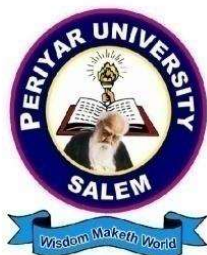


**PERIYAR UNIVERSITY**  
**(Accredited with 'A' Grade by NAAC)**  
**SALEM – 636 011**



**M.Sc., DEGREE**

**[Choice Based Credit System (CBCS)]**

***Branch IV (A) CHEMISTRY***  
***Programme Code : CHE3***

**REGULATIONS AND SYLLABUS**

**[For the Candidates admitted from the academic year  
2018– 2019 and onwards ]**

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### **I - Programme Outcomes:**

1. Graduates are prepared to be creators of new knowledge leading to innovation and entrepreneurship employable in various sectors such as private, government, and research organizations.
2. Graduates are trained to evolve new technologies in their discipline.
3. Graduates are groomed to engage in lifelong learning process by exploring their knowledge independently.
4. Graduates are framed to design and conduct experiments /demos/create models to analyze and interpret data.
5. Graduates ought to have the ability of effectively communicating the findings of Physical sciences; incorporating with existing knowledge.

### **II- Programme Specific Outcomes:**

1. Human and Social Values and Responsibilities in the context of learning Chemistry
2. Positive approach towards Environment and Ecology from the Chemistry perspective
3. Critical thinking and the Analytical mind, students develop for the in depth knowledge in advanced-level Chemistry
4. The relevance of extension of Chemistry in the social context for solving social issues
5. Entrepreneurial Skills shall empower the students to start their own industries / business in core-chemistry fields
6. Analytical or Experimental Skills make the students capable of doing higher-level research works in the emerging fields of chemistry.

### **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 Polymer chemistry, Environmental Chemistry, Dye Chemistry, Pharmaceutical Chemistry etc.

This programme is offered under Choice Based Credit System (CBCS). 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 university 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 Course**

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

## VI. Course of Study

### M.Sc. Chemistry - CBCS Structure of the Course

S. No	Paper code	Title of the Paper	Hours	L	T	P	C
<b>First Semester</b>							
1.	18UPCHE1C01	Core Course 1 - Stereochemistry and Reaction Mechanism	72	3	1	0	4
2.	18UPCHE1C02	Core Course 2 - Bonding, Structural and Nuclear Chemistry	72	3	1	0	4
3.	18UPCHE1C03	Core Course 3 - Group theory and Thermodynamics	72	3	1	0	4
4.	18UPCHE1C04	Core Course 4 -Analytical Chemistry	72	3	1	0	4
5.	18UPCHE1E0---	Elective course - 1	72	3	1	0	4
6.	18UPCHE1C05	Core Course 5 - Organic Chemistry Practical - I	90	0	0	5	3
7.	18UPCHE1C06	Core Course 6 - Inorganic Chemistry Practical - I	90	0	0	5	3
<b>Second Semester</b>							
8.	18UPCHE1C07	Core Course 7 - Organic reactions and conformational analysis	72	3	1	0	4
9.	18UPCHE1C08	Core Course 8 - Coordination Chemistry	72	3	1	0	4
10.	18UPCHE1C09	Core Course 9 – Quantum Chemistry and Chemical Kinetics	72	3	1	0	4
11.	18UPCHE1E0---	Elective Course - 2	72	3	1	0	4
12.	---	Supportive Course - 1	72	2	1	0	3
13.	18PHR01	Compulsory Course – Human Rights-Duties	72	3	1	0	2
14.	18UPCHE1C10	Core Course 10 - Physical Chemistry Practical - I	90	0	0	5	3
15.	18UPCHE1C11	Core Course 11 - Organic Chemistry Practical - II	90	0	0	5	3
<b>Third Semester</b>							
16.	18UPCHE1C12	Core Course 12 - Organic synthesis and natural products	72	3	1	0	4
17.	18UPCHE1C13	Core Course-13 - Organometallic & Bioinorganic Chemistry	72	3	1	0	4
18.	18UPCHE1C14	Core Course 14 - Physical Methods in Chemistry	72	3	1	0	4
19.	18UPCHE1E0--	Elective course - 3	72	3	1	0	4
20.	---	Supportive Course - 2	72	4	0	0	3
21.	18UPCHE1C15	Core Course 12 - Inorganic Chemistry Practical -II	90	0	0	5	3
22..	18UPCHE1C16	Core Course 13 –Physical Chemistry Practical - II	90	0	0	5	3
<b>Fourth Semester</b>							
23.	18UPCHE1C17	Core Course - 16 Spectroscopy	72	4	0	0	4
24.	18UPCHE1C18	Core Course 17 - Project Viva	252	0	0	0	6
25.	18UPCHE1C19	Elective Course - 4	72	4	0	0	4
<b>Elective Courses</b>							
1.	18UPCHE1E01	Medicinal Chemistry	72	3	1	0	4
2.	18UPCHE1E02	Environmental Chemistry	72	3	1	0	4
3.	18UPCHE1E03	Materials Chemistry	72	3	1	0	4
4.	18UPCHE1E04	Dye Chemistry	72	3	1	0	4
5.	18UPCHE1E05	Water Chemistry	72	3	1	0	4
6.	18UPCHE1E06	Green Chemistry	72	3	1	0	4
7.	18UPCHE1E07	Electroanalytical Techniques	72	3	1	0	4
8.	18UPCHE1E08	Instrumental Methods of Analysis	72	3	1	0	4

Supportive Courses for other Departments							
1	18UPCHE1S01	Medicinal Inorganic Chemistry	72	2	1	0	4
2	18UPCHE1S02	Conducting Polymers	72	2	1	0	4
3	18UPCHE1S03	Industrial and Agricultural Chemistry	72	2	1	0	4
4	18UPCHE1S04	Chemistry of Natural Products	72	2	1	0	4
5	18UPCHE1S05	Chemistry of Industrial Products	72	2	1	0	4
6	18UPCHE1S06	Fundamentals of Analytical Chemistry	72	2	1	0	4
7	18UPCHE1S07	Pharmaceutical Chemistry	72	2	1	0	4
8.	18UPCHE1S08	Applied Catalysis	72	2	1	0	4

SWAYAM Courses							
First Semester							
1.	SW1	Swayam course –1 Inorganic Chemistry of life	72	0	0	0	4
Third Semester							
2.	SW2	Swayam course –2 Advanced Kinetics and Thermodynamics	72	0	0	0	4

Note:

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

Credits for Core Courses	72;	Credits for Elective Courses	16
Credits for Supportive Courses	06;		
Total Credits	90		
Extra Credit: Swayam Courses	08;	Human rights Courses	02

## VII. Teaching Methodologies

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

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

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

## VIII. Examinations

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

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

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

## IX. Scheme of Examination

### M.Sc., Chemistry CBCS Structure of the Course

S. No	Paper code	Title of the Paper	Hours	I	E	M	C
<b>First Semester</b>							
1.	18UPCHE1C01	Core Course 1- Stereochemistry and Reaction Mechanism	3	25	75	100	4
2.	18UPCHE1C02	Core Course 2- Bonding, Structural and Nuclear Chemistry	3	25	75	100	4
3.	18UPCHE1C03	Core Course 3- Group theory and Thermodynamics	3	25	75	100	4
4.	18UPCHE1C04	Core Course 4-Analytical Chemistry	3	25	75	100	4
5.	18UPCHE1E0--	Elective course -1	3	25	75	100	4
6.	18UPCHE1C05	Core Course 5 -Organic Chemistry Practical - I	6	40	60	100	3
7.	18UPCHE1C06	Core Course 6 - Inorganic Chemistry Practical - I	6	40	60	100	3
<b>Second Semester</b>							
8.	18UPCHE1C07	Core Course 7 - Organic reactions and conformational analysis	3	25	75	100	4
9.	18UPCHE1C08	Core Course 8 - Coordination Chemistry	3	25	75	100	4
10.	18UPCHE1C09	Core Course 9 – Quantum Chemistry and Chemical Kinetics	3	25	75	100	4
11	18UPCHE1E0---	Elective Course -2	3	25	75	100	4
12.	---	Supportive Course-1	3	25	75	100	3
13.	18PHR01	Compulsory Course – Human Rights-Duties	3	25	75	100	2
14.	18UPCHE1C10	Core Course 10 - Physical Chemistry Practical - I	6	40	60	100	3
15.	18UPCHE1C11	Core Course 11 -Organic Chemistry Practical - II	6	40	60	100	3
<b>Third Semester</b>							
16.	18UPCHE1C12	Core Course 12- Organic synthesis and natural products	3	25	75	100	4
17.	18UPCHE1C13	Core Course- 13 - Organometallic & Bioinorganic Chemistry	3	25	75	100	4
18.	18UPCHE1C14	Core Course 14 - Physical Methods in Chemistry	3	25	75	100	4
19.	18UPCHE1E0--	Elective course -3	3	25	75	100	4
20	---	Supportive Course-2	3	25	75	100	3
21.	18UPCHE1C15	Core Course 12 - Inorganic Chemistry Practical -II	6	40	60	100	3
22..	18UPCHE1C16	Core Course 13 –Physical Chemistry Practical - II	6	40	60	100	3
<b>Fourth Semester</b>							
23.	18UPCHE1C17	Core Course-16 Spectroscopy	3	25	75	100	4
24	18UPCHE1C18	Core Course 17 - Project Viva	6	50	150	200	6
25.	18UPCHE1C19	Elective Course - 4	3	25	75	100	4
<b>Elective Courses</b>							
1.	18UPCHE1E01	Medicinal Chemistry	3	25	75	100	4
2.	18UPCHE1E02	Environmental Chemistry	3	25	75	100	4
3.	18UPCHE1E03	Materials Chemistry	3	25	75	100	4
4.	18UPCHE1E04	Dye Chemistry	3	25	75	100	4
5.	18UPCHE1E05	Water Chemistry	3	25	75	100	4
6.	18UPCHE1E06	Green Chemistry	3	25	75	100	4
7	18UPCHE1E07	Electroanalytical Techniques	3	25	75	100	4
8	18UPCHE1E08	Instrumental Methods of Analysis	3	25	75	100	4

Supportive Courses for other Departments							
1	18UPCHE1S01	Conducting Polymers	3	25	75	100	3
2	18UPCHE1S02	Industrial and Agricultural Chemistry	3	25	75	100	3
3	18UPCHE1S03	Chemistry of Natural Products	3	25	75	100	3
4	18UPCHE1S04	Chemistry of Industrial Products	3	25	75	100	3
5	18UPCHE1S05	Fundamentals of Analytical Chemistry	3	25	75	100	3
6	18UPCHE1S06	Pharmaceutical Chemistry	3	25	75	100	3
7	18UPCHE1S07	Applied Catalysis	3	25	75	100	3
8.	18UPCHE1S08	Medicinal Inorganic Chemistry	3	25	75	100	3

First Semester							
1.	SW1	Swayam course –1 Inorganic Chemistry of life namics	3	0	100	100	4
Third Semester							
2.	SW2	Swayam course –2 Advanced Kinetics and Thermodynamics	3	0	100	100	4

\* Periodic Presentation of Learning                      **50 marks**  
# Concise Dissertation 100 marks + Viva-Voce            **50 marks**

## X. Question Paper Pattern

Time: 3 Hours

Max. Marks - 75

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

(Four questions from each unit-Objective type)

**PART-B: 3 x 5=15**  
(Answer any three questions)  
(One question from each)

**PART C: 5x8=40**  
(Answer all questions)  
(One question from each unit with internal choice)  
(Maximum two Sub-Divisions only)

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



## XI. Distribution of Marks Theory and Practical Examinations

**Theory (Internal marks 25)**

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

**Internal**

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

**Practical (Internal marks 40)**

**Internal**

Class Experiments	25 marks
Model Test	15 marks
<b>Total</b>	<b>40 marks</b>

**Theory - External: 75 Marks**

**PART-A: 20x1=20, PART-B: 3x5=15, PART-C: 5x8=40**

**Practicals - External : 60 marks**

**Duration: 6 hours**

<b>Organic Chemistry Practical - I</b>	
Qualitative organic analysis	30 marks
Preparation	10 marks
Viva – Voce in practical	10 marks
Record	10 marks
<b>Total</b>	<b>60 marks</b>

<b>Organic Chemistry Practical - II</b>	
Quantitative organic analysis	20 marks
Preparation	20 marks
Viva – Voce in practical	10 marks
Record	10 marks
<b>Total</b>	<b>60 marks</b>

<b>Inorganic Chemistry Practical -I</b>	
Qualitative analysis	30 marks
Preparation	10marks
Viva-voce in practical	10 marks
Record	10marks
<b>Total</b>	<b>60 marks</b>

<b>Inorganic Chemistry Practical –II</b>	
Quantitative analysis	30 marks
Preparation	10 marks
Viva-voce in practical	10 marks
Record	10 marks
<b>Total</b>	<b>60 marks</b>

<b>Physical Chemistry Practical - I</b>	
Experiment	40 marks
Viva-voce in practical	10 marks
Record	10 marks
<b>Total</b>	<b>60 marks</b>

<b>Physical Chemistry Practical - II</b>	
Experiment	40 marks
Viva-voce in practical	10 marks
Record	10 marks
<b>Total</b>	<b>60 marks</b>

## **XII. Dissertation / Project Work**

Concise Dissertation 150 marks

Viva-Voce 50 marks

**Total** 200 marks

### **(a) Topic:**

The topic of the dissertation shall be assigned to the candidate before the end of first semester and a copy of the same should be submitted to the University for Approval.

### **(b) Advisory Committee:**

Each guide shall have a maximum of five students.

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

**(c) Plan of Work:**

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

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

**(d) Dissertation Work outside the Department:**

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

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

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

**(f) Format to be followed:**

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

Format for the preparation of project work:

- (a) Title page
- (b) Bonafide Certificate
- (c) Acknowledgement
- (d) Table of contents

**CONTENTS**

<b>Chapter No.</b>	<b>TITLE</b>	<b>Page No.</b>
1.	Introduction	
2	Review of Literature	
3.	Materials and Methods	
4.	Results	
5.	Discussion	
6.	Summary	
7.	References	

**Format of the Title Page:**

**TITLE OF THE DISSERTATION**

Dissertation Submitted in part fulfillment of the requirement for the 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 part fulfillment of the requirement 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 journals or magazines.

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 Principal.

**XIII. Passing Minimum**

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

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

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

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

#### **XIV. Classification of Successful Candidates**

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

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

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

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

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

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

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

#### **XV. Maximum Duration for the Completion of the Course**

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

#### **XVI. Commencement of this Regulation**

These regulations shall take effect from the academic year 2015-2016.i.e., for students who are to be admitted to the first year of the course during the academic year 2015-2016and thereafter.

#### **XVII. Transitory Provision**

Candidates who were admitted to the M.Sc. Degree in Chemistry with specialization in Organic/Inorganic/Physical Chemistry course of study before 2015-2016 shall be permitted to appear for the examinations under those regulations for a period of three years i.e., up to and inclusive of the examination of April/May 2018. Thereafter, they will be permitted to appear for the examination only under the regulations then in force.

# XVIII. Syllabus

## Core Courses

### First Semester

#### 18UPCHE1C01 REACTION MECHANISM AND STEREOCHEMISTRY

Hours	L	T	P	C
72	4	1	0	4

#### Course Objectives

1. To understand the structure and reactivity of chemically active centers
2. To study the mechanism of nucleophilic and electrophilic substitution reactions
3. To understand the stereochemistry of compounds.

#### Course Outcomes

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

CO No.	CO Statement	Knowledge Level
CO1	To understand the basic reaction mechanism	K2
CO2	To impart the concepts of aromaticity and synthesis of heterocyclic compounds.	K2
CO3	Learning in detail about the mechanism of nucleophilic substitution reactions.	K3
CO4	To understand the concepts of electrophilic substitution reactions.	K3
CO5	To impart the stereochemistry of organic compounds and its applications.	K3

#### UNIT - I Types of Reactions, Mechanisms and Structure Reactivity:

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

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

Tutorials: Problems on prediction of products

## UNIT - II Aromaticity:

Aromaticity of benzenoid, heterocyclic and non-benzenoid compounds, Huckel rule, aromatic systems with other than six  $\pi$  electrons, non-aromatic and anti-aromatic systems with more than 10  $\pi$  electrons – annulenes, azulenes, sydnones, tropolones, fulvenes and ferrocenes (synthesis not necessary). Homo-aromaticity.

Heterocycles: Nomenclature of heterocycles having not more than two hetero atoms, such as O, N and S. Synthesis and properties of imidazole, oxazole, thiazole and Pyrimidines.

Tutorials: Problems on prediction of products and conversions.

## UNIT - III Nucleophilic Substitution Reactions:

The  $S_N1$ ,  $S_N2$ , mixed  $S_N1$  and  $S_N2$ ,  $S_{Ni}$  and SET mechanisms. The neighbouring group mechanism, neighbouring group participation by  $\sigma$  and  $\pi$  bonds, anchimeric assistance. Nucleophilic substitution at an allylic, aliphatic trigonal and vinylic carbon; Reactivity effects of substrates structure, attacking nucleophile, leaving group and reaction medium, ambident nucleophile, regioselectivity. Reactions involving substitution at carbon doubly bonded to oxygen and nitrogen: Williamson reaction, Von Braun reaction, Claisen and Dieckmann condensation. Hydrolysis of esters.

Aromatic nucleophilic Substitution -  $S_{Ni}$ ,  $S_{NAr}$ ,  $S_{Ni}$ , Benzyne mechanism. Aromatic nucleophilic substitution of activated halides - Ziegler alkylation, Chichibabin reaction.

Tutorials: Problems on conversions and mechanisms.

## UNIT - IV Electrophilic Substitution Reactions:

Aromatic electrophilic substitution: The arenium ion mechanism, typical reactions like nitration, sulphonation, halogenation, Friedel-Crafts alkylation, acylation and diazonium coupling, electrophilic substitution on monosubstituted benzene, orientation and reactivity - ortho, meta and para directing groups, ortho-para ratio, ipso attack, Gatterman, Gatterman-Koch, Vilsmeier, Reimer-Tiemann reaction.

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 conversions of products and mechanisms.

## **UNIT - V Stereochemistry:**

Fundamentals of organic Stereochemistry: Projection Formulae: Fischer, Newman and Sawhorse projections and their interconversions. Homotopic, enantiotopic and diastereotopic atoms and groups in organic molecules; Optical activity in the absence of chiral carbon-biphenyls, allenes and spiranes. R-S notations; Chirality due to helical shape – transcyclooctene. E-Z isomerism of olefins containing one double bond and more than one double bonds; Definition of prochirality - Asymmetric synthesis - Cram's rule.

Tutorials: Problems on conversions of stereochemical products.

### **Text books:**

1. Jerry March, **Advanced Organic Chemistry-Reactions, Mechanisms and Structure**, Fourth Edition, John Wiley & Sons, 1992
2. **A Guide Book to Mechanism in Organic Chemistry** by Longman.
3. Robert Thornton Morrison, Robert Neilson Boyd, **Organic Chemistry**, Sixth Edition, Prentice-Hall of India private Ltd, 1992.
4. Dr. ArunSarkar, **Advanced Organic Chemistry: Reactions and Mechanisms**, Indramanipandey for swastik publication, 2011.
5. Dr. Jagdamba Singh, Dr. L.D.S. Yadav, **Advanced Organic Chemistry**, Sixth Edition, K.K. Mittal for pragatiprakashan pub, 2010.
6. **Stereochemistry Conformation and Mechanism**, Fourth Edition, by P.S. Kalsi, New age International (P) limited, publishers, 1990.
7. **Organic Reaction Mechanism, Third Edition**, by Dr. Raj. K. Bansal, McGraw-Hill Companies, 1998.

## Reference Books:

1. **Structures and Mechanism** by E.S. Gould
2. **Carbenes, Nitrenes and Arynes** by T.L. Gilchrist and C.W. Rees, Thomas Nelson and Sons Ltd., London.
3. Francis A. Carey, **Organic Chemistry**, Third Edition, McGraw-Hill Companies, Inc., 1996.
4. Ernest L. Eliel, **Stereochemistry of Carbon Compounds**, T.M.H Edition, Tata McGraw-Hill Publishing Company, 1995.
5. **Structure and Mechanism in Organic Chemistry** by C.K. Ingold, Cornell University press
6. **Aromatic Nucleophilic Substitution** by J. Miller
7. Francis A. Carey, Robert M. Giuliano, **Organic Chemistry**, Eighth Edition, Tata McGraw-Hill Publishing Company, 2012.
8. Bhupinder Mehta, Manju Mehta, **Organic Chemistry**, Prentice-Hall of India private Ltd, 2005.
9. **Introduction to Organic Chemistry** by John McMurry, 2007.
10. Thomas N. Sorrell, **Organic Chemistry**, Second Edition, VinodVasishtha for viva books pvt. Ltd, 2010.
11. Michael B. Smith, **March's Advanced Organic Chemistry Reactions, Mechanisms and Structure**, Seventh Edition, John Wiley & Sons, Inc, 2013.
12. **Advanced Organic Chemistry Reactions and Mechanisms** by Mayashankar Singh, Pearson edition (Singapore), 2005.
13. **Advanced Organic Chemistry, Reaction Mechanisms**, by Reinhard Bruckner, Elsevier, 2002.
14. Michael B. Smith, Jerry March, **March's Advanced Organic Chemistry, Reactions, Mechanisms and Structure**, Sixth Edition, John Wiley & Sons, Inc, 2007.

### Mapping with Programme Outcomes

<b>COs</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>
<b>CO1</b>	S	S	M	M	M
<b>CO2</b>	M	S	S	S	M
<b>CO3</b>	S	M	S	S	M
<b>CO4</b>	M	M	S	S	S
<b>CO5</b>	S	S	M	M	S

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

## 18UPCHE1C02 CHEMICAL BONDING, SOLID STATE AND NUCLEAR CHEMISTRY

Hours	L	T	P	C
72	4	1	0	4

### Objectives

- To understand the structure, bonding and properties of chemical compounds, clusters & Solids
- To study the types of Nuclear Reactions and Applications of Radioisotopes

### Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	To know the structure and bonding in molecules / ions and predict the structure of molecules / ions	K1
CO2	Understand the concepts of synthesis, bonding, structure and their application of polyacids, inorganic polymers, silicates and properties of allotropy of carbon.	K3
CO3	To learn the different groups of compounds focusing on synthetic methods, structure and bonding in cluster compounds.	K2, K3
CO4	Understand the different types of solids, theory, synthesis and crystallisation methods	K2
CO5	To get basic idea about the models of nucleus, nuclear reactions, detection of radioactivity and application of radioisotopes in various fields.	K2, K3

### UNIT I Bonding in chemical compounds

VSEPR model, shapes of molecules- $\text{ClF}_3$ ,  $\text{ICl}_4^-$ ,  $\text{TeF}_5^-$ ,  $\text{H}_2\text{O}$ ,  $\text{I}_3^-$ ,  $\text{TeCl}_6^{2-}$ ,  $\text{XeF}_6$ ,  $\text{SbCl}_6^{3-}$ ,  $\text{N}_2\text{O}_2^-$ ,  $\text{H}_3\text{PO}_4$ ,  $\text{IF}_7$ ,  $\text{ReF}_7$ ,  $\text{XeF}_8^{2-}$ ,  $\text{TaF}_8^{3-}$ ; Bent rules and energetics of hybridization; electronegativity and partial ionic character; Bonds- Multicenter, Synergic and Agostic bonding. Lattice energy: Born-Landé equation, Kapustinskii equation; polarizability and partial covalent character, Radius-Ratio rules - structures of simple solids, Zintl - isoelectronic relationship in solids. Molecular orbital theory: LCAO and MO diagrams of heteronuclear diatomic ( $\text{CO}$ ,  $\text{NO}$ ,  $\text{HF}$ ,  $\text{ICl}$ ) and triatomic molecules ( $\text{CO}_2$ ,  $\text{H}_2\text{O}$ , and  $\text{NO}_2^-$ ).

**Tutorial:** Problems related to the shape of molecules, Bent's rule, Radius-Ratio rule, lattice energy.

## UNIT II Chemical Bonding and Inorganic Polymers

Van der Waals bonding, Hydrogen bonding; HSAB concept - a general study; polyacids - Isopolyacids of V, Mo and W; Heteropolyacids of Mo and W (only structural aspects). Inorganic polymers - silicates - structure, properties, correlation and application; Molecular sieves; polysulphur nitrogen compounds – polythiazyl preparation, properties, structure and bonding and polyorganophosphazenes – preparation, properties, structure and bonding (tri and tetra compounds only). Allotropes of carbon (graphite, diamond, fullerenes) and their properties.

**Tutorial:** Comparison between the molecules, properties and structural aspects.

## UNIT III Boron Compounds and Clusters

A general study of preparation, properties, Structure and bonding in simple borane, polyhedral boranes and carboranes- - types such as closo and nido only, styx notation; Wade's rule; electron count in polyhedral boranes; isolobal analogy; boron halides; phosphine-boranes; boron heterocycles- borazine. Metallo carboranes - a general study; Metal clusters-chemistry of low molecularity metal clusters only, multiple metal-metal bonds.

Metal cluster: Occurrence of metal-metal bonds in metal complexes, Bonding in metal cluster. Metal carbonyl type clusters. Anionic and hydride cluster. Method of synthesis, super large cluster, electron counting in medium size cluster (Wade's rule, Capping rule), Isolable relationship, cluster of Fe, Ru, Os groups. Cluster of Co, Rh, Ir groups. Cluster of Ni, Pd, Pt groups. Chevrel phases and Zintl Ions.

