Telephone No. 2419677/2419361
Fax: 0821-2419363/2419301

e-mail : registrar@uni-mysore.ac.in
www.uni-mysore.ac.in

UNIVERSITY OF MYSORE

Estd. 1916

VishwavidyanilayaKaryasoudha
Crawford Hall, Mysuru- 570 005

No.AC2(S)/164/2021-22

Dated: 16-02-2022

Notification

Sub:- Revision of Organic Chemistry (PG) Syllabus with effective from the Academic year 2021-22.

Ref:-
1. Decision of Board of Studies in Organic Chemistry (PG) meeting held on 07-12-2021.
2. Decision of the Faculty of Science & Technology Meeting held on 20-12-2021.
3. Decision of the Academic Council meeting held on 23-12-2021.

*****

The Board of studies in Organic Chemistry (PG) which met on 27-11-2021 has recommended to revise the Syllabus of Organic Chemistry (PG) with effective from the Academic year 2021-22.

The Faculty of Science & Technology and Academic Council at their meetings held on 20-12-2021 and 23-12-2021 respectively have also approved the above said proposal and it is hereby notified.

The syllabus is annexed herewith and the contents may be downloaded from the University Website i.e., www.uni-mysore.ac.in.

DRAFT APPROVED BY THE REGISTRAR

16/2
Deputy Registrar (Academic)
University of Mysore
Mysore-570 005

Deputy Registrar(Academic)

To:-

1. The Registrar (Evaluation), University of Mysore, Mysuru.
2. The Chairman, BOS/DOS, in Organic Chemistry (PG), Manasagangothri, Mysore.
3. The Dean, Faculty of Science & Technology, DoS in Earth Science, MGM.
4. The Director, PMEB, Manasagangothri, Mysore.
5. The Deputy Registrar/Assistant Registrar/Superintendent, Administrative Branch and Examination Branch, University of Mysore, Mysuru.
6. The PA to Vice-Chancellor/ Registrar/ Registrar (Evaluation), University of Mysore, Mysuru.
7. Office Copy.

UNIVERSITY OF MYSORE

MASTER OF SCIENCE (M.Sc.) DEGREE PROGRAMME
(SEMESTER SCHEME)

Regulations and Syllabus

ORGANIC CHEMISTRY

Under

Choice Based Credit System-
Continuous Assessment Grading Pattern (CBCS-CAGP)

2021-2022 Onwards

GUIDELINES AND REGULATIONS LEADING TO MASTER OF 0RGANIC CHEMISTRY (TWO YEARS- SEMESTER SCHEME UNDER CBCS-CAGP)

Programme Details

Name of the Department : Department of Studies in Organic Chemistry
Subject : Organic Chemistry
Faculty : Science and Technology
Name of the Programme : Master of Organic Chemistry (M.Sc.)
Duration of the Programme : 2 years- divided into 4 semesters

Programme Outcomes

1. Students will have a strong foundation in the fundamentals and applications of current chemical, practical and theoretical including those in Analytical, Inorganic, Organic and Physical Chemistry.
2. Students will be able to design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.
3. Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.
4. Students will be able to explore new areas of research in both Organic chemistry and allied fields such as, Biochemistry, Material chemistry, Pharmaceutical chemistry and chemical biology and technology.
5. Students will understand the central role of chemistry to our society which includes, understanding of safe handling of chemicals, environmental issues and key issues facing our society in energy, health and medicine.
6. Students will be able to address social, economic, and member of an interdisciplinary problem solving team.

Programme Specific Outcome

- Global level research opportunities to pursue Ph. D programme targeted approach of CSIR – NET, and competitive civil service examinations**.**
- Enormous job opportunities in the field of teaching, chemical, pharmaceutical, food products, and life oriented material industries**.**
- Specific placements in R & D and synthetic division of polymer industries & Allied Division**.**
- Facile development for the synthesis of biologically significant organic molecules using the green route for chemical reactions for sustainable properties**.**
- To inculcate the scientific temperament in the students and outside the scientific community.
- Use modern techniques and sophisticated equipments for the characterization and applications.
- Use computational chemistry software skills to avoid the laborious work in wet labs**.**

Pedagogies utilized in the M.Sc., Organic Chemistry programme

- Conventional method such as black board and chalk, and modern methods like power point presentation and information and communications technology can be used in class room teaching.
- Molecular models can be used to teach molecular symmetry and stereo-chemistry courses.
- For teaching solids, crystal models (MX and MX_2 types) can be utilized.
- Each student performs experiments as per the protocol in practical classes.
- For the preparation of new compounds, each student can adopt new experimental setup, and also exposed to different analytical instruments for qualitative and quantitative

analysis. In addition to this, students will acquire a skill to handle instruments independently.

