

	selectivity of EDTA titration.		
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	K3	CO5

	chromatography (ii) Application of GPC		

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	K4	CO2

	(a) Butanoic acid (b) Butanal (c) 2-butanon (d)Methylpropanoate		
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	K3	CO5

	treatment. Write the name of the new metal complexes which are used to replace Pt complexes.		

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	K3	CO1

	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.		
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 $0 \leq x \leq \pi$ 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). $\Delta E \alpha (2n + 1)$ (b). $\Delta E \alpha n$ (c). $\Delta E \alpha (2n - 1)$ (d). $\Delta E \alpha 2n$	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 C2vd). C3v and C2v	K4	CO3
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	K4	CO3

	a). a/√6 b) a/√8 c).a/√3 d).a/√12		
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 Γ= 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: a) 1⁄2 b) 3⁄4 c) 1⁄2 d) None of the mentioned	K3	CO5
	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)

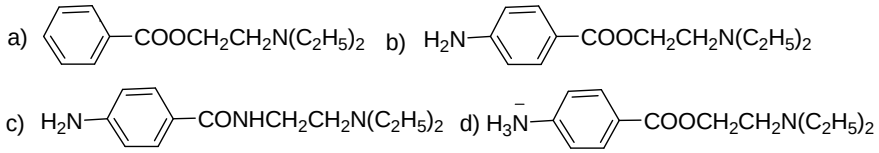
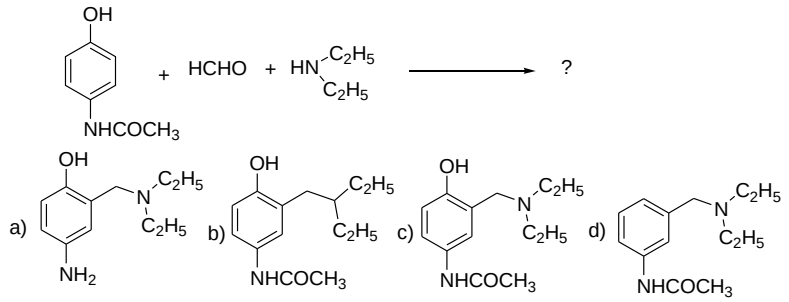
M. Sc. DEGREE EXAMINATION

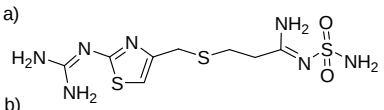
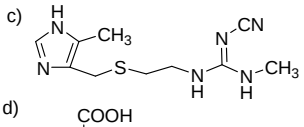
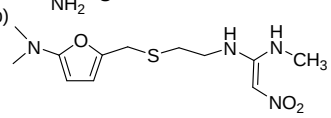
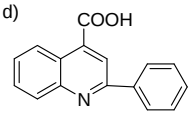
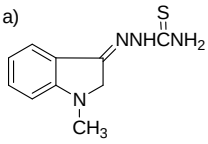
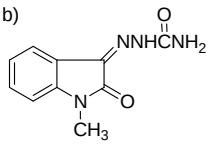
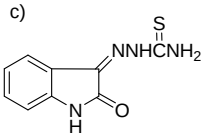
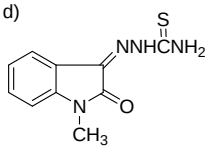
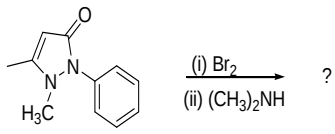
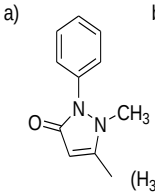
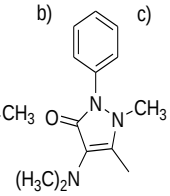
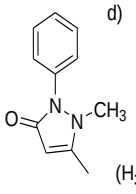
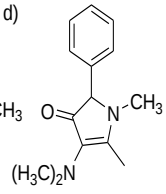
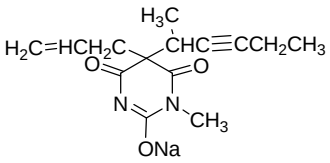
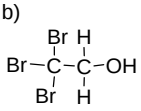
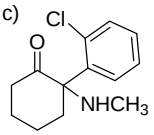
22UPCHE3E01 MEDICINAL CHEMISTRY

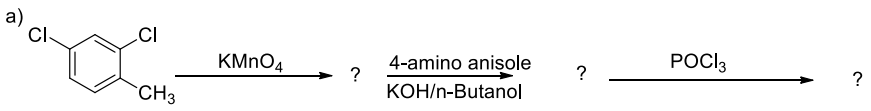
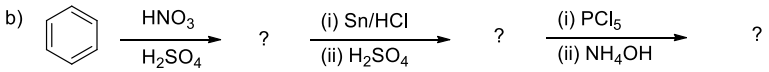
Time : Three Hours **Total marks = 75**

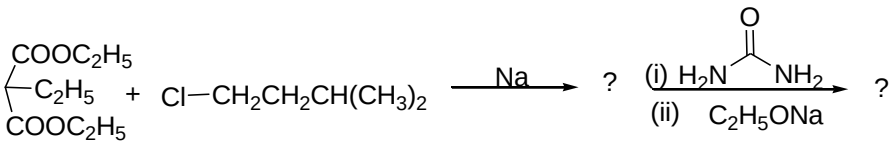
Part A (1X20) =20

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

	a)  c)  b)  d) 		
8	The correct structure of the drug Methisazone is, a)  b)  c)  d) 	K4	CO2
9	Which of the following gives Cinchophen on excess aq. ammonia a) Isatin and acetophenone b) Aldehyde and acetophenone c) Salicyclic acid and acetophenone d) None of these	K4	CO3
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, a)  b) 	K4	CO2
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	K3	CO5

	sulphadiazine b) N-methylglucamine antimonate and draw their structures.		

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	K3	CO1

	A) BH_3NH_3 B) $B_3N_3H_6$ C) B_2H_6 D) BH_3		
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	K3	CO5

	between the two appropriate marks was 60s and the time of flow for the solution was 80s		
	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 techniques (4+4=8)	K3	CO4
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		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. Siva Associate Professor Department of Physical Chemistry Madurai Kamaraj University, Madurai 625 021
2.	Dr. P. Viswanathamurthi Professor Department of Chemistry Periyar University, Salem – 636 011	2.	Dr. J. Madahvan Associate Professor Department of Chemistry Thiruvalluvar University Vellore-632 115.
3.	Dr. D. Gopi Professor Department of Chemistry Periyar University, Salem – 636 011	3.	Dr. M. Sundrarajan Professor & Head Department of Chemistry Alagappa University Karaikudi - 630 003
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. V. Sujatha Assistant Professor Department of Chemistry Periyar University, Salem – 636 011	5.	Dr. R. Karvembu Professor Department of Chemistry National Institute of Technology Tiruchirapalli

6.	Dr. K. Shanmuga Bharathi Assistant Professor Department of Chemistry Periyar University, Salem – 636 011	6	Dr. T. Selvaraju Associate Professor Department of Chemistry Bharathiar University Coimbatore 46
7.		7.	Dr. T. M. Sridhar Head, Department of Analytical Chemistry University of Madras, Guindy Campus, Chennai-600 025
8.		8.	Dr. S. Thirumaran Professor Department of Chemistry Annamalai University, Annamalai Nagar, Chidambaram
9.		9.	Dr. R. Prabhakaran Associate Professor Department of Chemistry Bharathiar University Coimbatore 46