**Tutorial:** Problems related to Wade's rule, Styx number metal cluster and Zintl Ions.

## UNIT IV Structure, Bonding and Preparative Methods of Inorganic Solids

Bonding in solids: Ionic, covalent, metallic and molecular solids, theory of solids – free electron theory and its limitations, band theory. Radius ratio rule and its limitations, Structure of solids- Pyroovskite, Cadmium iodide, Nickel arsenide; Spinels – classification, Structure and formation: Defects in solids- Point defects, Line defects and Plane defects, Non-stoichiometric compounds with examples.

Preparative methods: Solid state reaction, chemical precursor method, co-Precipitation, sol-gel, metathesis, self-propagating high temperature synthesis, ion exchange reactions, intercalation / deintercalation reactions; hydrothermal and template synthesis; High pressure synthesis

Methods of Single Crystal Growth: Solution growth; Melt Growth-Bridgeman, Czochralski, Kyropoulos, Verneuil; Chemical Vapour Transport; Fused Salt Electrolysis; Hydrothermal method; Flux Growth.

**Tutorial:** Problems related to Spinel, radius ratio rule and Defects in solids.

## **UNIT V Nuclear Reactions and Applications of Radioisotopes**

Nature of Nucleus – Elementary particles, quarks and mesons – Models of nucleus - shell model and liquid drop model; Binding energy, Modes of decay, half life period, orbital electron capture; nuclear isomerism; internal conversions; Q value; nuclear cross section; threshold energy and excitation functions. Different type of nuclear reactions with natural and accelerated particles - transmutation, fission; Characteristic of fission reaction, theories of fission; fissile and fertile isotopes -  $U^{235}$ ,  $U^{238}$ ,  $Th^{232}$  and  $Pu^{239}$ ; atom bomb; nuclear fusion – nuclear reactor, Stellar energy; Synthesis of new elements.

Nuclear emulsion, G.M. Counter, Scintillation counters and Cherenkov counters. Applications of radioisotopes in analysis – agriculture, industry, medicine, mechanism of chemical reactions; uses of radioisotopes in analytical chemistry; isotopic dilution analysis; neutron activation analysis and dating methods.

**Tutorial:** Problems related to Q-value, Half life period, Binding energy, Missing particles in the nuclear reaction, Uses of radioisotopes and Carbon dating.

### **Text Books**

1. J. E. Huheey, Inorganic Chemistry – Principles of structure and reactivity, Pearson edition, 4<sup>th</sup> edition, 2004.
2. J. D. Lee, Sundarsan Guha, Concise Inorganic chemistry for problems, 4<sup>th</sup> edition, 2017.
3. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, Wiley Eastern, 6<sup>th</sup> edition, 2000.
4. S.K. Agarwala, Keemti Lal, Advanced Inorganic Chemistry, Pragathi edition, 2013
5. Hari.Jeevan. Arniker, Essentials of nuclear chemistry, New Age International Publications, 2011.
6. A. R. West, Basic Solid State Chemistry, John Wiley Sons 2<sup>nd</sup> edition, 2014.
7. J.N. Gurtu, solid state chemistry, Pragathu prakashan, 1<sup>st</sup> edition, 2012.

8. R. West, Solid State Chemistry and its Applications, John Wiley & Sons, 1984.
9. L. Smart and E. Moore, Solid State Chemistry - An Introduction, Chapman & Hall, 1992.
10. H. V. Keer, Principles of the Solid State, Wiley Eastern Limited, 1993.
11. K. Chakrabarty, Solid State Chemistry, New Age Publishers, 1996.
12. A.K.De, Inorganic Chemistry and analysis (problems and exercise) , New Age International Publications, 3<sup>rd</sup> edition, 2010.
13. Advance Inorganic Chemistry by F.A. Cotton, G. Wilkinson & C. Murillo (6th edition).
14. Inorganic Chemistry by J.E. Helay, Harper and Row.
15. Comprehensive Coordination Chemistry, Eds. by Wilkinson, Gillarsand.
16. Modern Aspect of Inorganic Chemistry by Emelius and Sharp.

### Reference Books

1. E.L. Mutteri, Polyhedral boranes, Academic press, NY, 1975.
2. N.H. Ray, Inorganic polymers, Academic press, NY, 1975.
3. K.F. Purcell and J.C. Kotz, Inorganic Chemistry, WB Saunders Co. USA 1977.
4. G.S. Manku, Inorganic Chemistry, TMH Co., 1984.
5. A.K. Srivatsava and P.C. Jain, Elements of Nuclear Chemistry, S. Chand and Co., 1989.
6. G. Friedlander, J.W. Kennedy and J.M. Miller, Nuclear and Radiochemistry, Wiley, 2<sup>nd</sup> edition, 1981.
7. Muller, Inorganic Structural Chemistry, Wiley, New York, 2007.

### 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.

## 18UPCHE1C03 GROUP THEORY AND THERMODYNAMICS

Hours	L	T	P	C
72	4	1	0	4

### Course Objectives

1. To understand the concepts of group theory and thermodynamics
2. To study the concepts of equilibrium, non-equilibrium and statistical thermodynamics
3. To understand the basic concepts gaseous and colloidal states

### Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	Teach about the topic of group theory and thermodynamics.	K3
CO2	Analyze the concepts and their application of group theory.	K4
CO3	Analyze the concepts and their application of thermodynamics.	K4
CO4	Analyze the concepts and their application of gaseous and colloidal states.	K4
CO5	Evaluate the basic principles and application of group theory of molecules and crystals.	K5

### UNIT- I Group theory of molecules

Symmetry elements; symmetry operations; point groups - determination; comparison of molecular and crystallographic symmetry; reducible and irreducible representations; direct product representation; orthogonality theorem; character table. - selection rules for IR, Raman and electronic spectra of formaldehyde and ethylene-Hybrid orbitals in non-linear molecules –



Examples:  $\text{H}_2\text{O}$ ,  $\text{NH}_3$ ,  $\text{BF}_3$ ,  $\text{CH}_4$  and  $\text{XeF}_4$ . Determination of representations of vibrational modes in non-linear molecules such as water, ammonia,  $\text{BF}_3$ ,  $\text{CH}_4$  and  $\text{XeF}_4$ .

Tutorial : Problems in assigning point groups of molecules

## **UNIT – II Group theory of crystals**

Elements of crystallography-laws of crystallography; crystal systems of lower symmetry and point groups; translational symmetry elements and space groups; Crystal structures; X-Ray diffraction - Bragg's law and applications;.powder method; Neutron and electron diffraction- Principle and applications.

Tutorial : Problems in assigning space groups and structure of crystal

## **UNIT-III Equilibrium Thermodynamics**

Maxwell's relations; Temperature and pressure dependence of thermodynamic quantities; Free energy ; partial molar quantities; fugacity and activity; Variation of chemical potential with temperature and pressure; Gibbs-Duhem equation;. thermodynamics of ideal and non-ideal gases, and solutions. Response of chemical equilibrium to temperature and pressure- thermodynamic derivation of equilibrium constant. Phase equilibria- phase diagrams- one, two and three component systems.

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

## **UNIT- IV Non-equilibrium and Statistical Thermodynamics**

Thermodynamic criteria for non-equilibrium states; Phenomenological laws; entropy production; Onsager reciprocal relations- Statistical approach to the third law of Thermodynamics; Sackur tetrode equation; Boltzman distribution law; Maxwell-Boltzman, Bose-Einstein and Fermi-Dirac statistics; vibrational, rotational and electronic partition functions and their relation to thermodynamic functions ; heat capacity and equilibrium constants; Theories of specific heats of solids; Concept of negative absolute temperature.

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

## **UNIT-V Gaseous and Colloidal states**

Gaseous state-Kinetic theory of gases-Maxwell's distribution of molecular velocities – derivation of expression for average, most probable and root mean square velocities; Colloidal state-preparation methods-Stability; electrical properties of colloids; surfactants-micelles and reverse micelles – Solubilization; Emulsification by surfactants; micro and macroemulsions-gels – importance and application of colloids.

**Text books:**

1. P.W. Atkins, **Physical Chemistry**, Oxford University Press, Oxford, 1990.
2. D.A. McQuarrie, **Text Book of Physical Chemistry**, University Science Books, Mill Valley, California, 1983.
3. R.A. Alberty and R.J. Silbey, **Physical Chemistry**, John Wiley and Sons, New York, 1992
4. V. Ramakrishnan and M.S. Gopinathan, **Group theory in Chemistry**, Vishal Publications, 1988.
5. J. Rajaram and J.C. Kuriacose, **Thermodynamics for Students of Chemistry**, Lal Nagin Chand, New Delhi, 1986.
6. F.A. Cotton, **Chemical Application of Group Theory**, John Wiley and Sons Inc. New York, 1971.
7. K.V. Raman, **Group theory and its applications to Chemistry**, Tata McGraw-Hill Publishing Company, 1990.

**Reference Books:**

1. A. Walton, **Molecular and Crystal Structure Models**, Ellis Horwood, Chichester, 1978.
2. F. C. Phillips, **An Introduction to Crystallography**, John Wiley and Sons, New York, 1963.
3. A.R. West, **Solid State Chemistry and its applications**, John Wiley and Sons, New York, 1984.
4. M.C. Gupta, **Statistical Thermodynamics**, Wiley Eastern, New Delhi, 1990.
5. Yi-Chen Cheng, **Macroscopic and Statistical Thermodynamics**, World Scientific (2006).
6. J. Rajaram and J.C. Kuriacose, **Irreversible Thermodynamics**, Lal Nagin Chand, New Delhi, 1989.
7. S. Glasstone, **Thermodynamics for Chemists**, Affiliated East West Press, New Delhi 1960.
8. R.P.H. Gasser and W.G. Richards, **Introduction to Statistical Thermodynamics**, World Scientific, Singapore, 1995.

## Mapping with Programme Outcomes

<b>COs</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>
<b>CO1</b>	S	S	M	M	M
<b>CO2</b>	M	S	M	S	S
<b>CO3</b>	S	M	S	S	M
<b>CO4</b>	S	M	S	M	S
<b>CO5</b>	M	S	M	M	S

S- Strong; M-Medium.

## 18UPCHE1C04 ANALYTICAL CHEMISTRY

Hours	L	T	P	C
72	4	0	0	4

### Course Objectives

1. To understand the theory, principles and application of various analytical techniques.
2. To understand the concepts of sampling and sample handling.
3. To understand the theory and principles of various titrimetric analysis.
4. To understand the concepts of complexometric titrations.
5. To study the basic concepts and theories of photometric titrations.
6. To understand the basic concepts, theory and applications of chromatography

### Course Outcomes

After studying this course the student will be able to

CO Number	CO Statement	Knowledge Level
CO1	Demonstrate up-to-date analytical skills required to deal with the error identification and elimination. Apply the basic calculus to understand the statistical treatment of analytical data. Recognize the signification of Gaussian curves and F-test, Q-test, T-test, Z-test for the elimination of errors	K3
CO2	In depth knowledge and understanding about the fundamental concepts, principles and process underlying the sample and sample handling (different nature- solid, liquid and gases). Manipulation and handling of micro chemical laboratory, Drybox/glovebox, fiber micro balance. Determine the Trace analysis in solution and contamination control in chemicals. Demonstrate these skills required for employment in the quality & quality control unit in industries	K3
CO3	Describes the Neutralization reactions. Determine the, calculation of pH during the titration at different stages. Explain the Precipitation titrations – Theory and types. Discuss the Volhard, Mohr and Fejan's methods for accurate titration.	K4
CO4	Discuss the Complexometric titration. Explain the mono dentate ligand and multi dentate ligand. Describes the theory of metallochromic indicators to specify the metal ions. Discuss the masking and demasking reagents for the ions separation. Explain the precipitation titrations and types, describe the phenomenological laws and their uses.	K4
CO5	Explain the various types of chromatography for compounds separation. Discuss the Preparation of plates – Adsorbants and solvent systems used Techniques of zone detection – Determine the specific and easy identification of compounds using HPTLC	K4

## **UNIT I Analytical Data, Treatment and Evaluation**

Mean, Median, Precision and accuracy; Errors in chemical analysis- systematic errors random errors. Standard deviation of calculated results and reporting computed data. Measurement and reporting: Good laboratory practices, calibration of measurements, record management, quality control and control chart.

Treatment of data – Basic statistic concept and frequency distribution, Average and measure of dispersion; Significance of Gaussian distribution curves; Null hypothesis; confidence interval of mean, Criteria for rejection of data; Small sample t-test, Large sample z-test, F-test and Q-test, Regression and correlation.

Tutorial: Problems in standard deviation, confidence level and interval, significant figures, Q, F and T tests

## **UNIT II Sampling and sample handling**

Objectives and sampling – sampling definition, types of sample, sampling plan, quality of sample, sub sampling, sample registration, sample handling, transfer and storage samples.

Microchemical laboratory – Design, safety screen, fume chamber, heating, water supply, drybox/glovebox, Microbalance, quartz balance, fiber microgram balance.

Trace analysis in solution – Nature of trace analysis, scale of working sensitivity, sources of errors; Contamination control in trace analysis.

## **UNIT III Titrimetric Analysis**

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

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

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

Tutorial : Calculations of pH, electrode potential,

## UNIT IV Complexometric, and photometric Titrations

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

## UNIT V Chromatography

**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:** (i) Paper chromatography (Ascending, Descending, Radial, Two dimensional) solvent systems – Location.

**Thin-layer chromatography:** Preparation of plates – Adsorbants and solvent systems used Techniques of zone detection – Elementary idea of HPTLC.

### Text Books

1. D.A.Skoog and D.M.West, **Fundamentals of Analytical Chemistry**, Holt Rinehart and Winston Publications, IV Edn, 1982
2. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, **Fundamentals of Analytical Chemistry**, Thomson Asia Pte Ltd., Singapore, Viii<sup>th</sup> Edn., 2004.
3. D.A. Skoog, **Principles of Instrumental Analysis**, Saunders College Pub. Co, III Edn., 1985.
4. J.G. Dick, **Analytical Chemistry**, McGraw Hill Publishers, 1974.
5. T.S.Ma and V. Horak, **Microscale-Manipulations**, John, Wiley and Sons, 1976.
6. P.C.Jurns, T.L. Isenhour and C.C. Wilkins, **BASIC Programming for Chemists**, JW.& Sons, 1987.
7. K.V. Raman, **Computers in Chemistry**, Tata McGraw Hill, New Delhi, 1993.

8. A.I Vogel, **Text Book of Quantitative Inorganic Analysis**, Pearson V Edn., 2001.

### Reference Books

1. Albert Paul Malvino, **BASIC Programming**, PMH Publishers, III Edn., 1984.
2. N.Subramanian, **Programming for BASIC**, A.H. Wheeler and Co. Pvt.Ltd III Edn.,1987
3. Willard, Merit, Dean and Settle, **Instrumental Methods of Analysis**, CBS Publishers and Distributors, IV Edn.,1989
4. G. D. Christian and J.E.O Reilly, **Instrumental Analysis**, Allyn and Bacon Inc, II Edn., 1986.
5. G.W.Ewing, **Instrumental Methods of Chemical Analysis**, McGraw Hill Pub, 1975.
6. A.I Vogel, **Text Book of Quantitative Inorganic Analysis**, ELBS III Edn., 1987.
7. Analytical Chemistry : Principles and Techniques : Larry G. Hargis (Prentice-Hall International edition).
8. Introduction to Modern Liquid Chromatography : L. R. Shyder & J. J. Kirkland (John Wiley & Sons, New York).
9. Treatise on Analytical Chemistry : I. M. Kohthoff & P. J. Elving (John Wiley & Sons, New York).
10. Handbook of Analytical Chemistry : L. Meites (McGraw-Hill, New York).

### Mapping with Programme Outcomes

<b>COs</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>
<b>CO1</b>	S	S	M	M	M
<b>CO2</b>	M	S	S	S	M
<b>CO3</b>	S	M	S	S	M
<b>CO4</b>	M	M	S	S	S
<b>CO5</b>	M	S	M	M	S

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

## 18UPCHE1C05 ORGANIC CHEMISTRY PRACTICAL – I

Hours	L	T	P	C
90	4	0	5	3

### Course Objectives

1. To separate and identify the components in the binary organic mixture.
2. To familiar with some single stage preparation of organic compounds.

### 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 reflux, recrystallization, etc.	K5

- **Identification of components** in a two component mixture and preparation of their derivatives.
- **Preparation of organic compounds (single stage)**
  1.  $\beta$ -naphthyl methyl ether from  $\beta$ -naphthol (methylation)
  2.  $\beta$ -glucose penta acetate from glucose (acetylation)
  3. *ortho* - Benzoyl benzoic acid from phthalic anhydride (Friedel-Crafts)
  4. Resacetophenone from resorcinol (acetylation)
  5. Methyl orange from sulphanilic acid (diazocoupling)
  6. Anthraquinone from anthracene (oxidation)
  7. Methyl-m-nitrobenzoate from methylbenzoate (nitration)

**Text Books:**



1. B.S. Furniss, A.J. Hannaford, P.W.G. Smith and A.R. Tatchell, **Vogel's Practical Organic Chemistry**. 5th edn. ELBS, 1989
2. Raj K. Bansal, **Laboratory manual of Organic Chemistry**, III Edn., New Age International (P) Ltd. 1996.
3. N. S. Gnanapragasam and G. Ramamurthy, **Organic Chemistry Lab Manual**, New Ed., SV Publishers 2006

**Mapping with Programme Outcomes**

<b>COs</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>
<b>CO1</b>	S	S	S	S	S
<b>CO2</b>	S	S	S	S	S

S- Strong; M-Medium

## 18UPCHE1C06 INORGANIC CHEMISTRY PRACTICAL – I

Hours	L	T	P	C
90	4	0	5	3

### Objectives

1. To analyse systematically the inorganic mixture contains four cations.
2. To identify two familiar and two less familiar cations.
3. To prepared a very good yield of metal complexes.
4. To estimate metal ions by calorimetrically.
5. To study the basic properties of complexes.

### Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	Know the group separation and group reagents.	K5
CO2	Know the two familiar and two less familiar cations	K5
CO3	Learn the color, geometry and binding mode of ligands in transition metal complexes	K6

### 1. Semi micro Qualitative Analysis

Qualitative analysis employing semi micro methods and spot tests of mixtures of common cations and ions of the following less familiar elements: Thallium, Tungsten, Selenium, Tellurium, Molybdenum, Cerium, Thorium, Titanium, Zirconium, Vanadium, Beryllium, Uranium and Lithium.

### 2. Preparations

About ten preparations involving different techniques selected from the following: dipyridinium hexachloroplumbate, ortho and para- hydroxyphenylmercuric chloride, potassium cupricchloride, chrome alum, tris(thiourea)copper(I)nitrate, potassium trisoxalatoaluminate(III), potassium trisoxalatochromate(III), potassium trisoxalatoferate(III), hexamminecobalt(III) chloride, chloropentamminechromium(III) nitrate, tetramminecopper(II) sulphate, ammonium hexachlorostannate(IV).

### 3. Colorimetric Estimations:

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

**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.

### Outcomes:

1. The chemical literature and to read and understand technical literature related to the discipline
2. To know about the familiar and less-familiar cations in the mixtures.
3. To know about the group reagents.
4. To know about the colorimetric analysis and preparation of the metal complexes.

### Text books

1) V.M. Williamson, M. Larry Peck, Lab manual for General Chemistry, Cengage Learning India Private Limited, New Delhi, 2009.

2) Jeyavathana Samuel, Chemistry Practical Book, G.G. Printers, Chennai, 2012.

### Reference Books

1. V. V. Ramanujam, Inorganic Semimicro Qualitative Analysis, National Publishing Company, Chennai, third edition, 1974.

2. G. Svehla, Vogel's Qualitative Inorganic analysis, sixth edition, Orient Longman, 1987.

### 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

### 18UPCHE1C07 ORGANIC REACTIONS AND CONFORMATIONAL ANALYSIS

Hours	L	T	P	C
72	4	1	0	4

#### Course Objectives:

1. To obtain an idea on the mechanisms of elimination reactions and addition reactions.
2. To learn oxidation and reduction reactions in organic compounds along with the reagents used.
3. To learn the role of orbital symmetry in pericyclic reactions and analysis of pericyclic reactions.
4. To learn the photophysical and photochemical processes especially that of carbonyl compounds and olefins.
5. To learn the basics of conformational analysis, 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 mechanism of elimination and addition reactions – predict the products formed in the particular elimination reaction based on the rules-predict the products of addition using Markownikoff's and anti-Markownikoff's rules.	K2, K3
CO2	Predict the conditions and products of oxidation/reduction reactions in organic compounds- to understand the mechanisms involved –to predict the selectivity	K3
CO3	Construct the molecular orbitals from atomic orbitals with conservation of symmetry-determine the stereochemistry of the products in pericyclic reactions.	K4
CO4	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 mechanisms.	K3
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 $\alpha$ -haloketone rule for the stereochemical prediction of complex molecules like steroids.	K5

#### UNIT - I Elimination and addition reactions

1.1  $E_1$ ,  $E_2$ ,  $E_1CB$  mechanisms, Orientation of the double bond - Hofmann and Saytzeff rule, competition between elimination and substitution, dehydration and dehydrohalogenation reactions, stereochemistry of  $E_2$  eliminations in cyclohexane ring systems, mechanism of pyrolytic eliminations, chugaev reaction and Cope elimination.

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

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

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

## **UNIT - II Oxidation and Reduction Reactions:**

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

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

Tutorial : Prediction of products, reagents, conditions, mechanism

## **UNIT III Pericyclic reactions**

3.1 Basic concept of conservation of orbital symmetry, electrocyclic reactions, correlation diagram, FMO, PMO treatment. Ring closure reaction focusing system such as butadiene, pentadienylanion, pentadienyl cation, allyl anion, allyl cation and hexatriene.

3.2 Cycloaddition reactions. Stereoselectivity, regioselectivity, periselectivity and site selectivity in cycloaddition.  $2 + 2$ ,  $4 + 2$ ,  $4 + 4$ ,  $6 + 2$ , and  $6 + 4$  cycloaddition reactions. Secondary orbital interactions in cycloadditions. Normal and Inverse electron demand Diels-Alder reaction.

Tutorial : Problems on Prediction of products, conditions, mechanism

## UNIT - IV Organic Photochemistry

4.1 Organic photochemistry: Introductory theory of light absorption, photophysical processes – Jablonski diagram, energy transfer, photochemical reaction of ketones and enones, Norrish type I and type II reactions.

4.2 Photooxidation and photoreduction. Paterno - Buchi reaction, cis and trans isomerization and photochemistry of aromatic compounds.

4.3 Selected reactions: Photo Fries, Barton, di- $\pi$  methane, oxa and aza di- $\pi$  methane rearrangements.

4.4 Sigmatropic reactions, correlation diagram, FMO & PMO treatment. Hydrogen migration. Carbon migration with symmetric and asymmetric centre. C-C bond migration, Orbital treatment for Cope, Claisen and 2,3-Sigmatropic reaction.

Tutorial : Problems on Prediction of products, conditions, mechanism

## UNIT - V Conformational Analysis:

5.1 Conformational analysis of simple cyclic (chair and boat cyclohexanes) and acyclic (n-butane) systems, conformation of simple 1,2 disubstituted derivatives - ethylene chlorohydrin and ethylene glycol, Conformational analysis and stereochemical features of disubstituted cyclohexanes (1,2; 1,3; 1,4 dialkylcyclo hexanes), conformation and stereochemistry of cis and trans decalins, effects of conformation on reactivity in acyclic and cyclohexanes: Oxidation and acylation of cyclohexanols, reduction of cyclohexanones, esterification and hydrolysis of cyclohexane carboxylic acid derivatives.

5.2 ORD and CD – Circular birefringence and circular dichroism. Plain dispersion curves, single and multiple cotton effect curves and their applications. Octant rule and  $\alpha$ -haloketone rule.

Tutorial : Problems on stereochemical prediction of products

### Text Books:

1. Jerry March, **Advanced Organic Chemistry-Reactions, Mechanisms and Structure**, Fifth Ed., Wiley, 2007.
2. R.T. Morrison and R.N. Boyd, **Organic Chemistry**, Prentice-Hall, 1992.

- R. O. C. Norman and J. M. Coxon, **Principles of Organic Synthesis**, Nelson Thornes, Third Edition, 2005.
- S. Sankararaman, **Pericyclic Reactions- A Textbook**, Wiley-VCH, Weinheim, 2005.
- S.M. Mukherji and S.P. Singh, **Reaction Mechanism in Organic Chemistry**, III Edn. 1984. MacMillan.
- P.S. Kalsi, **Stereochemistry - Conformation and Mechanism**, 6th Edition, Wiley Eastern Limited, 2005.
- E. L. Eliel, S. H. Wilen and L.N. Mander, **Stereochemistry of organic Compounds**, John Wiley & Sons, Inc., New York, NY. 1994.

#### References Books:

- F. A. Carey and R. J. Sundburg, "Advanced Organic Chemistry, Part A&B", 5th Ed., Plenum Press, 2007.
- R. B. Woodward and R. Hoffmann, **The Conservation of Orbital Symmetry**, Academic Press, New York, 1971.
- M. J. S. Dewar and R. C. Dougherty, **The PMO Theory of Organic Chemistry**, Plenum Press, New York, 1975.
- I. Fleming, **Pericyclic Reactions**, Oxford University Press, Oxford, 1998.
- R. P. Wayne, **Principles and Applications of Photochemistry**, Oxford Science Publications, Oxford University Press, Oxford, 1988.
- A. Gilbert and J. Baggot, **Essentials of Molecular Photochemistry**, Blackwell Scientific Publications, Oxford & Boston, 1991.
- M. Klessinger and J. Michl, **Excited States and Photochemistry of Organic Molecules**, VCH Publishers, Inc., New York, 1994.
- 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



## 18UPCHE1C08 COORDINATION CHEMISTRY

Hours	L	T	P	C
72	4	1	0	4

### Objectives

1. To understand the theories of bonding in coordination compounds and reaction mechanism of transition metal complexes
2. To study the theory, stability, stereochemical aspects and magnetic properties of metal complexes
3. To understand the chemistry of lanthanides and actinides

### Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	Learn the selected crystal structures and to explain what kind of parameters that affects the crystal structure of a compound	K1, K2
CO2	Use Crystal Field Theory to understand the electronic spectra and the magnetic properties of complexes.	K1, K2, K3
CO3	Know about the stability of metal complexes by the use of formation constants and to calculate thermodynamic parameters, the types of isomers and macro cyclic ligands in coordination compounds.	K1, K2, K3
CO4	Understand about the Reaction Mechanism of transition metal complexes	K1, K2, K3
CO5	Learn about the f-block elements, synthesis, properties, structure, bonding and applications	K1, K2, K3

## UNIT I Metal-Ligand Bonding

18 Electron rule; EAN rule, theories of coordination compounds - valence bond theory, crystal field theory - splitting of d-orbitals in different symmetries, crystal field stabilization energy, 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; Molecular Orbital Theory - octahedral complexes, tetrahedral and square planar complexes, pi bonding and molecular orbital theory, experimental evidence for pi-bonding.

Tutorial: Problems related to 18 electron rule, magnetic properties of complexes and crystal field stabilization energy.

## UNIT II Electronic Spectra and Magnetic Properties

Term states of  $d^n$  ions - microstates and their classifications, electronic spectra of coordination compounds - selection rules, band intensities and band widths; energy level diagrams of Orgel and Tanabe - Sugano diagram; spectra of  $Ti^{3+}$ ,  $V^{3+}$ ,  $Ni^{2+}$ ,  $Cr^{3+}$ ,  $Co^{2+}$ ,  $Cr^{2+}$  and  $Fe^{2+}$ ; calculation of  $10Dq$  and  $B$  for  $V^{3+}$  (oct) and  $Ni^{2+}$  (oct) complexes.

Magnetic properties of coordination compounds - change in magnetic properties of complexes in terms of spin-orbit coupling; spin only moments of  $d^n$  systems; temperature independent paramagnetism; spin cross over phenomena.

Tutorial: Problems related to determination of ground state term symbol, calculation of number of microstates, electronic spectra of transition metals from  $d^1$  to  $d^{10}$  electrons.

## UNIT III Stability and Stereochemical Aspects

Stability of complexes - thermodynamic aspects of complex formation, factors affecting stability, stability correlations, statistical and chelate effects; Determination of stability constants - polarographic, photometric and potentiometric methods.

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

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

Tutorial: Problems related to stability of complexes.

## UNIT IV Reaction Mechanism of transition metal complexes

Energy profile of a reaction, reactivity of metal complexes, inert and labile complexes, kinetic application of valence bond and crystal field theories, kinetics of octahedral substitutions, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism, direct and indirect evidences in favour of conjugate mechanism, anation reactions, reactions without metal ligand bond cleavage. Substitution reactions in square planar complexes, the trans effect, mechanism of the substitution reactions. Redox reactions, electron transfer reactions, mechanism of one electron transfer reactions, outer sphere type reactions, cross reactions and

Marcus-Hush theory, inner sphere type reactions.

Tutorial: Problems related to reaction mechanism of transition metal complexes.

## UNIT V Chemistry of lanthanides and Actinides

Electronic configurations, physical and chemical properties, stable oxidation states, the lanthanide contractions, spectral and magnetic properties of the compounds of lanthanides and actinides in comparison with the compounds of transition metals; Structure and bonding in highly coordinated lanthanide and actinide complexes; Uses of lanthanide compounds as shift reagents. Synthesis of elements; extraction of Th and U; technical production of Pu.

Tutorial: Problems related to oxidation state and magnetic properties.

### References Books:

1. J.E. Huheey, E.A. Keiter and R.L. Keiter, Inorganic Chemistry- Principles of structure and reactivity, 4<sup>th</sup> edition, Pearson-Education, 2002.
2. F.A. Cotton and G. Wilkinson, C. A. Murillo, and M. Bochmann, Advanced Inorganic Chemistry, 6<sup>th</sup> Edition, Wiley Eastern 1988.
3. M.C. Day and J. Selbin, Theoretical Inorganic Chemistry, Van Nostrand Co., NY. 1974.
4. K.F. Purcell and J.C. Kotz, Inorganic Chemistry, WB. Sanders Co., USA 1977.
5. D. F. Shriver, P. W. Atkins and C.H. Longford, Inorganic Chemistry, ELBS, 2<sup>nd</sup> edition, 1994.
6. Catherine Housecroft, Alan G. Sharpe, Inorganic Chemistry, 4<sup>th</sup> Edition, 2012.
7. J.D. Lee, Concise Inorganic Chemistry, Springer 5th edition, 1996.
8. W.U.Malik, G.D.Tuli, R.D.Madan, Selected topics in Inorganic Chemistry, S.Chand & Co., 2004.
9. D. Bannerjea, Co-ordination Chemistry, Tata-McGraw Hill, 1993.
10. B.R.Puri, L.R.Sharma, K.C.Kalia, Principles of Inorganic Chemistry, Milestone Publishers, 2013.

### Mapping with Programme Outcomes

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

<b>CO2</b>	M	M	M	S	S
<b>CO3</b>	S	M	S	M	M
<b>CO4</b>	S	S	M	M	M
<b>CO5</b>	M	S	M	S	M

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

## 18UPCHE1C09 QUANTUM CHEMISTRY AND CHEMICAL KINETICS

Hours	L	T	P	C
72	4	0	0	4

### Course Objectives

1. To understand the basic concepts and hypothesis, principles and applications of quantum chemistry
2. To understand the kinetics, theory and mechanism of various reactions
3. To study the theory and mechanism of catalytic and surface reactions
4. 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	Teach the concepts of quantum, surface and photochemistry.	K3
CO2	Analyze the concepts and their application of quantum chemistry.	K4
CO3	Analyze the concepts and their application of chemical kinetics.	K4
CO4	Evaluate the concepts and their application of quantum chemistry.	K5
CO5	Evaluate the concepts and their application of chemical kinetics	K5

### UNIT-I Quantum Chemistry-I

Inadequacy of classical mechanics; Plancks Quantum theory of radiation; Operators- Commutational, Linear, Hermitian and Hamiltonian; Postulates of quantum mechanics; Schrodinger equation-Application to simple systems: Particle in a box (one, two and three dimensional systems) - harmonic oscillator, rigid rotator, hydrogen atom; Spin-orbit interaction; shapes of atomic orbitals; orbital and spin angular momenta; Quantum mechanical tunneling.

Tutorial: Problems in energy and wave function of simple systems

### UNIT-II Quantum Chemistry-II

Approximation methods-variation method-application to harmonic oscillator, hydrogen and helium atoms; perturbation theory up to second order in energy; applications;Born-Oppenheimer approximation- VB and MO theories; Application to hydrogen molecule; Huckel pi- electron

theory and its applications to ethylene, butadiene and benzene Calculation of electron density and bond order; Semi empirical methods- Slater determinant for n-electron atoms Hartree and Hartree – Fock self consistent field method; many-electron systems and antisymmetry principle.

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

### **UNIT-III Chemical Kinetics**

Theories of reaction rates – Hard sphere collision theory, Transition state theory; Treatment of unimolecular reactions (Lindemann-Hinselwood and Rice-Ramsperger-Kassel-Marcus[RRKM] theories); Marcus theory of electron transfer reactions; Reaction rates in solution; factors affecting reaction rates in solution; Kinetics of chain and explosive reactions-Linear free energy relationships- Hammett acidity function; Fast reactions- flow methods, relaxation method, flash photolysis and magnetic resonance method; reactions in crossed molecular beams; Shock tube technique;.

Tutorial: Problems in reaction rates and activation energy determination

### **UNIT – IV Surface Chemistry**

Adsorption of gases on solids-factors affecting adsorption-Surface area and its determination; Adsorption isotherms-Theory, derivation and applications of Freundlich, Gibbs, Langmuir, Temkin and BET adsorption isotherms. Catalysis: pH and temperature dependence of rate constants of catalysed reactions- Homogeneous catalysis- Acid base catalysis; Enzyme catalysis- Factors affecting enzyme catalysis; kinetics and mechanism of enzyme catalysed reactions; Heterogeneous catalysis; Kinetics of surface reactions- Unimolecular and bimolecular reactions-Langmuir-Hinshelwood mechanism-Rideal-Eley mechanism; Kinetics and mechanism of Micellar catalysis.

### **UNIT – V Photochemistry**

Photophysical processes ; radiative and non radiative processes-Theory of radiationless transitions- reaction paths of electronically excited molecules; - Jablanski 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; solar energy conversion and storage.

## Text Books

1. J. Rajaram and J.C Kuriacose, **Kinetics and Mechanism of Chemical Transformations**, MacMillan India Ltd., 1993.
2. A.W.Adamson, **Physical Chemistry of surfaces**, 4<sup>th</sup> edn., Wiley - Interscience, Newyork, 1982.
3. K.K.Rohatgi Mukherjee, **Fundamentals of photochemistry**, Wiley Eastern Ltd.,New York, 1978.
4. R.K.Prasad, **Quantum Chemistry**, Wiley Eastern, New Delhi,1992.
5. D.A. McQuarrie, **Quantum Chemistry**, University Science Books, Mill Valley, California, 1983.
6. P.W.Atkins, **Physical Chemistry**,Oxford University Press; Fifth edition ,2012.
7. D.A. McQuarrie, **Text Book of Physical Chemistry**, University Science Books, Mill Valley, California, 1983.
8. R.A. Alberty and R.J.Silbey, **Physical Chemistry**, John Wiley and Sons, New York, 1992
9. A.L.Lehninger, **Bioenergetics**, W.A.Benjamin Inc.,New York, 1965.
10. W.Hoppe, W.Lohmann, H.Markl and H.Uiegler, **Biophysics**, Springer-Verlag, 1983.

## Reference Books

1. R.G. Frost and Pearson, **Kinetics and Mechanism**, Wiley New York, 1961
2. C.Capellos and B.H.J.Bielski, **Kinetic Systems**, Wiley Interscience,
3. New York, 1968.
4. K.J.Laidler, **Chemical Kinetics**, Harper and Row, New York,1987.
5. R.G. Frost and Pearson, **Kinetics and Mechanism**, Wiley New York, 1961
6. G.M. Harris, **Chemical Kinetics**, D.C. Healthand Co., 1966.
7. A.W.Anderson, **Physical Chemistry of Surfaces**, Wiley - Interscience, Newyork, 1990.
8. N.J.Turro, **Modern molecular photochemistry**, Benjamin/Cummings, Menlo Park, California, 1978

9. P.W. Atkins, **Molecular Quantum Mechanics**, Oxford University Press, Oxford, 1983
10. M.W.Hanna, **Quantum Mechanics in Chemistry**, W.A.Benjamin Inc. London 1965
11. I.N. Levine, **Quantum Chemistry**, Allyn and Bacon, Boston, 1983
12. H. Eyring, J. Walter and G.Kimball, **Quantum Chemistry**, John Wiley and Sons, New York, 1944.
13. M.W. Hanna, **Quantum Mechanics in Chemistry**, W.A. Benjamin Inc. London, 1965.

### 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.



## 18UPCHE1C10 PHYSICAL CHEMISTRY PRACTICAL – I

Hours	L	T	P	C
90	4	0	5	3

### Course Objectives

1. To understand the principles behind various experimental techniques.
2. To learn various experiments like chemical kinetics, phase rule, Chemical equilibrium and Conductivity measurements titrimetric analysis.
3. To understand the phase diagram and to construct different component systems

### Course Outcomes

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

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

### :DETAILED LIST OF EXPERIMENTS

Typical list of possible experiments are given. Experiments of similar nature and other experiments may also be given. The list given is only a guideline. A minimum of 15 experiments have to be performed in a year.

1. Study the kinetics of acid hydrolysis of an ester, determination of the temperature coefficient of the reaction and determination of the activation energy of the hydrolysis of ethylacetate.
2. Study the kinetics of the reaction between acetone and iodine in acidic medium by half life method and determine the order with respect to iodine and acetone.
3. Study of the saponification of ethylacetate by sodium hydroxide conductometrically and determine the order of the reaction.
4. Determination of association factor of benzoic acid in benzene by distribution method.
5. Study the phase diagram for m-toluidine and glycerine system.

6. Construction of phase diagram for a simple binary system (naphthalene – phenanthrene and benzophenone – diphenylamine)
7. Construction of the phase diagram of the three component of partially immiscible liquid systems (DMSO – Water – Benzene; Water-Benzene –Acetic acid; Ethyl alcohol – Benzene – Water; Acetone-Chloroform – Water; Chloroform – Acetic acid-Water).
8. Determination of the equilibrium constant of the reaction between Iodine and KI by partition method.
9. Determination of equivalent conductance of a weak acid at different concentrations and verify Ostwald's dilution law and calculation of the dissociation constant of the acid.
10. Determination of equivalent conductivity of a strong electrolyte at different concentrations and examine the validity of the Onsager's theory as limiting law at high dilutions.
11. Conductometric titrations of a mixture of HCl and CH<sub>3</sub>COOH against Sodium hydroxide.
12. Compare the relative strength of acetic acid and monochloroacetic acid by conductivity method.

### Reference Books

1. B.P. Levitt (Ed.). Findlay's Practical Physical Chemistry, 9<sup>th</sup> Edn., Longman, London, 1985.
2. J.N. Gurtu and R.Kapoor, Advanced Experimental Chemistry, Vol I. S. Chand & Co. Ltd., New Delhi, 1980.

### Mapping with Programme Outcomes

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

S- Strong; M-Medium

## 18UPCHE1C11 ORGANIC CHEMISTRY PRACTICAL – II

Hours	L	T	P	C
90	4	0	5	3

### Objectives

1. To analyse the organic compound Quantitatively
2. To execute double stage preparation of organic compounds

### Course outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	Estimate the quantity of the given organic compound precisely. Also able to predict the quality of oils by estimating their saponification and iodine values	K4
CO2	Synthesize important organic compounds using standard procedures. Also will be familiarized with the techniques like distillation, separation and purification methods like recrystallization	K5

### I Quantitative analysis of organic compounds

#### Estimation of :

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

### II Preparation of organic compounds (Double stage)

- i. *p*-Bromoacetanilide from aniline (acetylation and bromination)
- ii. Acetyl salicylic acid from methyl salicylate (hydrolysis and acetylation)
- iii. 1,3,5-Tribromobenzene from aniline (bromination, diazotization and hydrolysis)
- iv. *p*-Nitroaniline from acetanilide (nitration and hydrolysis)
- v. Benzanilide from benzophenone (Beckmann rearrangement)
- vi. *p*-Bromoaniline from acetanilide (bromination and hydrolysis)
- vii. *m*-Nitroaniline from nitrobenzene (Nitration and reduction)

**Text Books:**

1. B.S. Furniss, A.J. Hannaford, P.W.G. Smith and A.R. Tatchell, **Vogel's Practical Organic Chemistry**. 5th edn. ELBS, 1989
2. Raj K. Bansal, **Laboratory manual of Organic Chemistry**, III Edn., New Age International (P) Ltd. 1996.
3. N. S. Gnanapragasam and G. Ramamurthy, **Organic Chemistry Lab Manual**, New Ed., SV Publishers 2006

**Mapping with Programme Outcomes**

<b>COs</b>	<b>PO1</b>	<b>PO2</b>
<b>CO1</b>	S	S
<b>CO2</b>	S	S

S- Strong; M-Medium.

## Third Semester

### 18UPCHE1C12 ORGANIC SYNTHESIS AND NATURAL PRODUCTS

Hours	L	T	P	C
72	4	0	0	4

#### Course Objectives

1. To understand the Retero-synthetic analysis of complex organic molecules.
2. To learn the applications of important reagents in organic synthesis.
3. To understand the mechanisms of common organic rearrangements.
4. To understand the structure and chemistry of natural products like steroids, terpenoids and alkaloids.
5. To learn the structure and chemistry of proteins and nucleic acids.

#### 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 reactions of significance for organic synthesis and to design syntheses of organic molecules.	K4, K5
CO2	Predict the reagents and products of important organic transformations and to understand the mechanisms involved.	K4
CO3	Understand the mechanisms of various rearrangement reactions and to predict the products.	K3
CO4	Elucidate the structure of steroids and terpenoids and also plan the inter-conversions of steroids	K3
CO5	Understand the structure and chemistry of proteins and nucleic acids	K2

#### UNIT - I Disconnection Approach:

An introduction to synthons and synthetic equivalents, disconnection approach: The importance of the order of events in organic synthesis, one group C-X and two group C-X disconnections, chemoselectivity, reversal of polarity, cyclization reactions, amine synthesis.

One group C-C disconnections - Alcohols and carbonyl compounds, regioselectivity, alkene synthesis, Olefination of carbonyl compounds - McMurry's method.

Two group C-C disconnections - Diels Alder reaction, Michael addition.

Use of acetylenes and aliphatic nitro compounds in organic synthesis.

Tutorial: Problems on retrosynthetic analysis of target molecules

## **UNIT - II Reagents in Organic Synthesis:**

Synthesis of simple organic molecules using standard reactions like acylation and alkylation of enamines and active methylene compounds. Protection and deprotection of functional groups (R-OH, R-CHO, RCOR, R- NH<sub>2</sub> and R-COOH)

Reagents and their uses: DCC, trimethylsilyl iodide, trimethylsilyl chloride, 1,3-dithiane (umpolung), diisobutylaluminium hydride (DIBAL), 9-BBN, Osmium tetroxide, DDQ, Selenium dioxide, Phase transfer Catalysts.

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

## **UNIT - III Molecular Rearrangements:**

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

Tutorial : problems on prediction of products, reagents, conditions, mechanism and name of the reaction

## **UNIT - IV Steroids and Terpenoids:**

Steroids: Structure and Stereochemistry of Cholesterol. Total synthesis of Cholesterol and estrone; Conversion of cholesterol into progesterone, testosterone and oestrone; Artificial hormones - Stilboestrol and Hexoestrol.

Terpenoids: Structure, Stereochemistry and synthesis of zingiberene, cadinene and abeitic acid

Tutorial : Problems on conversions in structural elucidation

## **UNIT - V Alkaloids, Proteins and nucleic acids**

Occurrence, Extraction of alkaloids, Classification of alkaloids, structure elucidation, synthesis and stereochemistry of the following alkaloids: Quinine, Papaverine, Morphine and Reserpine. Biosynthesis of alkaloids.

Classification of proteins - simple, conjugated and derived proteins. Primary structure of peptides- C and N terminal aminoacid determination. Synthesis of peptides.

Nucleic acids – structure of nucleosides and nucleotides, their chemistry including synthesis; RNA and DNA; Functions of nucleic acids

Tutorial : Problems on structural elucidation

**Text books:**

1. Jerry March, **Advanced Organic Chemistry-Reactions, Mechanisms and Structure**, Fifth Ed., Wiley, 2007.
2. S.M. Mukherji and S.P. Singh, **Reaction Mechanism in Organic Chemistry**, III Edn. 1984. MacMillan.
3. R. O. C. Norman and J. M. Coxon, **Principles of Organic Synthesis**, Nelson Thornes, Third Edition, 2005.
4. I.L. Finar, **Organic Chemistry**, Volume II, Fifth Edition, First Indian reprint, Pearson Education Asia Pte. Ltd., (2000)

**References Books:**

1. F. A. Carey and R. J. Sundburg, “Advanced Organic Chemistry, Part A&B”, 5th Ed., Plenum Press, 2007.
2. S. Warren, **Designing Organic Syntheses**, John Wiley & Sons 2009.
3. G. S. Zweifel and M. H. Nantz, **Modern Organic Synthesis-An Introduction**, W. H. Freeman and Company, 2006.
4. T.W. Greene, **Protecting Groups in Organic Synthesis** (3rd edition), J. Wiley & Sons, 1999.
5. E. J. Corey, X. Cheng, **The Logic of Chemical Synthesis**, John Wiley 1989.
6. W. Carruthers, **Some Modern Methods in Organic Synthesis**, Cambridge University Press 1989.
7. S. Warren, **Organic Synthesis: The Disconnection Approach**, John Wiley & Sons.
8. Paul de Mayo, **Molecular Rearrangements**, Vol I, Vol II, Interscience, NY. 1963.
9. P. Lloyd-Williams, F. Albericio, E. Giralt, **Chemical Approaches to the Synthesis of Peptides and Proteins**, 1st Edition, CRC Press, Boca Raton, 1997
10. S. Doonan, **Peptides and Proteins**, 1st Edition, RSC Publishing House, London, 2002
11. G. Chatwal, **Organic Chemistry of Natural Products**, Vol I & II, Himalaya Publishing House, 1988.
12. S.W. Pelletier, Van Nostrand, **Chemistry of Alkaloids**, Reinhold, 1970.
13. S. Doonan, **Nucleic Acids**, 1st Edition, RSC Publishing House, London, 2004

14. Lehninger, D. L. Nelson, Cox, M. M. **Principles of Biochemistry**, 5th Edition, W.H Freeman, 2008
15. K. Nakanishi, T. Goto, S.Ito, S. Najori and S. Nozoe, **Natural products Chemistry**, Vol. 1 and 2, Academic Press, 1974.
16. A. A. Newman, **Chemistry of Terpenes and Terpenoids**, Academic Press, 1972.
17. S. W. Pelletier, **Chemistry of the Alkaloids**, Van Nostrand Reinhold, 1970.
18. C. W.Shoppee, **Chemistry of the Steroids**, 2nd edition, Butter worths, 1964.

**Mapping with Programme Outcomes**

<b>COs</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>
<b>CO1</b>	M	S	S	M	M
<b>CO2</b>	S	M	S	S	M
<b>CO3</b>	S	S	S	M	S
<b>CO4</b>	S	S	S	S	M
<b>CO5</b>	M	S	M	M	S

S- Strong; M-Medium.



## 18UPCHE1C13 ORGANOMETALLIC & BIOINORGANIC CHEMISTRY

Hours	L	T	P	C
72	4	0	0	4

### Objectives

1. To study the synthesis, structure, bonding and reactions of metal carbonyls and nitrosyls.
2. To understand the chemistry of metal alkyl, metal allyl, metal alkene, metal alkyne complexes and metal complexes in life processes.

### Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	Know about the synthesis, structure, bonding in carbonyl, alkyl and carbene systems	K1, K2
CO2	Understand the concepts of Bonding of alkenes and Alkyne Complexes	K2, K3
CO3	To know about the Synthesis, bonding and reactivity of Allyl, Arene and Cyclopentadienyl complexes	K3
CO4	To study about the basics of transport properties and the various metal ions present in our body	K1
CO5	Understand about the metal toxicities, their detection and permissible levels in the body	K1

## UNIT I Structure and Bonding

Metal carbonyl complexes - synthesis, structure and reactions; nature of M-CO bonding, binding mode of CO; IR spectra of metal carbonyls, metal carbonyl anions, metal carbonyl hydrides, metal carbonyl halides; metal nitrosyls; dinitrogen complexes; dioxygen complexes, and isolobal relationship.

Tutorial: Problems related to application of IR spectra in bonding of carbonyls, nitrosyls, dinitrogen and dioxygen complexes.

### Alkyl, carbene and carbyne Complexes

Metal alkyl complexes - synthesis by alkylation of metal halides, oxidative addition, and nucleophilic attack on coordinated ligands; Reactivity - M-C bond cleavage reactions, insertion of

CO, alkenes and alkynes: insertions of metals with C-H bonds; Alkylidene and alkylidyne complexes - Alkylidene complexes - synthesis in low oxidation and high oxidation states, reactivity and bonding; Alkylidyne complexes – synthesis, reactivity and bonding.

Tutorial: Problems related to find final compound(s) in a reaction, mechanism of reactions.

## UNIT II Alkene Complexes

Ligand substitution, reduction and metal atom synthesis; Bonding of alkenes to transition metal complexes; Reactivity - ligand substitution, reactions with nucleophiles - olefin hydrogenation, hydroformylation, hydrosilation, Wacker process; C-H activation of alkenes – Isomerization; polymerization.

### Alkyne Complexes

Synthesis, bonding and reactivity - Cobalt catalyzed alkyne cycloaddition.

Tutorial: Problems related to find final compound(s) in a reaction, mechanism of reactions.

## UNIT III

### Allyl complexes

Synthesis, bonding and reactivity.

**Cyclopentadienyl complexes** – Metallocenes – synthesis, bonding and reactions; stereospecific polymerization of 1-alkenes; cyclopentadiene as a non-spectator ligand;  $\text{Cp}_2\text{Fe}/\text{Cp}_2\text{Fe}^+$  couples in biosensors; **Bent sandwich complexes** – Synthesis, bonding, metallocene halides, hydrides and their uses; **Monocyclopentadienyl (half-sandwich) complexes** - Synthesis and structures.

**Arene complexes** – Synthesis, structure and reactivity; multidecker complexes.

Tutorial: Problems related to find final compound(s) in a reaction, mechanism of reactions.

## UNIT IV Metal complexes in life processes

Metalloporphyrins - the porphyrin ring systems - Chlorophyll, cytochromes; Oxygen carriers - haemoglobin and myoglobin; Ferridoxins and rubredoxins; enzymes; vitamin  $\text{B}_{12}$  and  $\text{B}_{12}$

coenzymes - structure and function; synthesis model of enzyme action - Inhibition and poisoning; Nitrogen fixation; Biochemistry of essential and trace elements in biological systems.

Tutorial: Problems related to find final compound(s) in a reaction, structure and mechanism of reactions.

## **UNIT V      Metal complexes in Medicine**

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

Tutorial: Problems related to use of metals in medicine. Mechanism of action of metals in medicine.

### **Text Books**

1. Bockmann, Organometallics 1, complexes with transition metal-carbon bonds, Oxford science publications, Oxford, 1996.
2. Bockmann, Organometallics 2, complexes with transition metal-carbon bonds, Oxford science publications, Oxford, 1996.
3. R.C. Mehrotra, A.Singh, Organometallic Chemistry, New Age International (P) Ltd., 2000.
4. Indrajit Kumar, Organometallic Compounds, Pragati Prakashan publication, 2018.

### **Reference Books**

1. J. E. Huheey, Inorganic Chemistry – Principles of structure and reactivity, Harper International Edition, Harper and Rone, New York, 1978.
2. F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 5th Edition, Wiley, 1988.
3. W.L. Jolly, Modern Inorganic Chemistry, McGraw-Hill, 2<sup>nd</sup> edition, 1991.
4. K.M. Mackey and R.A. Mackey, Introduction to Modern Inorganic Chemistry, Prentice Hall, 4<sup>th</sup> edition, 1989.
5. J. Haiduc and J.J. Zuckerman, Basic Organometallic Chemistry, Walter de Gruyter, Berlin, 1985.

6. D.F. Shriver P.W. Atkins and C.H. Long ford, Inorganic Chemistry, ELBS 2<sup>nd</sup> Edition, 1994.
7. J. A. Cowan, Inorganic biochemistry, Wiley-VCH, New York, 1997.
8. D.E. Fenton, Biocoordination Chemistry, Oxford Science Publication 1995.
9. S.J. Lippard and Berg, Principles of Bioinorganic Chemistry, Univ. Science Books 1994.

**Mapping with Programme Outcomes**

<b>COs</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>
<b>CO1</b>	S	S	M	M	M
<b>CO2</b>	M	S	S	S	M
<b>CO3</b>	S	M	S	S	M
<b>CO4</b>	M	M	S	S	S
<b>CO5</b>	M	S	M	M	S

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

## 18UPCHE1C14 PHYSICAL METHODS IN CHEMISTRY

HOURS: L (3) + T(1)+P(0)=C (4)

MARKS : 75

### Course Objectives

1. To understand the theory, principles of rotational spectroscopy.
2. To understand the basic concepts and principles of diatomic molecules, wave number and atomic mass.
3. To understand the theory and principles of absorption spectroscopy atomic fluorescence spectroscopy.
4. To understand the basic concepts of electrochemistry.
5. To study the basic concepts of Electrocapillary phenomena.
6. To understand the basic concepts kinetics of electrode reactions

### 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 and understanding about the fundamental concepts of Micro wave spectroscopy theory selection rules, quantization of energy Einstein coefficients, instrumentation signal-to-noise ratio, resolving power; width and intensity of spectral transitions transition probability; energy levels in atoms and molecules Fourier Transformation. Discuss the rotational spectra of diatomic and polyatomic molecules and effect of isotopic substitution. Enlighten Non-rigid rotator- Linear molecules.	K2, K3
CO2	Innovatively launch the Vibrational spectra of diatomic molecules. Establish energy of diatomic molecule, simple harmonic oscillator, morse potential of real molecules, selection rules, overtones and combination fermi resonance. Clarify the theory of Vibrational Raman spectroscopy. Determine the trace analysis in solution and contamination control in chemicals. Discuss harmonic oscillator, rotational character of vibrational spectra and breakdown of the Born-oppenheimer approximation.	K2, K3
CO3	Illustrate the Absorption spectroscopy (Principles, Elementary theory, instrumentation, Flames, Nebulizer burner system, Non-Flame Techniques, Resonance Line Sources, Detectors, Chemical Interferences). Explain applications and photometric titration in depth. Find out the Atomic Fluorescence spectroscopy. Elucidate the Precipitation titrations – Theory and Instruments of fluorimetry. Resourcefully discuss Flame photometry – Principles, theory,	K3

	instrumentation, advantage and disadvantage of flame photometry and a few important applications.	
CO4	Acquire in depth knowledge of the Electrolytic conductance, Kohlrausch's law and its applications; Conductometric titrations. Comprehend the concept of Debye-Huckel theory- Debye-Huckel-Onsager equation - Debye-Huckel limiting law. Discuss the theory of Mean ionic activity and activity coefficient, Nernst equation and standard electrode potentials - redox systems. Determine electrochemical, thermodynamics of electrochemical cells and EMF measurements – Explain the applications- Potentiometric titrations- Batteries-primary and secondary; fuel cells;	K3
CO5	Elucidate the Electrode-electrolyte interface, interionic attraction; structures of electrical double layer - Helmholtz-Perrin Gouy-Chapman -Stern model. Establish the electro kinetic phenomena of Electrophoresis, Electroosmosis, Sedimentation Potential, Streaming Potential; Kinetics of electrode reactions - Butler-Volmer equation - Tafel plot; Non-equilibrium electrode processes - Polarisation, Over voltage; Corrosion and its prevention- Pourbaix and Evans diagrams.	K2

## Unit-I Rotational Spectroscopy

Micro wave spectroscopy- Theory- selection rules, Quantization of energy-Einstein coefficients;-Instrumentation- signal-to-noise ratio, resolving power; Width and intensity of spectral transitions-transition probability; Energy levels in atoms and molecules- Fourier transformation. Rotational spectra of diatomic and polyatomic molecules– rigid diatomic molecule, effect of isotopic substitution. Non-rigid rotator- Linear molecules. Rotational Raman spectra.

Tutorial : Problems in rotational energy of diatomic and polyatomic molecules

## Unit –II Vibrational spectroscopy

Vibrational spectra of diatomic molecules – Energy of diatomic molecule, simple harmonic oscillator, Morse potential of real molecules – selection rules –overtones and combination - Fermi resonance. Anharmonic oscillator, rotational character of vibration spectra, Breakdown of the Born-oppenheimer approximation. Theory of Vibrational Raman spectroscopy.

Tutorial : Problems in vibrational energy, wave number and atomic mass.

## Unit III Atomic absorption spectroscopy

Absorption spectroscopy (AAS) – Principles, Elementary theory, instrumentation, Flames, Nebulizer burner system, Non-Flame Techniques, Resonance Line Sources, Detectors, Chemical Interferences, applications and photometric titration.

Atomic Fluorescence spectroscopy (AFS) – Instruments of fluorimetry. Turbidimetry and nephelometry. Flame photometry – Principles, theory, instrumentation, advantage and disadvantage of flame photometry and a few important applications.

#### **Unit IV Electrochemistry-I**

Electrolytic conductance – Kohlrausch's law and its applications; Conductometric titrations. Debye–Huckel theory- Debye-Huckel-Onsager equation - Debye-Huckel limiting law; Mean ionic activity and activity coefficient, Nernst equation, standard electrode potentials - redox systems, electrochemical cells - Thermodynamics of electrochemical cells; EMF measurements; Solubility product- Applications- Potentiometric titrations-Batteries-primary and secondary; fuel cells;

Tutorial : Problems in solubility product and emf.

#### **UNIT – V Electrochemistry-II**

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

Tutorial : Problems in current density, over potential.

#### **References**

##### **Text Books**

1. P. Atkins and J. de Paula, Atkins' physical chemistry, 8th Ed., Oxford University Press, New Delhi, 2008
2. H.S.Randawa, **Modern Molecular Spectroscopy**, Macmillan India Ltd. 2003
3. Willard, Merit, Dean and Settle, **Instrumental Methods of Analysis**, CBS Publishers and

Distributors, IV Edn. 1986

4. C.N. Banwell, **Fundamentals of Molecular Spectroscopy**, McGraw Hill, Education(India) Edition, 2013.

### **Reference Books**

1. D. A. Skoog, D. M. West, F. J. Holler and S. R. Couch, Fundamentals of analytical chemistry. Brooks/ColeCengage learning, New Delhi, 2004.
2. F. Scholz, **Electroanalytical Methods**, Springer, 2<sup>nd</sup> Ed., 2010.
3. Schoog, Holler, Nieman, Principles of Instrumental Analysis, Thomson Asia Pte Ltd., Singapore, 2004.
4. D.A. Skoog, Principles of Instrumental Analysis, Saunders College Pub.Co, III Edn., 1985.
5. Allen J. Bard, Larry R. Faulkner, Electrochemical Methods: Fundamentals and Applications, John Wiley and Sons, 2nd edition, 2000, ISBN 0-471-04372-9.
6. S.Glasstone, **Introduction to Electrochemistry**, Affiliated East west Press, New Delhi 1960.
7. D.R. Crow, Principles and application of Electrochemistry, Chapman and Hall, 1991.
8. P.H.Rieger, Electrochemistry, Chapman and Hall, New York, 1994.
9. J.O.M. Bockris and AKN Reddy, **Modern Electrochemistry**, Plenum, New York 2<sup>nd</sup> Edition, 2001.

### **Mapping with Programme Outcomes**

<b>COs</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>
<b>CO1</b>	S	S	M	M	M
<b>CO2</b>	M	S	S	S	M
<b>CO3</b>	S	M	S	S	M
<b>CO4</b>	S	S	S	S	S
<b>CO5</b>	M	S	M	M	S



## 18UPCHE1C15 INORGANIC CHEMISTRY PRACTICAL – II

Hours	L	T	P	C
90	4	0	5	3

### Course Objectives

1. To estimate the amount of metal ion present in the environment quantitatively by complex formation.
2. To estimate the amount of metal ion present in the environment quantitatively by volumetric and gravimetric analysis.
3. To study the basic properties of complexes.

### Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	Know the content and amount of the sample by complex formation	K5
CO2	Know the content and amount of the sample by volumetric and gravimetric analysis.	K5
CO3	Learn the structure and mode of coordination of ligands in complexes	K6

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

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

3. **Preparation, Analysis and Study of the Properties of Co-ordination Complexes**

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

### Reference Books

1. J. Basset, R.C. Denney, G.H. Jeffery and J. Mendham, Vogel's text book of quantitative inorganic analysis, ELBS, 1994.
2. W.G. Palmer, Experimental Inorganic Chemistry, Van Nostrand Reinhold Co., London, 1972.

3. D.N. Grindley, An advanced course in practical Inorganic Chemistry, Butterworths, 1964.

## 18UPCHE1C16 PHYSICAL CHEMISTRY PRACTICAL – II

Hours	L	T	P	C
90	4	0	5	3

### Course Objectives:

To get depth knowledge in catalysis phase diagram and conductance.

### Course Outcome:

CO Number	CO Statement	Knowledge Level
CO1	Gain depth knowledge in catalysis, kinetics, order of a reaction, equilibrium reactions, phase diagram and conductance by doing practicals individually in the laboratory.	K3, K4 & K5

### Experiments in Electrochemistry, Polarography and Chemical Kinetics.

#### EMF Measurements

1. Determination of standard potentials (Cu and Ag)
2. Determination of thermodynamic quantities from EMF measurements
3. Potentiometric titrations.
4. Determination of pH and calculation of pKa.
5. Determination of stability constant of complex.
6. Determination of solubility product of a sparingly soluble salt, Redox titrations.
7. Precipitation titration of mixture of halides by emf measurements.

#### 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 15 experiments have to be performed.

1. Determination of the activity coefficient of an electrolyte at different molalities by emf measurements.
2. Determination of the dissociation constant of acetic acid by titrating it with sodium hydroxide using quinhydrone as an indicator electrode and calomel as a reference electrode.
3. Determination of the strength of a given solution of KCl using differential potentiometric

titration technique.

5. Determination of the pH of the given solutions with the help of the indicators using buffer solutions and by colorimetric method.
6. Determination of the pH of a given solution by emf method using hydrogen electrode and quinhydrone electrode.
7. Determination of the composition and instability constant of a complex by mole ratio method.
8. Calculation of the thermodynamic parameters for the reaction  
$$\text{Zn} + \text{H}_2\text{SO}_4 \text{ -----} \rightarrow \text{ZnSO}_4 + \text{H}_2$$
 by emf method.
9. Determination of the formation constant of silver ammonia complex and stoichiometry of the complex potentiometrically.
10. Solubility and solubility products by emf method.
11. Determination of the activity coefficient of Zinc ions in the solution of 0.002M Zinc sulphate using Debye - Huckel Limiting law.
12. Determination of solubility product of Silver bromide and calculate its solubility in water and 0.1 M and 0.01 M  $\text{KBrO}_3$  using Debye- Huckel limiting law.
13. Determination of the electrode potentials of Zn and Ag electrodes in 0.1 M and 0.001M solutions at 298 K and find the standard potentials for these electrodes and test the validity of Nernst equations.
14. Study the inversion of cane sugar in presence of acid using polarimeter.
15. Determination of the rate constant and order of reaction between potassium persulphate and potassium iodide and determine the temperature coefficient and energy of activation of the reaction.
16. Study the primary salt effect on the kinetics of ionic reactions and test the Bronsted relationship (iodide ion is oxidized by persulphate ion.)

17. Determination of the viscosities of mixtures of different compositions of liquids and find the composition of a given mixture.
18. Determination of the partial molar volume of glycine/methanol/formic acid/ sulphuric acid by graphical method and by determining the densities of the solutions of different compositions.
19. Study the surface tension – concentration relationship of solutions (Gibb's equation)

### Mapping with Programme Outcomes

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

S- Strong; M-Medium.

# Fourth Semester

## 18UPCHE1C17 SPECTROSCOPY

Hours	L	T	P	C
72	4	0	0	4

### 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.
4. To get an insight into various properties of inorganic complexes using different spectral data.

### Course outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	Calculate the $\lambda_{\max}$ values for unsaturated compounds using Woodward-Fischer rules and predict the functional groups present using IR frequencies	K4
CO2	Elucidate the structure of the compounds more precisely with NMR spectral data	K4
CO3	Familiarize with advanced NMR techniques and use them to solve the complex molecular structures. Use the mass spectra to predict the fragmentation patterns and exact molecular weight and structure	K4
CO4	Understand the ESR, Mössbauer and NQR Spectroscopy and use them for the structure elucidation of inorganic complexes.	K3
CO5	Understand the principles and applications of PES, ESCA and Auger Electron Spectroscopy	K2

## UNIT I Applications of UV-Visible and IR Spectroscopy

UV-Visible spectroscopy-; Application to inorganic and organic compounds - Woodward-Fischer rules for  $\lambda_{\max}$  calculations. FTIR spectra- characteristic group frequencies-finger print

region; Interpretation of vibrational spectra; Applications to inorganic and organic compounds.

Tutorial:  $\lambda_{\max}$  calculations, and functional group assignments

### **UNIT III $^1\text{H}$ NMR Spectroscopy**

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

Tutorial: Structure elucidation by  $^1\text{H}$  NMR spectra

### **UNIT III $^{13}\text{C}$ NMR and Mass Spectroscopy**

$^{13}\text{C}$ -NMR Spectroscopy: Theory and principles - Fourier Transformation; decoupled spectra-  $^1\text{H}$  decoupling-noise decoupling-broadband decoupling-off resonance-spin tickling; Nuclear Overhauser effect- Structural applications of  $^{13}\text{C}$ -NMR. 2D NMR, COSY, ROSSY, NOESY, CIDNP, INDOR (Basic idea only).

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

Tutorial: Structure elucidation of organic molecules by IR,  $^1\text{H}$  NMR,  $^{13}\text{C}$ -NMR and Mass Spectra

### **UNIT IV ESR, Mössbauer and NQR Spectroscopy**

ESR Spectroscopy-theory and instrumentation- line width, the 'g' values, factors affecting the magnitudes of g and A tensors, zero field splitting and Kramer's degeneracy. Applications of ESR to few biological molecules containing Cu(II), Fe(II) and Fe(III); Jahn-Teller distortions in Cu(II) complexes;

Mössbauer spectroscopy – Theory and principles-Doppler effect, isomer shift, ortho effect-electron-neutron hyperfine interactions, Quadrupole interactions and magnetic interactions; simple applications of Mossbauer spectroscopy to Iron and Tin compounds.

Tutorial: Problems related to Structure of elucidation of inorganic complexes

### **Unit V PES, ESCA and Auger Electron Spectroscopy**

Photo electron spectroscopy- Principles, theory, instrumentation, types of photo electron spectroscopy, Koopman's Theorem, Chemical Shifts, Core Binding Energy and important applications. Electron spectroscopy for chemical analysis-Augur electron spectroscopy -

Principles, theory, instrumentation and applications. Auger electron spectroscopy - Principles, theory, instrumentation and applications.

**Text Books:**

1. R.M Silverstein, C.G. Bassler and Morrill, **Spectrometric identification of organic compounds**, VI Edn., John Wiley & Sons, New York, 2002.
2. P.S. Kalsi, **Spectroscopy of organic compounds**, Wiley Eastern Ltd., Madras, 1995.
3. C.F. Banwell, **Fundamentals of Molecular Spectroscopy**, McGraw Hill, New York, 1966.
4. R.S. Drago, **Physical methods in chemistry**, Reinhold, New York, 1968.

**Reference Books:**

1. G.M. Barrow, **Introduction to Molecular Spectroscopy**, McGraw Hill, New York, 1988.
2. J.R. Dyer, **Application of absorption spectroscopy of organic compounds**, Prentice Hall of India Pvt. Ltd., New Delhi, 1974.
3. William Kemp, **Organic Spectroscopy**, ELBS, New Delhi, 1982.
4. A. Carrington and A.D. McLachlan, **Introduction to Magnetic Resonance**, Harper and Row, New York 1967.
5. William Kemp, **NMR in Chemistry**, MacMillan Ltd., 1986.
6. C.N.R. Rao and J.R. Ferraro, **Spectroscopy in Inorganic Chemistry**, Methven Co., London, 1968.
7. Raymond Chang, **Basic Principles of Spectroscopy**, Mc Graw Hill Ltd., New York, 1993.
8. E.A.V. Ebsworth, D.W.H. Rankine and S. Craddock, **Structural methods in Inorganic Chemistry**, Black well Scientific Publ., 1987.

**Mapping with Programme Outcomes**

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

S- Strong; M-Medium.



# Elective Courses

## 18UPCHE1E02 ENVIRONMENTAL CHEMISTRY

Hours	L	T	P	C
72	4	0	0	4

### Course Objectives

1. To understand the fundamentals of environmental chemistry
2. To study water, soil and hazards waste

### Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	To understand the fundamental concepts of different polymers	K1
CO2	To understand the impact of pollutant in water	K2
CO3	To study the impact of chemical composition in atmosphere	K2
CO4	To understand the impact of chemical component & pollutant in soil	K2
CO5	To know the detailed issues of hazards chemicals in environmental	K2, K3

### 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, Sulphur Cycle; Natural and Man-made Disasters – Recent Natural Disasters; Anthropogenic Effects.

### UNIT II Water Chemistry

Water chemistry- properties of water, nature of metal ions in water, solubility of gases in water, occurrence of chelating agents in water; Redox potential, Significance of redox equilibria in natural and waste water; microorganisms; The catalyst of aquatic chemical reactions, water pollution and its effects, eutrophication concept of DO, BOD, COD, Sedimentation. Coagulation and filtration. Sampling techniques for water.

### UNIT III Atmospheric Chemistry

Atmosphere- Nature and composition of atmosphere, chemical and photochemical, reactions in the atmosphere – OZONE and PAN ions and radicals in the atmosphere; gaseous organic and inorganic pollutions in the atmosphere; Global warming and effects of CO, SO<sub>2</sub>, NO<sub>x</sub>, sampling techniques for air.

### UNIT IV Soil Chemistry

Soil chemistry- inorganic and organic components of soil, Nitrogen pathways. NPK in soils; Toxic chemicals in the environment pesticides and their toxicity; biochemical aspects of arsenic, cadmium, lead & 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; Health effects of hazardous wastes. Nuclear, Radioactive Wastes, Anthropogenic Sources and Effects of Radioactive Pollution, Preventive Measurements. Energy from Wastes - Water-Based Biomass, Solid Wastes, 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 and Creatchman (Ed.), **Elemental Analysis of Airborne Particles**, Gordon and Breach Science Publication New York, 1998.
3. S.M. Khopkar, **Environmental Pollution analysis**, Wiley Eastern, New Delhi, 1994.

#### Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
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<b>CO1</b>	M	M	S	M	M
<b>CO2</b>	M	M	S	M	S
<b>CO3</b>	M	M	S	M	M
<b>CO4</b>	M	M	S	M	S
<b>CO5</b>	M	M	S	M	S

## 18UPCHE1E03 MATERIALS CHEMISTRY

Hours	L	T	P	C
72	4	0	0	4

### Objectives

1. To understand the preparation, characterizations and applications of various types of polymers
2. To study the detailed preparation of commercial polymers and their physico-chemical properties.
3. To understand the preparation, characterizations of various types of nanomaterials
4. To study the application of nanomaterials in the various fields

### Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	To understand the concepts and mechanism of different polymers	K2
CO2	To apply the processing techniques for polymer preparation	K3
CO3	To apply the processing techniques for the preparation of commercial polymers	K3
CO4	To understand the concepts and apply various synthesis methods for nanomaterials	K3
CO5	To analyse the characteristics of nanomaterials using various techniques and to test the applicability of nanomaterials in various fields	K4

## UNIT I Kinetics and Mechanism of polymerization

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

Coordination Polymerization: Kinetics; mono and bimetallic mechanism. Copolymerization: Kinetics and mechanism- Evaluation of monomer. Reactivity ratio. Rate of copolymerization. Polymerization in homogeneous and heterogeneous systems.

## UNIT II Processing of polymers

Polymer Processing: Plastics elastomers and fibres. Compounding processing techniques: calendaring, die casting, rotational casting, film casting, injection moulding, blow moulding

extrusion moulding, thermoforming, foaming, reinforcing and fibre spinning.

### **UNIT III Commercial polymers and their properties**

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

Measurement of molecular weights. Gel permeation chromatography, viscosity, light scattering, osmotic and ultracentrifugation methods. Polymer structure and physical properties – crystalline melting point  $T_m$ . Determination of  $T_g$ . Relationship between  $T_m$  and  $T_g$ .

### **UNIT IV Nanomaterials – Types and synthesis**

Different types of nanomaterials-Nanotubes: Single and Multiwalled carbon nanotubes, nanowires, nanorods, nanofibres and nanoflowers of polymers, semiconductors, metals and alloys-nanocrystalline materials-nanoporous materials-nanofilm-nanocomposites-nanoquantum dots.

Wet processes-colloidal chemical method, hydrothermal method, sol-gel method; Precipitation processes-Solid state processes-gas phase synthesis, Dry coatings- PVD, CVD, Electron beam evaporation techniques, RF sputtering-Magnetron sputtering-DC and Pulsed electrodeposition-Electrophoretic deposition-Anodic oxidation-Autocatalytic deposition and Laser deposition-Arc discharge and plasma polymerization methods.

### **UNIT V Properties and Application of Nanomaterials**

Physical, chemical, Thermal, electrical, mechanical, optical and magnetic, catalytic and biological properties of nanomaterials.

Photocatalytic applications-applications of nanomaterials in the field of fuel cells, batteries; Energy and environmental applications- -nanomaterials as actuators and thermal insulators-membranes for chemical processes-Applications of nanomaterials in electronics, biotechnology and medicine.

#### **Text Book**

1. F.W.Billmeyer, **Text Book of Polymer Science**, 3<sup>rd</sup> Edn., John Wiley & Sons, New York, 2003.
2. V.R.Gowariker, N.V.Viswanathan and J. Sreedhar, **Polymer Science**, New Age International, New Delhi, 2005.
3. C.N.R.Rao, A.Muller and A.K.Cheetham (Eds.), **The Chemistry of Nanomaterials** Vol.I & Vol.II., Wiley-VCH, 2004

4. P.Ajayan, L.S.Schadler, P.V.Brawn, **Nanocomposite Science and Technology**, Wiley-VCH, 2003.

**References Books:**

1. R.Alcock and F.W.Lamber, Contemporary Polymer Chemistry, Prentice Hall,1981.
2. K.L.Choy, Process principles and applications of novel and cost-effective ESAVD based methods, World Scientific Publishing, Singapore, 2002.
3. A.Jones and M.Mitchell, Nanotechnology-Commercial Opportunity, Evolution Capital Ltd. London, 2001.
4. G.Schmid (Eds), Nanoparticles, Wiley-VCH, 2004
5. G.Hodes(Eds.), Electrochemistry of Nanomaterials, Wiley-VCH, 2001.
6. M.Kohler, W.Fritzsche, Nanotechnology, Wiley-VCH, 2004
7. R. J. Young and P. A. Lovell, Introduction to Polymers, 2<sup>nd</sup> Edition, Chapman and Hall, 2002.
8. V. R. Gowariker, N. V. Viswanathan, Jayadev Sreedhar, New Age International (P) Ltd, 2005.
9. G. Odian, Principles of Polymerization, Fourth edition, Wiley-Interscience, 2004.
- 10.L. H. Sperling, Introduction to Physical Polymer Science, Wiley- Interscience, 1986.
- 11.M. Rubinstein and R. A. Colby, Polymer Physics, Oxford University Press, 2003.

**Mapping with Programme Outcomes**

<b>COs</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>
<b>CO1</b>	S	S	S	M	M
<b>CO2</b>	S	S	S	S	M
<b>CO3</b>	S	S	S	S	M
<b>CO4</b>	S	S	S	S	S
<b>CO5</b>	S	S	S	S	S

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

Hours	L	T	P	C
72	4	0	0	4

**Course Objectives**

1. To understand the basic concepts of medicinal chemistry
2. To understand the structure activity relationships of selected drug molecules

**Course Outcomes**

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

CO Number	CO Statement	Knowledge Level
CO1	To understand the drug analogues	K2
CO2	To impart the classification of anticonvulsants and analgesics	K2
CO3	Learning the preparation and properties of antihistamines and anti-inflammatory drugs	K3
CO4	To understand the properties expectorants.	K3
CO5	To learn about antimalarials and antibiotics.	K3

**Unit I Basic Concepts**

Drug design - analogues and pro-drugs, factors governing drug design, rational approach, method of variation and tailoring of drugs; Physical properties-factors governing drug action at active site, factors governing ability of drugs to reach active site, dissociation constants, isosterism and bioisosterism; general anaesthetics-inhalation anaesthetics, intravenous anaesthetics and basal anaesthetics; mode of action; local anaesthetics-classification and syntheses, sedatives and hypnotics-classification, synthesis, mode of action and structure-activity relationship.

**Unit II Anticonvulsants, Stimulants and Antipyretic Analgesics**

Classification, synthesis and mode of action;- Anticonvulsants Muscle relaxants. Central nervous system stimulants, Antipyretic analgesics, Narcotic or Opiate analgesics Narcotic antagonists; Cardiovascular drugs- Autonomic drugs, sympathomimetic drugs, antiadrenergic drugs, cholinomimetic drugs, antimuscarinic drugs, ganglionic blocking agents and adrenergic neurone blocking agents; Diuretics - synthesis and mode of action of mercurial and non-mercurial diuretics.

## Unit IV     **Antihistamines, Anti-inflammatory and Antiparkinson drugs**

Antihistaminics - synthesis and mode of action of histamine H<sub>1</sub> receptor antagonists and histamine H<sub>2</sub>-receptor blockers; prevention of histamine release; structure-activity relationships amongst H<sub>1</sub>-receptor blockers. Non-steroidal anti-inflammatory drugs(NSAID)-synthesis and mode of action of heteroarylacetic acid analogues, arylacetic acid analogues, arylpropionic acid analogues, naphthalene acetic acid analogues, gold compounds, salicylic acid analogues and pyrazolones and pyrazolodiones; Antiparkinsonism agents-synthesis and mode of action of piperidine analogues, pyrrolidine analogues and phenothiazine analogues.

## Unit V     **Other Drugs**

Expectorants and antitussives-synthesis and mode of action of sedative expectorants, stimulant expectorants and centrally acting antitussive agents. Sulphonamides-preparation and mode of action of sulphonamides for general, urinary, intestinal and local infection; sulphonamide inhibition. Antimalarials-synthesis and mode of action of aminoquinoline analogues, aminoacridine analogues, guanidine analogues, pyrimidine analogues, sulfone and quinine analogues; Steroids-synthesis and mode of action of sterols, sex hormones, cardiac glycosides, bile acids and sapogenins. Antibiotics-synthesis and mode of action of penicillins, aminoglycoside antibiotics, chloramphenicol and tetracyclines.

### **Text Books**

1. Ashutosh Kar, **Medicinal Chemistry**, New Age International, 1996.
2. W.O.Foye, **Principles of medicinal chemistry**, 2<sup>nd</sup> edn., Lea & Febiger, Philadelphia, 1981.

### **Reference Books**

1. M.E.Wolff, **Burger's medicinal chemistry**, 4<sup>th</sup> Edn., John Wiley & Sons, New York, 1981.
2. F.F.Blicke and R.H.Cox, **Medicinal Chemistry**, John Wiley & Sons, New York, 1959.
3. D.Lednicer and L.A.Mitscher, **Organic Chemistry of drug synthesis**, John Wiley & Sons, New York, 1959.
4. J.E.Hoover, **Remington's Pharmaceutical sciences**, 15<sup>th</sup> Edn. Mack Publ.Company, Easton, 1975.

### **Mapping with Programme Outcomes**



<b>COs</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>
<b>CO1</b>	S	S	M	M	M
<b>CO2</b>	M	S	S	S	M
<b>CO3</b>	S	M	S	S	M
<b>CO4</b>	M	M	S	S	S
<b>CO5</b>	M	S	M	M	S

18UPCHE1E04

## DYE CHEMISTRY

Hours	L	T	P	C
72	4	0	0	4

### Objectives

1. To understand the structures, synthesis of various types of dyes
2. To know the industrial applications of various dyes.

### Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	To understand the basic constitution of dyes	K2
CO2	To Impart the classification and properties of acid and basic dyes.	K2
CO3	Learning the preparation and properties of azo and vat dyes.	K3
CO4	To understand the applications of commercial dyes.	K3
CO5	To learn the colouring agents and its applications.	K3

### Unit I Introduction

Colour and chemical constitution - chromophore, auxochrome and resonance, various theories; History of natural and synthetic dyes; Names of commercial dyes; Study of raw materials and dyestuff intermediates; Unit operations - nitration, sulphonation, halogenation, amination, diazotisation and alkali fusion; Colour index and its significance; Classification of dyes based on chemical constitution and method of applications; General properties - linearity, coplanarity and fastness.

### Unit II Direct, Acid and Basic Dyes

Classification, preparation, properties, structure and uses of direct, acid and basic dyes - mechanism of dyeing, post treatment of dyeing; Characteristics, trade names, Nature of affinity on cellulose and protein fibres.

### Unit III Mordant, Azo and Vat Dyes

Classification, methods of preparation, properties and applications of mordant, azo and vat dyes; Metal complex dyes – types of bond formation between dye and various fibres- Stripping agents and correction of faulty dyeing.

#### **Unit IV Other Dyes**

Chemistry involved in the production of Aniline black; Prussian black; Sulphur colours; phthalocyanines; Disperse dyes - classification based on chemical structure, properties and principles of application; Solvent soluble dyes - Nigrosines and Indulines; Cyanine dyes.

#### **Unit V Colour and Brightening**

Fluorescent brightening agents (FBA) - Theory and applications; Identification and estimation of dyes on fibres; The action of light on dyes and dyed fibres; Mechanism of fading.

#### **Text Books:**

1. K. Venkataraman, **The chemistry of synthetic dyes** Part I & II, Academic Press, New York, 1952.
2. V. A. Shenai, **Introduction to Chemistry of Dyesuffs**, Sevak Prakashan Pub., Mumbai, 1991.

#### **Reference books**

1. V. A. Shenai, **Chemistry of Dyes and Principles of Dyeing** Vol.-II, Sevak Prakashan, Mumbai, 1987.
2. V. A. Shenai, **Ecology and Textiles**, Sevak Publications, Mumbai, 1997.
3. D. M. Nunn, **The Dyeing of Synthetic Polymer and Acetate Fibres**, Dyers Company, Publication Trust, 1979.
4. V. A. Shenai, **Toxicity of Dyes and Intermediates**, Sevak Publications, Mumbai, 1998.
5. **Directory of safe dyes conforming to German Consumer Goods Ordinances**, The Dyestuff Manufacturers Association of India, 1996.

#### **Mapping with Programme Outcomes**

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

<b>CO3</b>	S	M	S	S	M
<b>CO4</b>	M	M	S	S	S
<b>CO5</b>	M	S	M	M	S

## 18UPCHE1E05 CHEMISTRY OF WATER TREATMENT

Hours	L	T	P	C
72	4	0	0	4

### Objectives

1. To understand water pollution and treatment techniques for water purification

### 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
CO3	Get an insight about the waste water treatment	K2, K3
CO4	Knowledge on industrial waste water treatment and removal of particular organic matters	K2, K3
CO5	Understand about treatment plants for nitrification and denitrification	K2, K3

### Unit I Introduction

Sources of Water; Physical and chemical characteristics of water; Water analysis; Potable water – WTO standard: uses of water

### Unit II Water Pollution

Water pollution – wastewater generation - classification of water pollutants; constituents and characteristics of wastewater; measurement techniques – sampling, colour & odour, dissolved oxygen, BOD, COD, TOC, N & P, suspended solids and bacteriological measurements.

### Unit III Wastewater Treatment

Wastewater treatment: Pretreatment – screening, grit removal and pre-chlorination; Primary treatment – settling and sedimentation; Secondary treatment – trickling filter process, activated sludge process; Aeration.

### Unit IV Industrial Wastewater Treatment

Industrial wastewater treatment: Activated sludge treatment plants – mass balances, with and without recycle plants; Types of plants – single tank, contact stabilization, biosorption plants. Biofilters: Hydraulic film diffusion, two component diffusion; Types of plants – trickling filters,

submerged filters and rotating disc; removal of particulate organic matter.

## Unit V Treatment Plants

Treatment plants for nitrification – mass balances, nitrifying plants and types of plants.

Treatment plant for denitrification - mass balances, denitrifying plants and types of plants; redox zones in the biomass.

Anaerobic wastewater treatment: Plant types – pretreatment, plant with suspended sludge and filter process.

### Text books

1. A.K.De, **Environmental Chemistry**, Wiley Eastern, 1989.
2. S.K.Banerji, **Environmental Chemistry**, Prentice Hall of India, New Delhi, 2003.

### Reference books

1. L.Winther, **Wastewater Engineering**, Polyteknisk Forlag, Lyngby, 1978.
2. M.Henze, P.Harremoes, J.C.Jansen and E.Arvin, (Ed.), **Wastewater treatment**, Springer Verlag, New York, 1995.
3. P.Harremoes, **Water Chemistry**, Polyteknisk Forlag, Lyngby, 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.

## 18UPCHE1E06 GREEN CHEMISTRY

Hours	L	T	P	C
72	4	0	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.	K2
CO2	Get an idea on the alternate energy sources for carrying out the reactions under solvent free conditions leading to greener protocols.	K3
CO3	Familiarize with the use of catalysts for chemical conversions leading to waste free environment.	K3
CO4	Know the newer techniques used for waste water treatment.	K3
CO5	Use the green chemistry principles for the research in the advanced areas like pharmaceutical and agrochemical industries.	K4

### Unit I Introduction

The need for green chemistry – Twelve principles – Atom economy – Scope for green chemistry – Inception and awards.

### Unit II Solvent free reactions

Exploration of solvent free reactions – Microwave assisted organic synthesis – Functional group transformations – Protection and deprotection reactions, Condensation reactions, reduction and oxidation.

Ionic liquids – Synthesis of ionic liquids – Applications in organic synthesis.

### Unit III Eco-friendly green Techniques

Biocatalysts – Modified biocatalysts – Transition metal catalysts – Supported metal catalysts.

Eco-friendly synthesis and reactions of  $\alpha$ ,  $\beta$ -unsaturated nitroalkanes.

Heterogenised reactions – Mineral solid catalysed reactions – Solid supported catalysts – Super critical fluids.

#### **Unit IV Alternative Treatment Technologies**

Oxidation at ambient conditions for wastewater treatment – Photocatalytic reactions – Electrocatalytic reactions – Fentons chemistry – Hybrid processes.

Chemical methods for dye removal – Oxidative processes – physical treatments – Biological treatments.

#### **Unit V Exploration of Green Chemistry**

Trace element speciation by hyphenated techniques – tools for analytical speciation.

Green chemicals – Prospects and future in designing new drugs. Designing of next generation agrochemicals from nature.

#### **REFERENCE BOOKS:**

1. Rashmi Sanghi and M.M.Srivastava (Eds.), **Green Chemistry – Environment friendly alternatives**, Narosa Publishing house, New Delhi, 2003.
2. P.T.Anastas and J.C.Warner, **Green Chemistry: Theory and Practice**, Oxford Science Publications, Oxford, 1998.
3. P.Tundo and P.T.Anastas(Eds.) **Green Chemistry: Challenging Perspectives**, Oxford University Press, Oxford, 2000.
4. P.T.Anastas and 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	S	S	S	S	M
CO2	M	M	S	M	S
CO3	S	S	M	S	S
CO4	S	M	S	S	M
CO5	M	S	S	S	S

S- Strong; M-Medium.



## 18UPCHE1E07 ELECTROANALYTICAL TECHNIQUES

Hours	L	T	P	C
72	4	0	0	4

### Course Objectives

1. To understand the basic concept of electrochemistry.
2. To understand the concepts, principles and application of basic diffusion methods.
3. To empathize the principles, instrumentation and application for coulometric and potentiometric methods.
4. To understand the concepts of various stripping voltammetry processing.
5. To study the principles, basic concepts, instrumentation and application of impedance spectroscopy.

### Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	Establish the basic concepts of mass transfer processes, migration, diffusion and convection. Enlighten the planar and spherical diffusion methods. Discuss in detail the reversible and irreversible processes in electrochemical techniques.	K2
CO2	Understand the principle, instrumentation and applications of the following techniques: chronoamperometry, polarography through Ilkovic equation, square wave polarography, linear sweep voltammetry using Randles-Sevcik equations. Discuss and detail evaluation of cyclic voltammetry using normal and differential pulse and square wave voltammetry analysis.	K3
CO3	Clarify the galvanostatic and potentiostatic methods. Determine and explain the principle, instrumentation and applications of the various techniques: controlled potential coulometry and electrolysis, chronocoulometry, potentiometry and chronopotentiometry.	K3
CO4	Enlighten the principle, instrumentation and applications of anodic stripping voltammetry,	K3

	cathodic cyclic voltammetry and also adsorptive cyclic voltammetry	
CO5	Determine the principle of impedance spectroscopy techniques. Discuss and explain the analysis of faradic impedance and bode diagrams. Enlighten the dynamic electrode techniques, principle, instrumentation and applications of RDE and RRDE techniques.	K4

## UNIT I Basic Electrochemical principles

Mass transfer processes – migration, diffusion and convection– planar and spherical diffusion – Reversible and Irreversible processes.

## UNIT II Methods Based on Diffusion

Principle, instrumentation and applications of the following techniques: Chronoamperometry; Polarography - Ilkovic equation - Square wave polarography; Linear Sweep voltammetry – Randles Sevrík equation; Cyclic voltammetry - Normal pulse, Differential pulse and Squarewave voltammetry.

## UNIT III Coulometric and Potentiometric Methods

Galvanostatic and potentiostatic methods. Principle, instrumentation and applications of the following techniques: Controlled potential coulometry and electrolysis; Chronocoulometry; Potentiometry and Chronopotentiometry.

## UNIT IV Stripping Voltammetry

Principle, instrumentation and applications of Anodic stripping voltammetry, Cathodic stripping voltammetry and Adsorptive stripping voltammetry.

## UNIT V Sine wave methods (Electrochemical Impedance Spectroscopy)

Principle of Impedance technique - Analysis of Faradaic impedance – Bode Diagrams.

Dynamic electrode techniques, Principle, instrumentation and applications of RDE and RRDE techniques.

### Text Books

1. D.A.Skoog and D.M.West, Fundamentals of Analytical Chemistry, Holt Rinehart and

Winston Publications, IV Edn, 1982.

2. Willard, Merit, Dean and Settle, Instrumental Methods of Analysis, CBS Publishers and Distributors, IV Edn. 1986

## **2. Reference Books:**

3. B. H. Vassos and G.W. Ewing, Electroanalytical Chemistry, John Wiley and Sons, NY, 1983.
4. A. J. Bard and L.R. Faulkner, Electrochemical methods; Fundamentals and applications, J. Wiley and Sons, NY, 1980,
5. J.Wang, Stripping Analysis, VCH Publications, 1985.
6. A.M. Bond, Modern Polarographic methods in analytical chemistry, Macel Decker Inc., 1980.

Journals and Documents: Nil

### **Mapping with Programme Outcomes**

<b>COs</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>
<b>CO1</b>	S	S	M	M	M
<b>CO2</b>	M	S	S	S	M
<b>CO3</b>	S	M	S	S	M
<b>CO4</b>	S	S	S	S	S
<b>CO5</b>	M	S	M	M	S

# 18UPCHE1E08 INSTRUMENTAL METHODS OF ANALYSIS

HOURS: L (3) + T(1)+P(0)=C (4)

MARKS : 75

## Course Objectives

1. To understand the basic concept, principles and analysis of potentiometric methods
2. To understand the definitions, concepts and types of modern polarography.
3. To study the theory, principles and applications of voltammetry to determine the techniques.
4. To understand the concepts and activation analysis through various radio chemical analysis method.
5. To study the theories, principles, instrumentations, applications and properties of various chromatographic techniques

## Course outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	Get in depth knowledge and understanding about the classification of electrodes and its fundamental concepts and selection of electrodes. Detailed knowledge on types and selectivity of the electrodes and its selectivity coefficients for potentiometric analysis. Quantitative analysis using ISE method through potentiometry, standard addition, subtraction and dilution methods. Determine the analysis of double known addition methods, ionimeter and numericals	K2
CO2	Understand the detail study of electrochemical definitions and terminology of Faradaic and Non-Faradaic processes and concentrations profiles at microelectrode surface during electrolysis. Determine the principle of Sinusoidal alternating applied potential. Detail study on AC polarogram with peak current density and study characteristic AC polarographic peak and its comparison with DC polarography. Clarify principle of Square wave polarography and applied voltage, frequency, problems and limitations of the techniques. Determine the effect of capillary response and its principles, difference between normal and differential pulse polarography. Elucidate the importance of charging and faradic current and instrumentations.	K3
CO3	Study the principle and similarity of voltammetry with polarography. Determine the types of electrodes and applications of the technique to determine the hydrodynamic voltammetry reaction rate. Clarify the concentration, stripping steps for anodic stripping voltammetry and its importance of hanging mercury drop electrode and MTFE. Get in depth	K3

	knowledge in sensitivity of the technique, applications and comparison with cathodic stripping.	
CO4	Clarify the various interaction of radiation with matter, radioactivity and statistic counting along with the background corrections. Determine the neutron activation analysis, sources of neutrons and discuss the theory of instrumental neutron activation analysis. Illustrate the experimental considerations for isotope dilution analysis through direct and inverse method. Discuss the radio immuno assay through radiometric titrations to determination the radio release methods. Reveal the radiation safety through numericals calculations.	K3
CO5	Study the theory, principle and instrumentation of gas liquid chromatography. Determine in detail the techniques of sample injection, column type, stationary phases, column switching techniques and carrier gas. Explain the thermal conductivity, flame ionization and electron capture of gas chromatography in addition this chapter discuss few applications of GLC. Determine in detail the theory, principle and its instrument working principles of high performance liquid chromatography. In this the optimization of column performance, gradient elution derivatization through mobile phase delivery system, sample injection and column separation are studied in detail.	K4

### UNIT-I Potentiometric Methods of Analysis:

Classification of ion selective electrodes – Glass electrode – Crystalline membrane electrode – Liquid ion-exchanger electrode – Neutral carrier membrane electrode – Gas permeable membrane electrode – Biocatalytic membrane electrodes – Selectivity coefficients – Quantitative Analysis using ISE – Standard addition, Standard subtraction methods – Dilution method – Double known addition methods – Ionimeter – Numericals.

### UNIT-II Modern Polarographic Methods:

Electrochemical Definitions and Terminology – Faradaic and Non-Faradaic processes – Concentration profiles at microelectrode surface during electrolysis.

**A. C. Polarography:** Principle of Sinusoidal alternating applied potential – AC peak polarogram – Peak current equation – Characteristic of AC polarographic peak – Importance of signal to noise ratio for the sensitivity – Comparison with DC polarography.

**Square-wave Polarography:** Principle of alternating rectangular wave voltage applied – Frequency of square wave applied – Problems of large condenser currents in A.C. – Peak polarogram – Peak current equation – Limitations of techniques.

**Pulse Polarography:** Effect of capillary response with frequency of applied square wave potential – Principles and difference between Normal Pulse Polarography and Differential Pulse Polarography – Importance of charging and faradaic currents. Instrumentation.

### **UNIT-III Voltammetry**

**Hydrodynamic Voltammetry:** Principle and similarity with dc polarography – Types of electrodes used – Applications of the technique in determination of rate constant of the reaction.

**Anodic Stripping Voltammetry:** Concentration and stripping steps – Importance of Hanging mercury drop electrode and MTFE – Sensitivity of the technique – Applications – Cathodic stripping.

**Cyclic Voltammetry:** Principle – Forward and reverse scan, cyclic voltamogram – Detection limits – Applications.

### **UNIT-IV Radio-Chemical Methods of Analysis:**

Interaction of radiation with matter – Units of radioactivity – Statistic of counting – Background corrections – Neutron activation analysis – Sources of neutrons – Theory of instrumental neutron activation analysis – Experimental considerations – Isotope dilution analysis (Direct and Inverse) – Radioimmuno assay – Radiometric titrations – Radio release methods – Radiation safety – Numericals.

### **UNIT-V Chromatography**

Gas liquid chromatography (GLC) – Theory, principles and Instrumentation- Sample injection, Column types, Solid/Liquid Stationary phases, Column switching techniques, , carrier gas. Detectors -; Thermal conductivity, flame ionization and electron capture; Gas chromatographs and chemical analysis- few applications of GLC.

High Performance Liquid Chromatography (HPLC)-Theory, Principles and instrumentation-Optimization of column performance, Gradient elution-Derivatization, Mobile phase delivery system, sample injection, column separation and detectors.

### **Text Books**

1. H. R. Willard, L. L. Merrit, J. A. Dean, F. A. Settle: Instrumental Methods of Analysis (Van Nostrand Reinhold Co., New York), 6th edition.
2. R. D. Braun : Introduction to Instrumental Analysis (1987), (McGraw-Hill Book Company), New Delhi.

### **References Books**

1. G. D. Caristian and J. E. O'Reilly: Instrumental Analysis: (Allyn & Bacon Inc., New York, 2nd edition.
2. G. W. Ewing: Instrumental Methods of Chemical Analysis : (McGraw-Hill, New York), 5th edition.
3. Pecsok, Shield & Cairns Modern Methods of Chemical Analysis : (John Wiley), 2nd edition
4. Larry G. Hargis Analytical Chemistry : Principles and Techniques : (Prentice-Hall International edition).
5. L. R. Shyder & J. J. Kirkland : Introduction to Modern Liquid Chromatography : (John Wiley & Sons, New York).
6. M. Kohthoff & P. J. Elving : Treatise on Analytical Chemistry : (John Wiley & Sons, New York).
7. L. Meites Handbook of Analytical Chemistry : (McGraw-Hill, New York).
8. D. Van Nostrand Co Standard Methods of Chemical Analysis : Vol. I & II (6th edition),. Inc. (London).

### **Mapping with Programme Outcomes**

<b>Cos</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>
<b>CO1</b>	S	S	M	M	M
<b>CO2</b>	M	S	S	S	M
<b>CO3</b>	S	M	S	S	M
<b>CO4</b>	S	S	S	S	S
<b>CO5</b>	M	S	M	M	S

## SUPPORTIVE COURSES

### 18UPCHE1S01 MEDICINAL INORGANIC CHEMISTRY

Hours	L	T	P	C
72	4	0	0	4

#### Objectives

1. To understand the importance of inorganic compounds in medicinal chemistry

#### Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	To know about the metal deficiency and its toxicity, chelation therapy, crown ether complexes, product formations of different compounds and applications of complexes as drug	K1, K2
CO2	Understand the concepts of topical agents like Protectives, astringents, anti-infectives and its compounds and the Dental applications from dentifrices and anti-caries agents	K2
CO3	To learn the different groups of compounds focusing on acidifiers and antacids, adsorbents and related drugs, laxatives and some nutrients	K3
CO4	Understand the Physiological role of some elements, Electrolytes used for replacement therapy, acid-base therapy, combination therapy and dialysis fluids	K2, K3
CO5	To get basic idea about radioactivity, Hazards and precautions in various radioactive components and Miscellaneous Inorganic Pharmaceutical Agents	K1, K2

#### Unit-I Essential and Trace Elements in Biological Systems:

structure and functions, metal deficiency and disease; toxicity of mercury, cadmium, lead, beryllium, selenium and arsenic, chelation therapy: metals used for diagnosis and chemotherapy, crown ether complexes of Na<sup>+</sup> and K<sup>+</sup>; ATP and ADP.



## Co-ordination Compounds and Complexation:

Theoretical considerations and official products: Calcium disodium edetate, Disodium edetate, Dimercaprol & Penicillamine; Platinum complexes as anticancer drugs, Pt-DNA binding, complexes of gold, copper, zinc, mercury, arsenic and antimony as drugs.

### Unit-II Topical Agents

**Protectives:** Calamine, Talc, Zinc Oxide, Zinc Stearate, Titanium dioxide, Silicon Polymers and Dimethicone.

**Astringents:** Zinc sulphate, Alum.

**Anti-infectives:** Boric acid, Hydrogen peroxide, Iodine, Potassium permanganate, Chlorinated Lime.

### Dental Products

**Anti-caries Agents:** Role of Fluorides as anti-caries agents, Sodium fluoride\*.

**Dentifrices:** Calcium carbonate, dibasic calcium phosphate, Zinc chloride.

### Unit III Gastro-intestinal agents.

**Acidifiers and Antacids:** Dilute hydrochloric acid, sodium acid phosphate, sodium bicarbonate, aluminium hydroxide gel, dried aluminium hydroxide gel, magnesium oxide (Magnesia), magnesium hydroxide mixture, magnesium trisilicate.

**Adsorbents and related drugs:** Light kaolin, heavy kaolin, and activated charcoal.

**Laxatives:** Magnesium sulphate, sodium phosphate.

### Mineral Nutrients / Supplements

(a) **Haematinics** – Ferrous sulphate, ferrous fumarate, ferrous gluconate, ferric ammonium citrate, iron and dextrose injection.

(b) **Halogens:** Iodine, Iodides.

### Pharmaceutical aids:

(a) **Excipients:** Dicalcium phosphate, magnesium stearate, talc and calcium carbonate (Precipitated chalk).

(b) **Suspending agents:** Bentonite, colloidal silica.

(c) **Colorants:** Titanium oxide, Ferric oxide

## **Unit-IV Electrolytes:**

### **Major intra and extra cellular electrolytes:**

Physiological role of Chloride, Phosphate, Bicarbonate, Sodium, Potassium, Calcium and Magnesium; **Electrolytes used for replacement therapy:** Sodium chloride, Potassium chloride, Calcium chloride, Calcium lactate, Tribasic calcium phosphate; Physiological acid-base balance: Sodium dihydrogen phosphate, Sodium acetate, Sodium bicarbonate and their importance; **Electrolytes used in the acid-base therapy:** Sodium acetate, Potassium acetate, Sodium citrate, Potassium citrate, Sodium lactate, Ammonium chloride; **Electrolyte combination therapy:** Compound sodium chloride solution, Sodium chloride injection and Oral rehydration salt (ORS); **Dialysis fluids:** Haemodialysis fluids.

## **Unit-V Inorganic Radio-Pharmaceuticals:**

Radioactivity, Units of radioactivity, radiation dosimetry, Measurement of radioactivity, Hazards and precautions in handling of radiopharmaceuticals, storage, radio pharmaceutical preparations and standards of radioactive material iodine-131 (I131), Cobalt -58 (Co58). Radio opaque contrast medium-barium sulphate.

**Miscellaneous Inorganic Pharmaceutical Agents:** Inhalants, respiratory stimulants, expectorants and emetics, antidotes, tableting aids and suspending agents.

### **Text Books**

1. L.M. Artherden, Bentley and Driver's Textbook of Pharmaceutical Chemistry, 8<sup>th</sup> edition, Oxford University Press, New Delhi, 2003.
2. J.H. Block, E. Roche, T.O. Soine & C.O. Wilson, Inorganic Medicinal & Pharmaceutical Chemistry. 1<sup>st</sup> edition, Varghese publishing house, Mumbai, 1986.
3. K.S. Rao and C.V. Suresh, "Pharmaceutical Inorganic Chemistry", PharmaMed Press, 2011.
4. A.V. Kasture, S.G. Wadodkar, Pharmaceutical Chemistry-I, Nirali Prkashan, 25<sup>th</sup> edition, 2008.

5. N. Rajasekaran, Text Book of Pharmaceutical Inorganic Chemistry Theory and Practical, 2<sup>nd</sup> edition, Sun Publication, Chennai, 2005.
6. J. Ghosh, A Textbook of Pharmaceutical Chemistry, S.Chand, 3<sup>rd</sup> edition, 2003.

### Reference Books

1. Chatwal, Pharmaceutical Chemistry Inorganic. 3<sup>rd</sup> edition, Himalaya publishing house, Mumbai, 2007.
2. T.O.Soine and C.O.Wilson, Roger's Inorganic Pharmaceutical Chemistry, 4<sup>th</sup> edition, Lea & Febiger, Philadelphia, 1948.
3. G.L. Miessler, and D.A. Tarr, Inorganic Chemistry, Pearson Education, 2005.
4. S.J. Lippard and 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).

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

S- Strong; M-Medium

## 18UPCHE1S02 CONDUCTING POLYMERS

Hours	L	T	P	C
72	4	0	0	4

### Course Objective

1. To study the basic concepts of conducting polymers
2. To study the various synthesis methods of conducting polymers
3. To learn the different doping in polymers and catalytic properties

### Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	To know the basic concepts and chemical synthesis of conducting polymers	K2
CO2	To understand the electrochemical synthesis of various conducting polymers	K2, K3
CO3	To know the structural and synthesis route of specific conducting polymers	K2
CO4	To understand the electrochemical doping for the development of conducting polymers	K3
CO5	To understand the catalytic properties and the performance of conducting polymer	K2, K3

### UNIT – I Basic Concepts and Synthetic methods

Basics of conducting polymers - Organic - conjugated unsaturated hydrocarbons-

Chemical Synthesis of conducting polymers – Other synthetic methods

### UNIT – II Electrochemical Synthesis

Electrochemical synthesis of conducting polymers – monomers, electrolytic condition, electrodes and mechanism; Electrochemical synthesis of derivatives of poly pyrrole, polythiophene, polyazulene, polycarbazole, polyindole, polyaniline and polyphenylene.

### UNIT – III Semiconducting and Metallic Polymers

Structural basis for semiconducting and metallic polymers – introduction; Organic meta polymers - Synthetic route, isomers and electronic structure (polymers like polyacetylene, poly(p-phenylene), polypyrrole, polythiophene, etc.,).

## UNIT – IV Doping

Electrochemical doping; deadline to the development of conducting polymers; role of reduction and oxidation potential in doping; polyacetylene as electrode materials.

## UNIT – V Catalytic Conducting Polymers

Catalytic properties of conducting polymers; catalysis of electron donor-acceptor complexes; electrocatalysis by semiconducting polymers.

### Text Books

1. Terje A. Skotheim, Ronald L. Elsenbaumer, John R. Reynolds, **Handbook of Conducting Polymers**,  
**Second Edition, Marcel Dekkar, 1995.**
2. Hari Singh Nalwa (Edn), **Handbook of Organic Conductive Molecules and Polymers**,  
Four Volumes, Wiley, 1997.

### Reference Books

1. Jean-Pierre Farges, **Organic Conductors**, Marcel Dekkar, 1994
2. David B Cotts, Z Reyes, **Electrically Conductive Organic Polymers for Advanced Applications**, William Andrew Inc, 1987
3. Larry Rupprecht, **Conductive Polymers and Plastics**, William Andrew Inc, 1999.
4. Raymond B Seymour, **New Concepts in Polymer Science, Polymeric Composites**, VSP, 1990.
5. Wallace Gordon, Gordon G Wallace, Geoffrey M Spinks, **Conductive Electroactive Polymers**, CRC Press, 2002

### Mapping with Programme Outcomes

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

## 18UPCHE1S03 INDUSTRIAL AND AGRICULTURAL CHEMISTRY

Hours	L	T	P	C
72	4	0	0	4

### Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	To familiarize the purification of water and detailed study about the fuels and industrial gases in an industrial application	K1, K2
CO2	Understand the concepts of seeds development, classification and reclamation methods of soil and the Irrigation projects	K3
CO3	To learn the different techniques of soil and water conservation and to know about the different form of fertilizers with its effects of components	K1, K3
CO4	To get the basic idea about the Pesticides and Insecticides with its classification, uses and the safety measures	K2
CO5	To learn about the different compounds in Fungicides and in Herbicides.	K2

### UNIT-I Water, Fuels and Industrial Gases

Water - Treatment for domestic and industrial purpose; Fuels- Calorific value, requirement of a fuel, types, refining crude petroleum, octane number, anti-knocking compound; Industrial Gases-Manufacture and industrial applications of coal gas, producer gas, water gas, semi-water gas and LPG.

### UNIT-II Irrigation

Crop seasons - seeds, seed development organization, natural seeds project phase-III, new policy on seed development; Soil- soil reclamation, alkali soil, saline soils, methods for soil reclamation; Irrigation- Environmental degradation and irrigation projects.

### UNIT-III Conservation and Fertilizers

Soil and water conservation - plant protection; integrated pest management; Technology mission on oil seeds and pulses; Fertilizers; Effect of nitrogen, potassium and phosphorous on

plant growth. Manufacture and composition of urea, triple super phosphate, complex fertilizers, mixed fertilizers and biofertilizers; secondary nutrients and micro nutrients-their function in plants.

#### **UNIT-IV Pesticides and Insecticides**

Pesticides - classification, organic, inorganic and general; methods of application and toxicity; safety measures in using pesticides; Insecticides: plant products-nicotine and pyrethrin; Inorganic pesticides-borates; organic pesticides-DDT and BHC

#### **UNIT-V Fungicides and Herbicides**

Fungicides - sulfur compounds, copper compounds and Bordeaux mixture; Herbicides-Acaricides, Rodenticides, Attractants; Repellents; Preservation of seeds

#### **Text Books**

1. B.K.Sharma, **Industrial Chemistry**, Goel Publishing House, Meerut, 1992.
2. N.C. Brady, **The nature and properties of soils**, Eurasia Publishing House, New Delhi, 1977.
3. G.N. Pandey, **A Textbook of Chemical Technology, Vol. I & II**, Vikas Publishing House Pvt Ltd, 1997.

#### **Reference Books**

1. B.N.Chakrabarty, **Industrial Chemistry**, Oxford and IBH, New Delhi, 1981.
2. P.P. Singh and T.M. Joseph, **College Industrial Chemistry**, Himalaya Publishing House, Bombay, 1987.
3. V.S. Jones, **Fertilizers and soil fertility**, Prentice Hall of India, New Delhi, 1993.
4. D.E.H. Freer, **Chemistry of pesticides**, D.Van Nostrand Co, Reinhold, 1969.

#### **Mapping with Programme Outcomes**

<b>COs</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>
<b>CO1</b>	S	S	S	M	M
<b>CO2</b>	S	M	S	M	M
<b>CO3</b>	S	S	M	S	M
<b>CO4</b>	M	S	S	S	M
<b>CO5</b>	M	S	S	S	M

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

## 18UPCHE1S04 CHEMISTRY OF NATURAL PRODUCTS

Hours	L	T	P	C
72	4	0	0	4

### Objectives

1. To understand the classification of carbohydrates, terpenoids and carotenoids
2. To know the extraction and structural elucidation of steroids and alkaloids.

### Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	To introduce carbohydrates and polysaccharides	K2
CO2	Understand the classification of terpenoids	K4
CO3	To elucidate the structure of carotenoids	K4
CO4	To introduce the concepts of steroids	K5
CO5	To evaluate the extraction and classification of alkaloids	K5

## UNIT I Carbohydrates

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

## UNIT II Terpenoids

Classification; Isoprene rule; Monoterpenoids – structure elucidation and total synthesis of citral,  $\alpha$ -terpineol and  $\beta$ -pinene.

## UNIT III Carotenoids

Introduction – carotenes, xanthophylls, apocarotenoids, epipasic carotenoids and hypophasic carotenoids; Structure elucidation and total synthesis of  $\beta$ -carotene and vitamin – A.

## UNIT IV Steroids

Classification with examples; nomenclature of steroids; Structure of Cholesterol; Structure



of bile acids.

## UNIT V Alkaloids

Definition; Occurrence; Extraction of alkaloids; General properties; Classification of alkaloids; Structure elucidation and synthesis of piperine and nicotine.

### Text Books

1. I.L. Finar, **Organic Chemistry, Vol.II**, 5<sup>th</sup> Edn. Pearson Education Asia Pvt. Ltd. 2000
2. Atta-Ur-Rahman and M.I.Choudhary, **New Trends in Natural Product Chemistry**, Gordon & Breach Science Publishers, I Edn., 1998.
3. Pinder, **The Chemistry of Terpenes**, Chapman and Hall, 1960.
4. Bentley, **The Natural Pigments**, Interscience, 1960
5. Fisher and Fisher, **Steroids**, Reinhold, 1959.

### Reference Books

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

### 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

6. S- Strong; M-Medium

## 18UPCHE1S05 CHEMISTRY OF INDUSTRIAL PRODUCTS

Hours	L	T	P	C
72	4	0	0	4

### Objectives

1. To Know about the industrial products

### Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	Gain knowledge about the types and manufacture of glass	K2
CO2	Understand the types and quality of cement	K2, K3
CO3	Understand the classification and application of dyes	K2, K3, K4
CO4	Knowledge about types of pigments and paints	K1, K2, K3
CO5	Understand the classification of fertilizers	K1, K2

### UNIT I Glass

Glass - Introduction, raw material, steps involved for manufacture of glass, some special glasses, fused silica glasses, high silica, optical glasses, coloured glasses, opal glasses, safety glasses, bottle glasses.

### UNIT II Cement

Cement - Introduction, types of cement, types of Portland cement, raw materials, quantitative requirements, setting of cement, factors affecting quality of cement.

### UNIT III Dyes

Dyes - Sensation of colour, classification of dyes, acid dyes, basic dyes, direct dyes, mordant dyes, vat dyes, ingrain dyes, food dyes, application of dyes for cotton fabric.

### UNIT IV Pigments and Paints

Pigments - white pigment, white lead, blue pigment, ultramarine blue, red pigment, red lead, green pigments, Chrome green.

Paints - constitutions of paint, requirement of a good paint, paint failure.

### UNIT V Fertilizers

Fertilizers - Plant nutrients, need for fertilizers requirement, classification of fertilizers, natural fertilizers, artificial fertilizers, phosphate fertilizers.

### Text Books

1. B.K. Sharma, **Industrial Chemistry**, Goel Publishing House Pvt Ltd, 1999.
2. M.G. Arora and M. Singh, **Industrial Chemistry**, Anmol Publications, 1<sup>st</sup> edition, 1994.
3. G.N. Pandey, **A Textbook of Chemical Technology, Vol. I & II**, Vikas Publishing House Pvt Ltd, 1997.

### 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 and J. Rajaram, **Chemistry in Engineering & Technology, Vol. I & II**, Tata Mc Graw Hill, 1984.

### Mapping with Programme Outcomes

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

S- Strong; M-Medium.

## 18UPCHE1S06 FUNDAMENTALS OF ANALYTICAL CHEMISTRY

HOURS: L (3) + T(1)+P(0)=C (4)

MARKS : 75

### Course Objectives

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

### Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	Define the terms Mean, Median, Precision and Accuracy. Determine the errors calculation in chemical analysis using systematic errors and random errors. Get in depth knowledge in treatment of data through Basic statistical concept, Frequency distribution, Average and measure of dispersion. Study the significance of Gaussian distribution curves, confidence interval of mean, Criteria for rejection of data. Understand the regression and correlation, quality control and control chart.	K3
CO2	Understand the sample Preparation for analysis. Elucidate the effect of sampling uncertainties, gross sample and also study the determination of the size of the sample and analytical sample. Clarify the sampling techniques for solids for preparation of laboratory sample from gross sample, moisture in the sample and estimate the sampling of gases and liquids.	K2, K4
CO3	Get in depth knowledge in neutralization reactions based on the theory of acid-base titrations. Study the titration curves and feasibility of reactions. Clarify the Indicators theory and choice and calculation of pH during titrations. Elucidate the redox titrations and determine redox potentials, theory and feasibility of redox titrations, redox indicators, their choice and application. Understand the precipitation titrations theory and types, Volhard, Mohr and Fejan's methods.	K3
CO4	Investigate the Ore and cement analysis for the oxides,	K4

	<p>sulphides and carbonate ores with one example each. Enlighten the properties of cement, silicate and glass. Clarify the liquid fuels through study the Flash point, viscosity, carbon residue aniline point, pour point.</p>	
CO5	<p>Determine the Gaseous fuels properties through sampling procedure, ultimate and proximate analysis, specific volatile index, ash content, calorific value by bomb calorimeter, and Junker's calorimeter. Explain the methods of Water analysis and determine the values of BOD, COD and hardness of water.</p>	K3, K4

## References

### Text Books

1. D.A.Skoog and D.M.West, **Fundamentals of Analytical Chemistry**, Holt Rinehart and Winston Publications, IV Edn., 1982.
2. A.I Vogel, **Text Book of Quantitative Inorganic Analysis**, ELBS III Edn, 1987.
3. A.I Vogel, **Text Book of Quantitative Inorganic Analysis**, Pearson V Edn 2001.
4. J.G. Dick, **Analytical Chemistry**, McGraw Hill Publishers, 1974.
5. T.S.Ma and V. Horak, **Microscale-Manipulations**, John Wiley and Sons, 1976.

### Reference Books

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

### Journals and Documents: Nil

#### Mapping with Programme Outcomes

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

## 18UPCHE1S07 PHARMACEUTICAL CHEMISTRY

Hours	L	T	P	C
72	4	0	0	4

### Course Objective

1. To study the basic terms of pharmaceutical chemistry
2. To study the various types Antibiotics, Sulpha drugs and Vitamins
3. To learn the different types Analgesics and Antiseptics
4. To study the various types Anaesthetics, Tranquilisers and Antineoplastics
5. To learn the about the various types of Organic pharmaceutical aids

### Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	To know the basic terms used pharma chemistry	K2
CO2	To understand the preparation and used of drugs and vitamins	K2, K3
CO3	To know the structural and synthesis route of analgesics and antiseptics	K2
CO4	To understand the preparation and used Anaesthetics, Tranquilisers and Antineoplastics	K3
CO5	To understand the preservative methods and uses of Organic pharmaceutical aids	K2, K3

### UNIT I Introduction

Important terminologies - pharmaceuticals, drugs, pharmacodynamics, Pharmacokinetics, pharmacopoea, virus, bacteria, fungus, actinomycetes, metabolites, antimetabolites, LD50 and ED50; Therapeutic index- their use in selecting drugs; assay of drugs; Use of plaster of paris in bone – fracture;

### UNIT II Antibiotics, Sulpha drugs and Vitamins

Antibiotics-synthesis, assay and structure and uses of penicilline, chloramphenicol and tetracyclines. Sulphonamides- mechanism and action of sulpha drugs, preparation and uses of

sulphadiazine, sulphapyridine, sulphathiazole and sulphafurazole; Vitamins-classification as water soluble and liquid soluble vitamins, sources, deficiencies and assay of vitamins A, B<sub>1</sub>, B<sub>2</sub> and C

### **UNIT III Analgesics and Antiseptics**

Narcotic analgesics-isolation, pharmacological action and uses of morphine, heroin and codeine; Synthetic analgesics-pethidine and methadone; Antipyretic analgesics-synthesis and structure and action of methyl salicylate, aspirin, paracetamol and phenacetin; Antiseptics and disinfectants-phenol as disinfectant and phenol coefficient; dyes and organo mercurials and cationic surfactants

### **UNIT IV Anaesthetics, Tranquilisers and Antineoplastics**

Anaesthetics - classification as general, local and intravenous anaesthetics, chemistry of anaesthetic ether, nitrous oxide, halothane, chloroform, thiopental sodium methohexitone, cocaine and benzocaine; Alkaloids - detection of alkaloids, colour reagents; Isolation, colour reaction and SAR of quinine; Tranquilisers, hypnotics and sedatives; Antineoplastic and hypoglycemic agents - detection sugar and serum in urine; cause and control of diabetes; Oral hypoglycemic agents; causes and control of cancer; Preparation and uses of thiotepa and cyclophosphamide.

### **UNIT V Organic pharmaceutical aids**

Preservatives and antioxidants, colouring, flavouring and sweetening agents and ointment bases; Blood-blood groups, Rh factor, blood pressure normal, high and low; control of pressure; Causes and control of anaemia-antianaemic drugs, coagulants and anticoagulants; causes and control of AIDS.

#### **Text Books**

1. T.C. Daniels and E.C. Jorgensen, **Text book of organic medicinal and pharmaceutical chemistry**, J. B. Lippincott, Philadelphia, 1977.
2. Ashutosh Kar, **Medicinal Chemistry**, New Age International, 1996.

#### **Reference Books**

1. M. Gordon, **Psychopharmacological agents**, Academic press, New York, 1965.
2. J.M. Ritchie and P.J. Cohen, **The pharmacological basis of therapeutics**, 5<sup>th</sup> Edn., Macmillan, New York, 1975.

3. D.Lednicer and L.A. Mitscher, **Organic Chemistry of drug synthesis**, John Wiley & Sons, New York, 1959.
4. J.E. Hoover, **Remington's Pharmaceutical sciences**, 15<sup>th</sup> Edn. Mack Publ.Company, Easton, 1975.

#### 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.



## 18UPCHE1S08 APPLIED CATALYSIS

Hours	L	T	P	C
72	4	0	0	4

### Objectives

To understand the reaction rates and types of catalysis

CO Number	CO Statement	Knowledge Level
CO1	Knowledge on reaction rate and the influence of catalyst	K2, K3
CO2	Advantages and applications of homogeneous catalysis- acid base catalysis	K2, K3
CO3	Significance and product selectivity concept in heterogeneous catalysis	K1, K2, K3
CO4	Applications of photocatalysts	K2, K3
CO5	Reaction specificity and enzyme catalysis mechanism	K2, K3

### UNIT I Reaction Rates

Activation energy concepts - arrhenius theory, collision theory – biomolecular and unimolecular reactions, ARR theory, influence of  $\Delta S$ ,  $\Delta H$  and  $\Delta G$  on reaction rates with and without catalyst.

### UNIT II Homogeneous Catalysis

Concepts of acidity – Bronsted – Lewis acids. Concept of base – Brosted – Lewis bases. Acid base strength. Application of acid – base catalysis – alkylation, oxidation and reduction of organic molecules. Advantage and disadvantage of homogeneous catalysis.

### UNIT-III Heterogeneous Catalysis

Metal and metal oxide catalyst - Metal oxide supported catalyst, polymer supported catalyst. Solid acid and base catalyst – molecular sieves – neutral catalyst – alumino phosphate molecular sieves. Isomorphous substitution. High temperature reactions. Product selectivity concept – pore size, reactant ratio, time on stream, coke deposition and conversion.

### UNIT IV Photocatalysts

Light absorption, laws of photochemistry, quantum yield, semiconductor concept, photo chemical application of dye degradation, molecular sieves based photo chemical applications.

## UNIT V Enzyme Catalysts

Reaction specificity, enzyme catalysis mechanism – induced fit, lock and key. Coenzyme – mechanism. Factors influencing enzyme action – temperature, pH, enzyme concentration and substrate concentration. Michaelis – Menton theory and Lineweaver – Burk plot.

### Text Books

1. K.J. Laidler, **Chemical Kinetics**, III<sup>rd</sup> Edn., Harper and Row publisher, New York, 1987.
2. B.Viswanathan, **Catalysis: Principles and applications**, Narosa Publ., New Delhi, 2004.
3. V. Ramamurthy, **Photochemistry in organized and constrained media**, VCH Edn., New York, 1991.

### Reference Books

1. V. Murugesan, **Recent trends in catalysis**, Narosa publ., New Delhi, 2004.
2. K. Kalyanasundaram, **Photochemistry in microheterogenous systems**, Academic Press, New York, 1987.
3. Samuel H. Maron, **Principles of Physical Chemistry**, Mac Millan, Publisher, New York, 1972.
4. E. Conn and K.Stump, **Outlines of Biochemistry**, John Wiley and Sons, 1987.
5. Friedlich Liebau, **Structural Chemistry of Silicates**, Springer-Verlog, Berlin, 1985.

### 6. Mapping with Programme Outcomes

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

7. S- Strong; M-Medium.

## XIX Model Question Papers

(For the candidates admitted from 2018 onwards)

**M. Sc., DEGREE EXAMINATION**

**18UPCHE1C01 Stereochemistry and Reaction Mechanism**

Time: Three hours

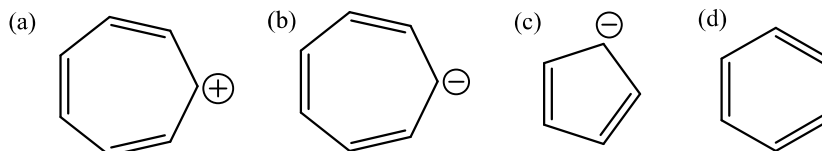
Maximum : 75 marks

### **SECTION A Answer all Questions (20 x 1 = 20)**

1. When 1,3-butadiene reacts with HCl, two products form: 3-chloro-1-butene and 1-chloro-2-butene. At low temperatures ( $-78^{\circ}\text{C}$ ), which of the following statements is correct?
  - (a) Thermodynamic control favors formation of 3-chloro-1-butene.
  - (b) Kinetic control favors formation of 3-chloro-1-butene.
  - (c) Thermodynamic control favors formation of 1-chloro-2-butene.
  - (d) Kinetic control favors formation of 1-chloro-2-butene.
2. In comparing kinetic control to thermodynamic control for the reaction of butadiene and HCl, which of the following statements represents kinetic control?
  - (a) The intermediate is more stable and the product is more stable.
  - (b) The intermediate is less stable and the product is more stable.
  - (c) The intermediate is more stable and the product is less stable.
  - (d) The intermediate is less stable and the product is less stable.
3. Which pair of isotopes is likely to result in the greatest isotope effect?
  - (a) Carbon -12 and Carbon-14.
  - (b) Carbon -13 and Carbon-14.
  - (c) Hydrogen and deuterium.
  - (d) Nitrogen – 14 and Nitrogen – 15
4. Number of valence electrons in a carbene is,
  - (a) two
  - (b) four
  - (c) six
  - (d) eight
5. Identify the correct statement which is related to aromatic hydrocarbon.
  - (a) It has only sigma bonds
  - (b) It has only pi bonds

- (c) It has a sigma and two pi bonds
- (d) It has a sigma and delocalized pi bond

6. Which of the following is not aromatic?



7. Ferrocene is,

- (a) An inclusion compound
- (b) A catenane
- (c) A sandwich compound
- (d) An annulene

8. Which statement below is incorrect?

- (a) Pyrimidine and pyrazine are isomers
- (b) In imidazole, each nitrogen atom contributes one electron to the pi system
- (c) 4-Methylimidazole and 5-Methylimidazole are tautomers
- (d) Pyrazine is a diazine

9. Which of the following compounds yield only one product on monobromination?

- (a) Neopentane
- (b) Toluene
- (c) Aniline
- (d) Phenol

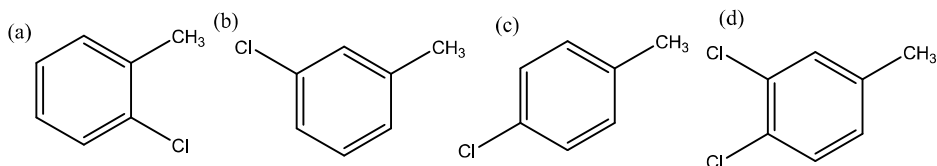
10. Correct order of leaving group ability is

- (a)  $I^- > Br^- > Cl^- > F^-$
- (b)  $F^- > Cl^- > Br^- > I^-$
- (c)  $I^- > Cl^- > Br^- > F^-$
- (d)  $F^- > Br^- > Cl^- > I^-$

11. Which of the following compounds will undergo nucleophilic substitution exclusively by  $S_N1$  mechanism?

- (a) Isopropyl chloride
- (b) Chlorobenzene
- (c) Ethyl Chloride
- (d) Benzyl Chloride

12. Which gives about 1:1 *p*- and *m*-methylanilines as the main products when treated with sodium amide in liquid ammonia??



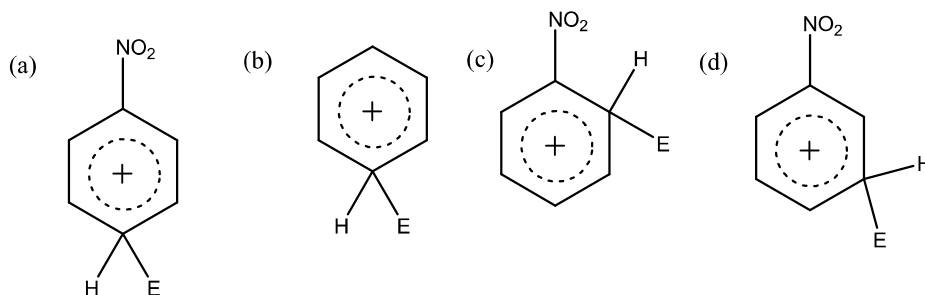
13. Nitration of toluene takes place at

- (a) o-position
- (b) m-position
- (c) p-position
- (d) Both o- and p-positions

14. Which among the following is a deactivating group

- (a) -Cl
- (b) -OR
- (c) -NH<sub>2</sub>
- (d) -NHR

15. The electrophile E<sup>+</sup> attacks the benzene ring to generate the intermediate  $\sigma$  complex. Of the following, which  $\sigma$  complex is of lowest energy?



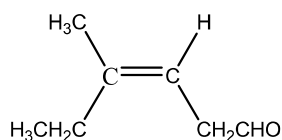
16. Which among the following compounds will not undergo Friedel-Craft's reaction easily?

- (a) Xylene
- (b) Nitrobenzene
- (c) Toluene
- (d) Cumene

17. Which of the following isomers of lactic acid is optically inactive?

- (a) ( $\pm$ )- lactic acid
- (b) (+)- Lactic acid
- (c) (-) – Lactic acid
- (d) All the above

18. The compound



- (a) has Z configuration
- (b) has E configuration
- (c) has R configuration
- (d) has S configuration

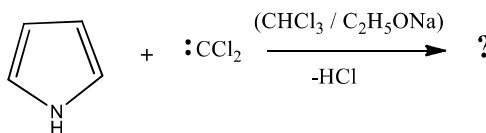
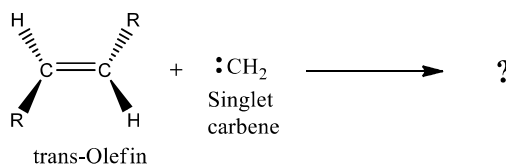
19. Ligands are \_\_\_\_\_ if they can interchange position by rotation around a simple axis

$C_n$  (where  $n$  is  $\infty > n > 1$ )

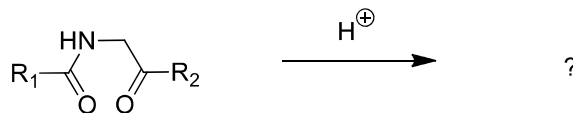
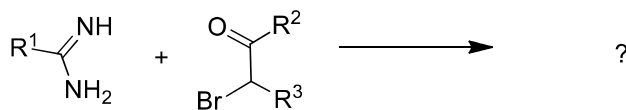
- (a) homotopic
  - (b) heterotopic
  - (c) enantiotopic
  - (d) All of the above
20. When the position of the ligand on the molecule are related in mirror image fashion, the ligands are called,
- (e) Enantiotopic
  - (f) homotopic
  - (g) diastereotopic
  - (h) none of the above

**SECTION-B      Answer any 3 Questions      (3 × 5 = 15 marks)**

21. a) Find the product:

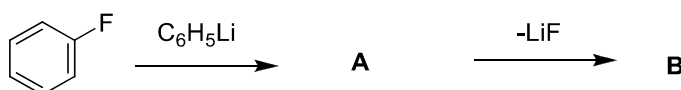


22. a) Predict the products

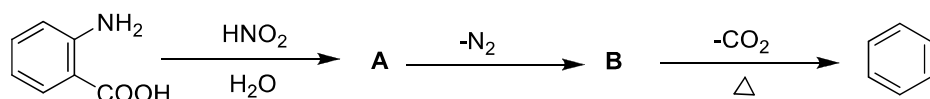


23. a) Complete the following reactions

i)

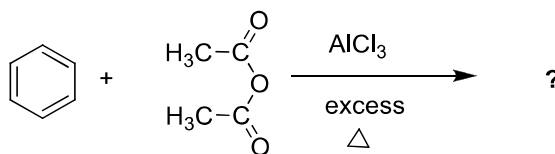


ii)

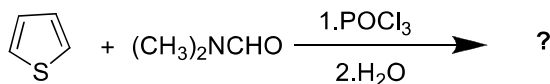


24. a) Give the product of following reactions

i)

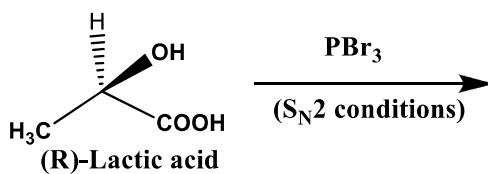


ii)

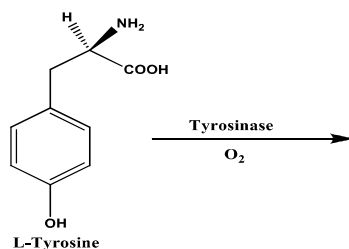


25. a) Solve the following reaction and give the short notes

i.



ii.



**SECTION-C Answer all Questions (5×8=40 marks)**

26. a) (i) What happens when hydrogen bromide reacts with 1,3-butadiene. Discuss the thermodynamic and kinetic control of the reaction. (4)

(ii) Derive Hammett equation (4)

**Or**

b) (i) Derive Taft equation (4)

(ii) Discuss the significance of reaction constant and substituent constant (4)

27. a) (i) Discuss the aromaticity in annulenes and ferrocenes (4)

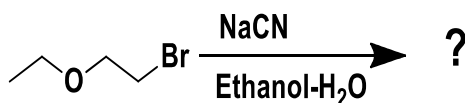
(ii) Give the synthesis of thiozole (4)

**Or**

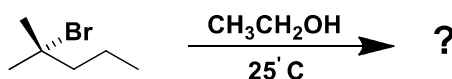
b) Discuss the synthesis of pyrimidines in detail (8)

28. a) Find out the reactions to be  $S_N1$  or  $S_N2$  with the products (8)

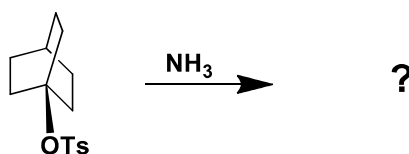
i)



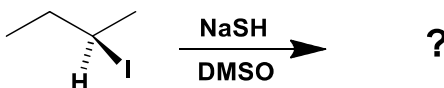
ii)



iii)



iv)



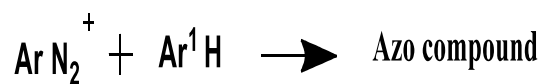
**Or**

b) Elucidate the mechanism for  $S_N1$  and  $S_N2$  (8)



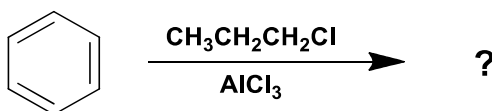
29. a)

i)



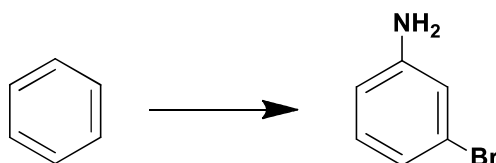
Discuss on the reaction with mechanism (4)

ii) Give the mechanism for alkylation reaction (4)

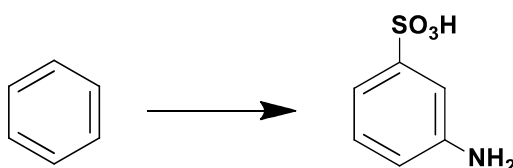


Or

b) i) Prepare a synthesis for the molecule with mechanism (4)



ii) (4)



30. a) Discuss the stereochemistry of biphenyls and allenes (8)

Or

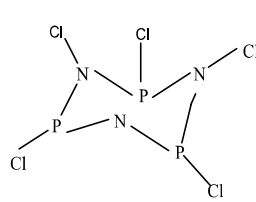
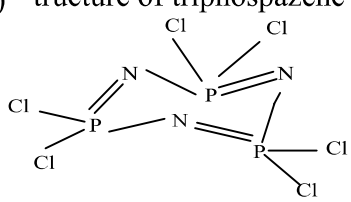
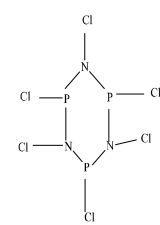
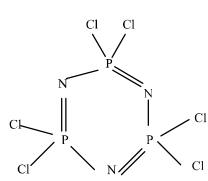
b) Brief enantiotopic and diastereotopic atoms and groups in organic molecules

(For the candidates admitted from 2015 onwards)

## SECTION A

[Answer all the Question]

20 x 1 = 20 Marks

- The molecule with highest number of lone pairs and has a linear shape based on VSEPR theory is
  - CO<sub>2</sub>
  - I<sub>3</sub><sup>-</sup>
  - NO<sub>2</sub><sup>-</sup>
  - NO<sub>2</sub><sup>+</sup>
- [XeO<sub>6</sub>]<sup>4+</sup> is octahedral whereas XeF<sub>6</sub> is a distorted one because,
  - Fluorine is more electronegative than oxygen
  - Xe has a lone pair in XeF<sub>6</sub>
  - XeF<sub>6</sub> is neutral whereas is [XeO<sub>6</sub>]<sup>4+</sup> anionic
  - [XeF<sub>6</sub>]<sup>+</sup> has more ionic character.
- The bond order of CN<sup>-</sup> is
  - 4
  - 3
  - 5
  - 6
- Apply Molecular orbital theory to determine which molecule is diamagnetic.
  - CO
  - B<sub>2</sub>
  - O<sub>2</sub>
  - None of the above (all are paramagnetic)
- The ring size and number of linked tetrahedral present in [Si<sub>6</sub>O<sub>18</sub>]<sup>12-</sup> are, respectively
  - 6 and 6
  - 12 and 6
  - 12 and 12
  - 6 and 12
- BaTi[Si<sub>3</sub>O<sub>9</sub>] is a class of
  - Ortho silicate
  - Cyclic silicate
  - chain silicate
  - sheet silicate
- BH<sub>3</sub>.CO is more stable than BF<sub>3</sub>.CO because
  - CO is a soft base and BH<sub>3</sub> and BF<sub>3</sub> are soft and hard acid respectively.
  - CO is a hard base and BH<sub>3</sub> and BF<sub>3</sub> are hard and soft acid respectively.
  - CO is a soft base and BH<sub>3</sub> and BF<sub>3</sub> are hard and soft acid respectively.
  - CO is a soft acid and BH<sub>3</sub> and BF<sub>3</sub> are soft and hard base respectively.
- structure of triphosphazene is
  - 
  - 
  - 
  - 
- Styx number for B<sub>4</sub>H<sub>10</sub> is
  - 4120
  - 4220
  - 4012
  - 3203
- Metal-Metal bond in metal cluster is
  - σ bond
  - π- bond
  - σ and π bond
  - 1 σ, 2 π and 1 delta bond
- How many metal-metal bonds in CO<sub>4</sub>CO<sub>16</sub>
  - 1
  - 2
  - 4
  - 6
- Structure of a carborane with formula, C<sub>2</sub>B<sub>4</sub>H<sub>8</sub> is formally derived from
  - Closo-borane
  - Nido-borane
  - Arachno-borane
  - Conjuncto-borane
- When Frenkel defect are created in an otherwise perfect ionic crystal, the density of the ionic crystal
  - Increases
  - Decreases



26. a) i) Explain the Born-Landé equation.  
 ii) Explain the Kapustinskii equation.  
 (Or)  
 b) i) Explain the MO diagrams of NO and NH<sub>3</sub> molecules.  
 ii) Define Radius ratio rule with an example. And problem
27. a) i) What are poly acids? How are they classified? Write note on heteropoly acids of W?  
 ii) Explain the structural features of silicates with example.  
 (Or)  
 b) Discuss the preparation, properties, structure and bonding of polyorganophosphazenes?
28. a) i) What are styx numbers? Rationalise the structure of B<sub>10</sub>H<sub>14</sub> on the basis of its styx number.  
 ii) What are closo-carboranes? Discuss the structure of closo-carborane formally related to C<sub>2</sub>B<sub>10</sub>H<sub>12</sub>.  
 (Or)  
 b) i) Explain the occurrence of metal-metal bond in metal complex.  
 ii) Explain the Zintl ions and Chevrel phases.
29. a) i) Explain non-stoichiometric compounds with an example.  
 ii) What are spinels? Discuss the application of spinel structures using CFSE.  
 (Or)  
 b) Explain the preparative methods:  
 i) Chemical precursor  
 ii) Hydrothermal and template synthesis
30. a) i) What is nuclear cross section? Bring out its significance.  
 ii) Give an account on the shell model of the nucleus.  
 (Or)  
 b) i) Give a brief account on G.M counter.  
 ii) Explain the uses of radio isotopes in medicine and industry.

(For the candidates admitted from 2018 onwards)

**Paper code: 18UPCHE1C08**

**COORDINATION CHEMISTRY**

**SECTION A**

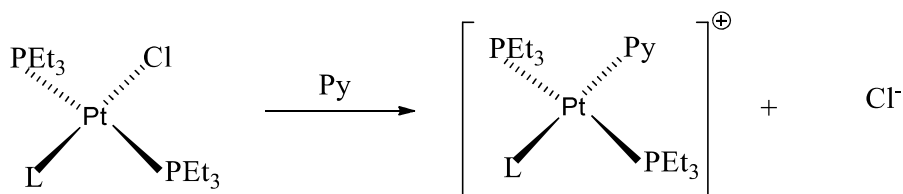
**[Answer all the Question]**

**20 x 1= 20 Marks**

- Which one of the following complexes obey EAN rule.  
(a)  $[\text{Fe}(\text{F})_6]^{3-}$  (b)  $\text{Ni}(\text{CO})_4$  (c)  $[\text{CoF}_6]^{3-}$  (d)  $[\text{Ni}(\text{CN})_4]^{2-}$
- John teller distortion of  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  acts to  
(a) Raise symmetry (b) remove an electronic degeneracy  
(c) Causes loss of  $\text{H}_2\text{O}$  ligand (d) Promote a d- electron to an anti-bonding molecular orbital.
- The crystal field stabilization energy (CFSE) value for  $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$  that has an absorption maximum at 492 nm is  
(a)  $20325 \text{ cm}^{-1}$  (b)  $12915 \text{ cm}^{-1}$  (c)  $10162 \text{ cm}^{-1}$  (d)  $8130 \text{ cm}^{-1}$
- For the complex ion  $[\text{Cu}(\text{NH}_3)_6]^{2+}$ , the coordination geometry will be  
(a) Octahedral (b) Tetragonally distorted octahedral  
(c) Trigonal prismatic (d) Trigonal antiprismatic
- Write the ground state term symbol for  $\text{V}^{3+}$   
(a)  ${}^3\text{F}_2$  (b)  ${}^3\text{F}_4$  (c)  ${}^3\text{F}_6$  (d)  ${}^3\text{F}_3$
- Orgal diagram is used for  
(a) Low spin complexes (b) High spin complexes  
(c) Both low and high spin complexes (d) All the above
- Calculate the spin only magnetic moment of  $[\text{Fe}(\text{F})_6]^{3-}$  is  
(a) 4.87 (b) 1.73 (c) 2.84 (d) 3.97
- How many micro state possible for  $\text{P}^2$  configuration  
(a) 10 (b) 15 (c) 20 (d) 5
- Which of the following ligand is symmetrical poly dentate ligand?  
(a)  $\text{nta}^{3-}$  (b)  $\text{P}^n$  (c)  $\text{ac at}^{1-}$  (d)  $\text{gly}^{1-}$
- Which of the following complexes does not show geometrical isomerism?  
(a)  $[\text{Co}(\text{CO})_3(\text{en})_2]^+$  (b)  $[\text{Cr}(\text{en})_2(\text{NCS})_2]^+$   
(c)  $[\text{CoCl}(\text{en})_2(\text{NO}_2)]^+$  (d)  $\text{CrCl}_2(\text{en})(\text{NH}_3)_2^+$
- Which of the following have chiral center  
(a)  $\text{Pn}$  (b)  $\text{gly}^{1-}$  (c)  $\text{en}$  (d)  $\text{tn}$
- The ligand system present in vitamin  $\text{B}_{12}$  is

- (a) Porphyrin      b) Corrin      (c) Phthalocyanine      d) Crown ether.

13. The rates of substitution for the following reaction vary with L in the order.



- (a)  $\text{CH}_3^- > \text{Cl}^- > \text{ph}^- > \text{H}^-$  (b)  $\text{Cl}^- > \text{ph}^- > \text{H}^- > \text{CH}_3^-$  (c)  $\text{ph}^- > \text{CH}_3^- > \text{H}^- > \text{Cl}^-$  (d)  $\text{H}^- > \text{CH}_3^- > \text{ph}^- > \text{Cl}^-$

14. Identify X in the reaction  $[\text{Pt}(\text{NH}_3)_4]^{2+} + 2\text{HCl} \longrightarrow \text{X}$ .

- (a) Cis  $[\text{PtCl}_2(\text{NH}_3)_2]$       (b) Trans  $[\text{PtCl}_2(\text{NH}_3)_2]$   
 (c)  $[\text{PtCl}(\text{NH}_3)_3]$       (d)  $[\text{PtCl}_3(\text{NH}_3)]$

15. In an inner-sphere electron transfer reaction which of the following ligands could not act as bridging ligand.

- (a) 1, 10-phenanthroline      (b) 4, 4'-bip      (c) Pyrazine  
 (d) bis(4-pyridyl) methane

16. Which statement best describes the electronic spectra of lanthanides

- (a) Absorption due to 4f-4f transitions are, in theory, forbidden, but nonetheless give rise to intense absorptions.  
 (b) Absorption due to 4f-4f transitions are sharp; those assigned to 4f-5d transitions are broad  
 (c) Absorption due to 4f-4f transitions are broad; those assigned to 4f-5d transitions are sharp  
 (d) when an  $\text{Ln}^{3+}$  ion forms a complex, absorptions due to 4f-4f transitions undergo significant shifts, the magnitude depending on the ligands.

17. Which of the following ions has the least tendency towards complexes formation?

- (a)  $\text{Lu}^{3+}$       (b)  $\text{La}^{3+}$       (c)  $\text{Eu}^{3+}$       (d)  $\text{Mo}^{3+}$

18. Which of the following characteristics is not the point of resemblance between lanthanoids and actinoids?

- (a) Reducing property      (b) Oxidation state of +III  
 (c) Trends of ionic radii for  $\text{M}^{3+}$  ions      (d) Tendency towards complex formation

19. The magnetic moment of  $\text{Am}^{5+}$  ( $Z=95$ )

- (a)  $\sqrt{24}\text{BM}$       (b)  $\sqrt{35}\text{BM}$       (c)  $\sqrt{15}\text{BM}$       (d)  $\sqrt{3}\text{BM}$

20. Uranium can be obtained by the electrolysis of

- (a)  $\text{UF}_6$       (b)  $\text{UF}_4$       (c)  $\text{UCl}_6$       (d)  $\text{UI}_6$

**SECTION-B****[Answer any three of the following questions]****3x5=15 Marks**

21. Predict the formula for the following assuming that they obey EAN rule.
- |                      |                       |
|----------------------|-----------------------|
| 1) Nickel Carbonyl   | 2) Iron Carbonyl      |
| 2) Chromium Carbonyl | 4) Ruthenium Carbonyl |
22. What is the ground state term for  $d^3$ ,  $d^5$  and  $d^6$  ?
23. Explain the thermodynamic aspects of complex formation.
24. Electron transfer between  $[\text{Fe}(\text{CN})_6]^{3-}$  and  $[\text{Fe}(\text{CN})_6]^{4-}$  is much faster than between  $[\text{Co}(\text{NH}_3)_6]^{3+}$  and  $[\text{Co}(\text{NH}_3)_6]^{2+}$ .
25. Compare the basic nature of the hydroxides of lanthanides.
- ii) Calculate the magnetic moments of  $\text{Pm}^{3+}$ .

**SECTION-C****[Answer all questions]****5x8=40Marks**

- (a) i) Discuss the splitting of d orbitals in tetrahedral complexes.  
ii) Explain the factors which affect the magnitude of crystal field splitting.  
(Or)
- (b) i) Draw the VB diagram and indicate the hybridization and shape you would expect for each of the following:  
1.  $[\text{Cr}(\text{NH}_3)_6]^{3+}$                       2.  $[\text{Ni}(\text{CN})_4]^{2-}$   
ii) Explain the structure of  $[\text{Co}(\text{NH}_3)_6]^{3+}$  on the basis of MOT.
26. (a) On the basis of Orgel diagram, given the expected electronic transition of  $\text{V}^{3+}$ .  
(Or)
- (b) i) What are the important selection rule for the electronic spectra of coordination compounds?  
ii) Explain the magnetic properties of coordination compounds.
27. (a) Explain the polarographic method for the determination of stability constants of complexes.  
(Or)
- (b) Write a note on  
i) porphyrins.                      ii) Crown ethers.
28. (a) i) Write a note on the energy profile of a reaction.  
ii) Explain  $\text{S}_{\text{N}}1\text{CB}$  mechanism with an example.  
(Or)
- (b) i) Discuss the mechanism of outer sphere reactions of metal complexes.  
ii) Explain any one application of trans effect.
29. (a) Explain the structure and bonding in highly coordinated lanthanide and actinides complexes.  
(Or)
- (b) i) Discuss briefly the magnetic behavior and color of tripositive lanthanide ions. ii) How is Uranium extracted from pitch blende.

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(For the candidates admitted from 2018 onwards)



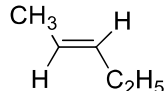
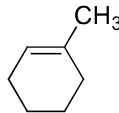
**Paper code: 18UPCHE1C13**

**ORGANOMETALLIC AND BIOINORGANIC CHEMISTRY**

**SECTION A**

**[Answer all the Questions]**

**20 x 1 = 20 Marks**

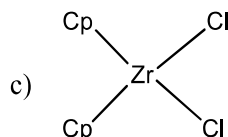
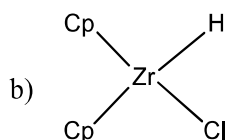
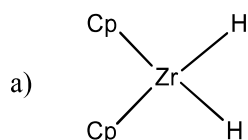
- Mn(CO)<sub>5</sub> is isolobal with  
(a) CH<sub>4</sub>      (b) CH<sub>3</sub>      (c) CH<sub>2</sub>      (d) CH
- Among the following in order of their increasing carbonyl stretching frequency.
  - [Fe(CO)<sub>4</sub>]<sup>2-</sup>,      1815 cm<sup>-1</sup>
  - [Fe(CO)<sub>6</sub>]<sup>2+</sup>,      2204 cm<sup>-1</sup>
  - [Fe(CO)<sub>5</sub>],      2030 cm<sup>-1</sup>1>2>3    (b) 3>2>1    (c) 3>1>2    (d) 2>3>1
- Which among the following complexes will not undergo O.A reaction with CH<sub>3</sub>I?  
(a) Ir(pph<sub>3</sub>)<sub>2</sub> COCl    (b) [RhL<sub>2</sub>(CO)<sub>2</sub>]<sup>-</sup>    (c) CP<sub>2</sub> Ti   
(d) CPRh(CO)<sub>2</sub>
- Fischer carbene is  
(a) Singlet and electrophilic      (b) Triplet and electrophilic  
(c) Singlet and nucleophilic      (d) Triplet and nucleophilic
- In the following three alkenes 1, 2 and 3, the rate of hydrogenation using Wilkinson's catalyst at 25° C vary in the order.  
              
1      2      3  
(a) 1>3>2    (b) 1>2>3    (c) 2>1>3    (d) 2>3>1
- Cobalt Catalyst used in Wacker process.  
(a) CuCl<sub>2</sub>    (b) CuCl    (c) PdCl<sub>2</sub>    (d) PdCl<sub>4</sub>
- The incorrect statement about Zeise's salt is  
(a) Zeise's salt is diamagnetic  
(b) The oxidation state of Pt in Zeise's salt is +2  
(c) All the Pt-Cl bond lengths in Zeise's salt are equal  
(d) C-C bond length of ethylene moiety in Zeise's salt is longer than that of free ethylene molecule



8. An efficient catalyst for hydrogenation of alkenes is  $[\text{Rh}(\text{pph}_3)_3\text{Cl}]$ . However  $[\text{Ir}(\text{pph}_3)_3\text{Cl}]$  does not.

- (a)  $\text{pph}_3$  binds stronger to Ir than to Rh
- (b) Cl binds stronger to Ir than to Rh
- (c)  $\text{pph}_3$  binds stronger to Rh than to Ir
- (d) Cl binds stronger to Rh than to Ir

9. Schwart 's reagent is



d) None of these

10. The  $^1\text{H}$  NMR spectrum of ferrocene gives

- (a) 5 signal
- (b) 1 signal
- (c) 2 signal
- (d) 4 signal

11. Dibenze Chromium is

- (a) Diamagnetic
- (b) Paramagnetic
- (c) Organometallic compound
- (d) 18 electron complexes

12. The hapticity of allyl cation is a

- (a) Mono hapto
- (b) Tri hapto
- (b) Mono hapto and tri hapto
- (d) Mono hapto (or) Tri hapto

13. Among the given PH values, the  $\text{O}_2$  binding efficiency of haemoglobin is maximum at

- (a) 6.8
- (b) 7.0
- (c) 7.2
- (d) 7.4

14.  $\text{Mg}^{2+}$  is preferred in photo synthesis chlorophyll 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

15. The metal ion present in vitamin  $\text{B}_{12}$  is

- (a)  $\text{Co}^{2+}$
- (b)  $\text{Co}^{3+}$
- (c)  $\text{Co}^{+1}$
- (d)  $\text{Mg}^{+2}$

16. What is role of calcium in biological process?

- (a) Bone formation
- (b) regulate blood circulation
- (c) to relax nervous system
- (d) immune function

17. The function of MRI reagent in biological system

(a) To remove excess of metal ion in the body.

(b) to decreases the metal in the body

(c) MRI reagent its is biocomportable

(d) MRI reagent introduce side effect

18. Cis platin is a anti cancer drug because of

(a) No carbon atom (b) limited solubility (c) Toxic in heath

(d) All the above

19. Patients suffering from Wilson's disease have

(a) low level of Cu-Zn superoxide dismutase

(b) high level of Cu-Zn superoxide dismutase

(c) low level of copper storage protein, ceruloplasmin.

(d) high level of copper storage protein, ceruloplasmin.

20. Cobalt-57 is used to treated as

(a) Nausea (b) Dizziness (c) Pernicious anemia (d) Diarrhoea

**SECTION-B Answer any three of the following questions. 3 x 5=15 Marks**

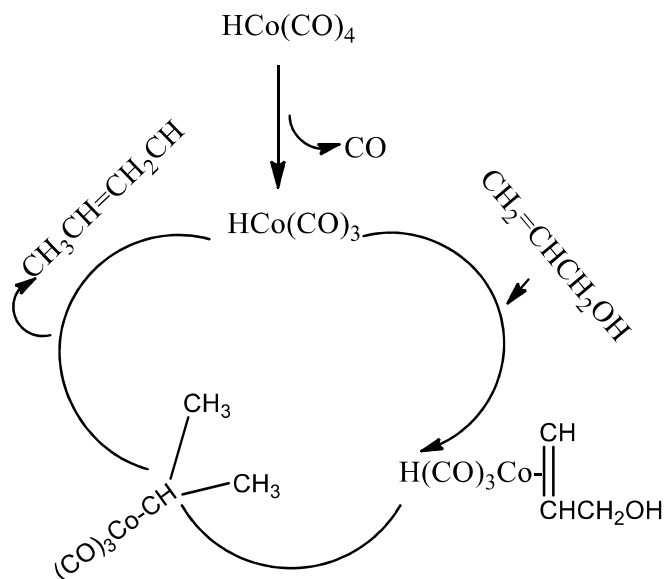
21. A compound (A) having composition  $[\text{Fe C}_9\text{H}_8\text{O}_3]$  shows one signal at 2.5 ppm and one around 5 ppm, in  $^1\text{H-NMR}$  spectrum. IR spectrum of this compound shows 2 bonds around 1900 and 1680  $\text{cm}^{-1}$ . The compound follows 18 electron rule of the following statements' regarding (A) the correct one is / are

(a) It has  $\square\square\square\text{CP}$  group (b) It has terminal CO group

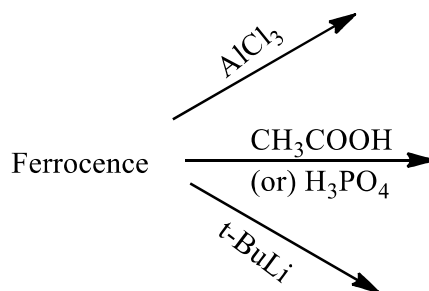
(c) It has  $\text{CH}_3$  ligand (d) It has Fe-H bond

(1) a and b (2) c (3) a and c (4) b and c

22. Give the description of what is happening in each step in the following figure:



23.



24. Give the product of reaction of Hemoglobin

- i)  $\text{CO}$                       (ii)  $\text{O}_2$                       (iii)  $\text{CN}$

25. (a) Explain the effect of deficiency of Fe on health and suggest its treatment.

### SECTION-C

[Answer the following questions]

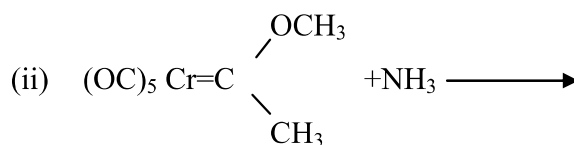
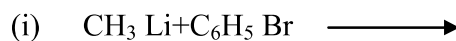
5x8=40 Marks

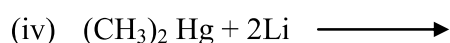
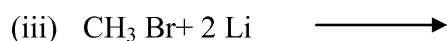
26. (a) i) Discuss the preparation, properties, structure and bonding in metal nitrosyls.

ii) What are the synthetic uses of carboxylate ions

(OR)

(b) Reaction





27. (a) i) Explain the Ziegler-Natta catalyst.

ii) What are Hydro-silylation reactions. Give its synthetic use.

(OR)

(b) i) Explain the role of Wilkinson's catalysts in hydrogenation reaction

ii) What is the role of Co-catalyst used in the weaker process?

28. (a) Discuss the preparation, properties, bonding and structure of allyl complexes.

(OR)

(b) i) Ferrocene cation is blue in colour. Explain.

ii) How are bent-sandwiched complexes prepared? Give its uses

29. (a) How is the role of haemoglobin as an oxygen carrier helped by

i) Co-operativity of the four heme groups in the molecule.

ii) Bohr Effect.

(OR)

(b) i) What are metalloenzymes?

ii) Discuss the structure and function of Vitamin-B<sub>12</sub>.

30. (a) (i) What are the major side effects of Cis-platin as anticancer drugs? Suggest the possible way to mitigate these side effects.

(ii) Give two important toxic effects of mercury.

(OR)

(b) i) Metabolic disorder produces Wilson's disease-explain.

ii) Write and discuss the drug action of Li-therapy used in psychiatric mind disorder

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(For the candidates admitted from 2018 onwards)

**M.Sc., DEGREE EXAMINATION**

**18UPCHE1C03 – Group theory and Thermodynamics**

**PART-A (Answer ALL questions)**

**20 x 1 = 20 marks**

- The point group symmetry of the molecule  $\text{CH}_2\text{Cl}_2$  is  
a).  $C_{2h}$  .                      b)  $C_{2v}$  .                      c)  $D_{2h}$                               d)  $D_{2d}$
- The point group symmetries of isosceles and equilateral triangles respectively are  
a).  $C_{3v}$  and  $D_{2d}$               b).  $D_{3h}$  and  $D_{2d}$               c).  $D_{3h}$  and  $C_{2v}$               d).  $C_{3v}$  and  $C_{2v}$
- The number of faces and edges in  $\text{IF}_7$  polyhedron are, respectively  
a). 15 and 15                  b). 10 and 15                  c). 10 and 10                  d). 15 and 10
- The interplanar distance of (111) planes in fcc lattice is  
a).  $a/\sqrt{6}$                       b)  $a/\sqrt{8}$                       c).  $a/\sqrt{3}$                       d).  $a/\sqrt{12}$
- Criteria for reversible process in terms of free energy change is  
a)  $dG < 0$                       b)  $dG > 0$                       c)  $dG = 0$                       d) All
- A real gas approximates to ideal behavior when  
a).  $f/P = 1$  when P approaches zero              b)  $f/P = 1$  when P approaches infinity  
c).  $f/P = 0$  when P approaches zero              d).  $f/P = 0$  when P approaches infinity
- If the particles are indistinguishable and any number of particles can occupy a given energy level, then they are  
a) Maxwellions              b) Bosons                      c) Fermions                      d) Boltzons
- The molar heat capacity of an ideal monoatomic gas is  
a)  $1/2 R$                       b)  $3/2 R$                       c)  $5/2 R$                       d)  $7/2 R$
- Kinetic gas equation is  
a)  $(1/2)mNc^2$                   b)  $(3/2)mNc^2$                   c)  $(2/3)mNc^2$                   d)  $(1/3)mNc^2$
- The process of separating colloidal substances from true solution with membrane is  
a) osmosis                      b) phoresis                      c) dialysis                      d) filtration
- Which of the following does not contain a  $C_3$  axis?  
a)  $\text{POCl}_3$     b)  $[\text{NH}_4]^+$               c)  $[\text{H}_3\text{O}]^+$               d)  $\text{ClF}_3$
- Which statement is true about the change in symmetry on going from  $\text{BF}_3$  to  $[\text{BF}_4]^-$ ?  
a) The point group changes from  $D_{3h}$  to  $T_d$               b) The point group changes from  $C_{3v}$  to  $T_d$   
a) The point group changes from  $D_{3h}$  to  $D_{4h}$               d) The point group changes from  $D_{3h}$  to  $C_{3v}$
- Which of the following cannot be obtained from an X-ray crystallography study?

- a) A bond angle Si-O-Si in a mineral. b) The absolute configuration of a chiral natural product.  
 c) The degree of folding of a  $Zn_2Cl_2$  four-membered ring.  
 d) The vibration frequency of a carbonyl group.
14. 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
15. An ideal gas is composed of particles of mass M in thermal equilibrium at a temperature T in one container. Another container contains ideal gas particles of mass 2M at a temperature 2T. The correct statement about the two gases is:  
 a) Average kinetic energy and average speed will be same in the two cases.  
 b) Both the averages will be doubled in the second case.  
 c) Only the average kinetic energy will be doubled in the second case.  
 d) Only the average speed will be doubled in the second case.
16. What do we get on equating the first and second TdS equations?  
 a)  $C_p - C_v = T \left( \frac{\partial T}{\partial p} \right) \left( \frac{\partial V}{\partial T} \right)$   
 b)  $C_p - C_v = T \left( \frac{\partial p}{\partial T} \right) \left( \frac{\partial V}{\partial T} \right)$   
 c)  $C_p + C_v = T \left( \frac{\partial p}{\partial T} \right) \left( \frac{\partial V}{\partial T} \right)$   
 d) none of the mentioned
17. Molecules of a dilute gas are identical, distinguishable particles which obey \_\_\_\_\_ statistics.  
 a) Maxwell-Boltzmann      b) Bose-Einstein      c) Fermi-Dirac      d) Rayleigh-Jeans.
18. Select the incorrect statement from the following options.  
 a) In the micelle formation, the water soluble heads are directed towards the centre.  
 b) In the micelle formation, the water soluble heads are on the surface in contact with the water  
 c) In the micelle formation, the water insoluble tails are directed towards the centre.  
 d) None of the mentioned
19. The transition of ions to micelle is  
 a) Reversible      b) Irreversible      c) None of the mentioned      d) All of the mentioned
20. In Bragg's equation  $[n\lambda = 2.d.\sin\theta]$ ,  $\theta$  is the angle between:  
 a) specimen surface and incident rays      b) normal to specimen surface and incident rays  
 c) parallel lattice surfaces d distance apart and incident rays  
 d) Normal to parallel lattice surfaces d distance apart and incident rays

**PART-B (Answer Any Three questions) 3 x 5 = 15 marks**

21. (a) Write the matrix representations of  $C_2$ ,  $\sigma_v$  and  $i$  operations
22. (a) The parameters of an orthorhombic unit cell are  $a, b, c$  are 50, 100 and 150 pm respectively. Calculate the spacing between the (123) planes.
23. Calculate the free energy change accompanying the compression of 1 mole of gas at  $57^\circ\text{C}$  from 25-200 atm. The fugacities at pressure 25 and 200 atm are 23 and 91 atm.
24. (a) Calculate the rotational partition function of fluorine at  $25^\circ\text{C}$ .  $I = 32.5 \times 10^{-47} \text{kgm}^2$ .
25. (a) What is CMC? What are the factors affecting CMC?

**PART-C (Answer ALL questions) 5 x 8= 40 marks**

26. (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?
27. (a) How will you determine the structure of a crystal by XRD?  
(Or)  
(b) Write notes on neutron diffraction
- 28.(a) For a van der Waals gas, express the fugacity as a function of  $V, T, R$  and van der Waals constant.  
(Or)  
(b) Explain with a phase diagram of a three component solid-liquid system
29. (a) Calculate the contribution of the two quantum energy states of 0 and  $E$  and degeneracies  $g_1$  and  $g_2$  to the heat capacity of the gas at constant volume  
(Or)  
(ii) Discuss the Fermi-Dirac statistics and derive Fermi-Dirac equation
30. (a) Discuss the electrical properties of colloids  
(Or)  
(b) Write notes on surfactants.

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**PART-A (Answer ALL questions)**

**20 x1 = 20 marks**

1. To calculate the mean value of 33.01, 55.04, 22.05, 26.04, 58.45, where  $\bar{X}=?$   
(A) 38.91(B) 37.5(C) 37(D) 38.5
2. The shape of normal distribution curve is:  
(A) Flat (B) Circular(C) Bell shaped (D) Spiked
3. Random errors also called as:  
(A) Methodic error (B) Gross error (C) Intermediate error (D) Determinate error
4. 0.169, 0.177, 0.181, 0.181 0.182, 0.183, 0.184, 0.186, 0.187, 0.189 the outlier is: 0.169, calculate the Q =?  
(A) 0.401 (B) 0.300(C) 0.400 (D)0.308
5. What effect does increase the sample size have upon the sampling error  
(A) It reduces the sampling error (B) It increase the sampling error  
(C) It has no effect on the sampling error (D) none of the above error
6. The term 'data processing error' refers to  
(A) Activities or events related to the sampling process  
(B) Faulty techniques of coding and managing data  
(C) Problems with the implementation of the research process  
(D) The unavoidable discrepancy between the sample and the population
7. A sampling frame is:  
(A) A summary of the various stages involved in designing a survey  
(B) An outline view of all the main clusters of units in a sample  
(C) A list of all the units in the population from which a sample will be selected  
(D) A wooden frame used to display tables of random numbers
8. Which solute would provide the sharper end point in a titration with 0.10 M HCl  
(A) 0.10M NaOCl (B) 0.10 M  $\text{NH}_3$  (C) 0.10  $\text{CH}_3\text{NH}_2$  (D) 0.10M NaCN.
9. In the titration of weak acid with strong base, the shape of the curve, the pH at the equivalence point and the suitable indicator depend on  
(A) Concentration of weak acid (B) Concentration of strong base (C)  $K_a$  of weak acid  
(D) All of the above.
10. Sodium benzoate can be determined by  
(A) Back titration (B) Biphasic titration (C) Displacement titration  
(D) Non aqueous titration



11. The following are buffer solutions except  
(A)  $\text{CH}_3\text{COOH}$  &  $\text{CH}_3\text{COONa}$  (B)  $\text{HCOOH}$  &  $\text{HCOONa}$  (C)  $\text{NH}_4\text{OH}$  &  $\text{NH}_4\text{Cl}^-$   
(D)  $\text{HCl}$  &  $\text{NH}_4\text{Cl}$ .
12. If 25 ml of 0.1M solution of HCL was diluted to 500ML, what is the new concentration of the HCL solution  
(A) 0.005M (B) 200M (C) 0.05M (D) 20M
13. When  $[\text{EDTA}]^{4-}$  coordinates to a metal ion,  $\text{M}^{2+}$ , to give  $[\text{M}(\text{EDTA})]^{2-}$ , the number of chelate rings formed is  
(A) 4 (B) 6 (C) 7 (D) 5
14. Which one of the following is a monodendate ligand  
(A)  $\text{CN}^-$  (B) EDTA (C)  $\text{C}_2\text{O}_4^{2-}$  (D)  $\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2$
15. Sketch what the photometric titration curves will look for the following scenarios  
(A) The unknown (beaker) absorbs light at the wave length, but the reagent (burette) and product do not  
(B) The reagent absorb the light, but neither their unknown nor product do  
(C) Both the unknown and the reagent absorb light, but not the product  
(D) Both the unknown and the product absorb, but not add reactant.
16. In column chromatography, the method of separation are  
(A) Adsorption (B) Ion-exchange (C) Partition (D) All of the above
17. The maximum adsorptive power is of  
(A)  $\text{MgO}$  (B)  $\text{CaCO}_3$  (C) Silica gel (D)  $\text{Al}_2\text{O}_3$
18. The factors considered during the separation of compound are  
(A) Judicious Selection of solvent and adsorbent (B) Concentration and temperature  
(C) Both a and b (D) None
19. The major cause of tailing and memory effects in adsorption chromatography is  
(A) Insufficient deactivation of the silica or alumina surface of the column  
(B) Desorption (C) Dipole interaction (D) Differential difference
20. 10% Dichloromethane in hexane as mobile phase can be substituted by  
(A) A volume ratio of 33:67 for isopropyl chloride/ hexane mixture  
(B) A ratio of 9:91 for diethyl ether/ hexane mixture (C) Pure  $\text{CS}_2$   
(D) All can be substituted

**PART-B (Answer any THREE questions)**

**5 x 3 = 15 marks**

21. Calculate the mean and the standard deviations for the following set of data were obtained from the replicate determination of the lead content of a blood sample: 0.752, 0.756, 0.752, 0.751 and 0.760 ppm Pb. (5)
- Apply the Q test to the following data set to determine whether the outlying result should be retained or rejected at the 95% confidence level. 41.27, 41.61, 41.84, 41.70 Note:  $Q_{crit}$  for 4 observations at 95 % confidence = 0.829 (5)
22. Construct the titration curve of weak acid versus strong base for 100 mL of 0.01M  $CH_3COOH$  being titrated with 0.01 M NaOH. (5)
23. What are complexometric titrations? Explain with an example. Outline the advantages of complexometric titrations (5)
24. State the Scope of the thin layer chromatography (TLC). (5)

**PART-C (Answer ALL questions) 5 x 10= 50 marks**

25. (a) An atomic absorption method for the determination of the amount of iron present in used jet engine oil was found, from pooling 30 triplicate analysis, to have a standard deviation  $s = 2.4 \mu\text{g Fe/mL}$ . If  $s$  is a good estimate of  $\sigma$ , calculate the 95 % confidence interval for the result,  $18.5 \mu\text{g Fe/mL}$ , if it was based on (a) single analysis, (b) the mean of two analysis (8)
- (Or)
- (b) i. Give reasons for determinant errors. How can they be minimized? (4)  
ii. Explain t - test, z test, and F test (4)
26. (a) i. What are importance of dry box /glove box in micro chemical laboratory (4)  
ii. Enumerate the guidelines for achieving quality in trace analysis of sampling process. (4)
- (Or)
- (a) Why should the sampling process is important and what are the different methods.(8)
27. (a) Construct a curve for the titration of 50 mL of a 0.1 M solution of HCl with a 0.1 M solution of NaOH in the following volumes. During the course of the titration

calculate the pH after addition of 0.00, 25.00, 30.00, 35.00, 40.00, 45.00, 47.00, 49.00, 49.50, 49.80, 49.90, 50.00, 50.01, 50.05, 50.10, 50.20, 50.50, 60.00, 70.00, 80.00, 100.00 mL of NaOH. (8)

(Or)

(b) Write the principles of Photometric titrations and Instrumentation. Explain briefly the application of Photometric titrations. (8)

28. (a) Briefly discuss the titrations involving monodentate and multidentate ligands. (8)

(Or)

(b) Write a note on:

(i) Masking agents (2)

(ii) Demasking agents (2)

(iii) Direct titrations (2)

(iv) Indirect titrations (2)

30. (a) i. Express mechanism for gel permeation chromatography.

ii. Why it's not desirable to pack the column with dry gel.

(Or)

(b) i. Explain the instrumentation for ion exchange chromatography (4)

ii. Briefly discuss factors affecting the ion exchange (4)

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(For the candidates admitted from 2018 onwards)

**M.Sc., DEGREE EXAMINATION**  
**18UPCHE1E01 MATERIALS CHEMISTRY**

Time: Three hours

Maximum : 75 marks

**Part- A**

**Answer all questions**

**(1×20=20)**

- The metal ion used in Zeigler-Natta catalysis is  
A) Rh B) Ir C) Ni D) Ti
- Caprolactum is the monomer of  
A) Nylon-6 B) PVC C) Backelite D) Teflon
- The monomer which undergoes polymerization to form Teflon is  
A)  $\text{CH}_2=\text{CH}_2$  B)  $\text{CH}_2\text{-CHCl}$  C)  $\text{CH}_2=\text{CHCN}$  D)  $\text{CF}_2=\text{CF}_2$
- Inorganic benzene is  
A)  $\text{BH}_3\text{NH}_3$  B)  $\text{B}_3\text{N}_3\text{H}_6$  C)  $\text{B}_2\text{H}_6$  D)  $\text{BH}_3$
- Textile fibers are prepared from  
A) Terglene B) Teflon C) PVC D) Nylon-6,6
- The copolymers which is used as cationic exchange resins is  
A) Styrene-acrylonitrile B) Nitrated styrene C) Halogenated styrene  
D) Sulphonated styrene
- The polymer which is used in adhesives and protective coating is  
A) Polystyrene B) Poly vinyl chloride C) Polyethylene D) Polyester
- Identify the biocompatibility polymer  
A) PVC B) Teflon C) Nylon-6,10 D) PLLA
- The ratio between phenol and formaldehyde in phenol-formaldehyde resin is  
A) 1:5 B) 1:3 C) 1:1.5 D) 1:10
- Identify the polymer is used for fabrication of artificial blood vessels  
A) PVC B) Teflon C) Fluoroalkoxy substituted phosphonitrilic polymers  
D) Polyesters
- Silicon has a stable  
A) Three dimensional structure B) Linear structure C) Two dimensional structure  
D) None of these
- Identify the polymer is used for injection moulded  
A) Polystyrene B) Styrene-acrylonitrile polymer C) Acrylonitrile-butadiene-styrene polymer  
D) Polyethylene

13. Silicon is  
 A) Copolymers B) Cross linked polymers C) Linear polymers D) Addition polymers
14. 1 bar is equal to ----- psi  
 A) 14.5038 B) 14.5138 C) 14.6036 D) 14.5234
15. Identify the chemical method for the deposition of thin films  
 A) ALD B) E-beam evaporation C) PVD D) Sputtering
16. What is 0D material?  
 A) CNTs B) Graphene C) Graphite D) GQDs
17. How to measure the surface roughness of thin film  
 A) AFM B) TEM C) SEM D) XPS
18. Unit of specific energy density  
 A)  $\text{mWh/cm}^3$  B)  $\text{F/g}$  C)  $\text{cm}^3$  D)  $\text{mW/cm}^3$
19. Choose the best photocatalytic material for organic dye degradation  
 A)  $\text{TiO}_2$  B)  $\text{MgO}$  C) PEDOT D) Na
20. Photochromic materials undergoes reversible colour change in presence of  
 A) Heat B) Light C) Stress D) Pressure

**Part- B Answer any three questions**

**(5×3=15)**

21. If average degree of polymerization of polypropylene was  $2 \times 10^4$ , calculate the weight average molecular weight of the polymer
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. Calculate the number and weight of average molecular weight and the polydispersity index
23. When 52 g of styrene was polymerized, average degree of polymerization was found to be  $1.5 \times 10^5$ . Calculate the number of styrene molecules in the original sample and number of molecules of polystyrene produced
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)
25. Calculate the relative viscosity, specific viscosity, reduced viscosity and inherent viscosity of a 0.5 % solution made by dissolving 0.25g of polymer in 50 mL of solvent) solution where the time for

solvent flow between the two appropriate marks was 60s and the time of flow for the solution was 80s

- Part- C                      Answer all questions                      (8×5=40)**
26. (A) Detailed explanation of copolymerization                      (8)  
(OR)  
(B) Detailed discussion on addition polymerization                      (8)
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)
28. (A) Synthesis and chemical structure of the followings  
(i) Polyethylene (ii) Polyamide (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)
29. (A) Detailed discussion on the followings:  
(i) 0D (ii) 1D (iii) 2D (iv) 3D                      (2+2+2+2=8)  
(OR)  
(B) (i) Explain theory and instrumentation of PVD and CVD techniques                      (4+4=8)
30. (A) List out the types of fuel cells and provide the detailed explanation of any two types of fuel cells                      (8)  
(OR)  
(B) List out the types of batteries and provide the detailed explanation of any two types of batteries                      (8)