- Students will be presenting seminar topic/research paper in each semester.
- The writing abilities in presentation of precise answer and essay type questions will be tested.
- Every semester, each student will be subjected to viva-voce examinations by external examiners.
- Every student will work for their project on a small research problem.
- Rigorous training will be giving for every student to interpret spectral data in the respective course including their dissertation.
- Arrange the invited talk/ lecture series by eminent scholars from different intuitions.
- Conduct the national/ international conferences to upgrade the subject knowledge.

GENERAL REQUIREMENTS

Scheme of Instructions

1. A Masters Degree programme is of 4 semesters-two years duration. A candidate can avail a maximum of 8 semesters – 4 years (in one stretch) to complete Masters Degree (including blank semesters, if any). Whenever a candidate opts for blank semesters, he/she has to study the prevailing courses offered by the department when he/she continues his/her studies.

2. A candidate has to earn a minimum of 76 credits, for successful completion of a Master Degree. The 76 credits shall be earned by the candidate by studying Hardcore, Soft Core, Dissertation and Open Elective courses.

3. **Minimum for Pass:** In case a candidate secure less than 30% in C_1 and C_2 put together, the candidate is said to have DROPPED the course, and such a candidate is not allowed to appear for C_3.

4. In case a candidate secure less than 30% in C_3, or secures more than 30% in C_3 but less than 50% in C_1, C_2 and C_3 put together or as per the University Regulations, the candidate is said to have not completed the course and he/she may either opt to DROP the course or to utilize PENDING option.

5. **Credits (Minimum) Matrix:** A candidate has to study 48 credits from hard Core, a minimum of 24 credits in Soft Core (sum total of 4 semesters) and 04 credits in Open Elective (II or III Semester) for the successful completion of the Masters Degree programme.

6. All other rules and regulations hold good which are governed by the University of Mysore from time to time.

Definitions

1. In the Choice Based Credit System – Continuous Assessment Grading Pattern (CBCS-CAGP), programme means a course and a course means a paper.
2. **HC:** Hard Core; **SC:** Soft Core; **OE:** Open Elective

GENERAL SCHEME WITH RESPECT TO ASSESSMENT OF CREDITS

Semester	Hard Core		Soft Core			Open Elective
	Theory			Theory	Practicals	
I	I	3 + 0 + 0 = 3	I	2 + 0 + 0 = 2	0 + 0 + 4 = 4[ab]	--
	O	3 + 0 + 0 = 3	O	2 + 0 + 0 = 2	0 + 0 + 4 = 4[ab]	
	P	3 + 0 + 0 = 3	P	2 + 0 + 0 = 2	0 + 0 + 4 = 4[ab]	
	A	3 + 0 + 0 = 3	A	2 + 0 + 0 = 2	0 + 0 + 4 = 4[ab]	
II	I	3 + 0 + 0 = 3	I	2 + 0 + 0 = 2	0 + 0 + 4 = 4[ab]	4 + 0 + 0 = 4[c]
	O	3 + 0 + 0 = 3	O	2 + 0 + 0 = 2	0 + 0 + 4 = 4[ab]	
	P	3 + 0 + 0 = 3	P	2 + 0 + 0 = 2	0 + 0 + 4 = 4[ab]	
	G-1	3 + 0 + 0 = 3	A	2 + 0 + 0 = 2	0 + 0 + 4 = 4[ab]	
III	OC-1	3 + 0 + 0 = 3	SCO-1	2 + 0 + 0 = 2	0 + 0 + 2 = 2[b]	4 + 0 + 0 = 4[c]
	OC-2	3 + 0 + 0 = 3	SCO-2	2 + 0 + 0 = 2	0 + 0 + 2 = 2[b]	
	OC-3	3 + 0 + 0 = 3	SCO-3	2 + 0 + 0 = 2		
	G-2	3 + 0 + 0 = 3	SCO-4	2 + 0 + 0 = 2		
IV	OC-4	3 + 0 + 0 = 3		**DISSERTATION/PROJECT WORK (04 credits)[d]**		
	OC-5	3 + 0 + 0 = 3				
	OC-6	3 + 0 + 0 = 3				
	OC-7	3 + 0 + 0 = 3				
Total Credits	**48**		**24(48)**			**04**

Note:

- A – Analytical; I – Inorganic; O – Organic; P – Physical; G – Spectroscopy; e.g., (L + T + P): Theory + Tutorial + Practical.
- [a] 50% of the students will attend Analytical/Inorganic Practicals and remaining 50% students will attend Organic/Physical Practicals in I Semester and vice-versa during II Semester. Otherwise, department may offer Two practical courses in I semester and remaining Two practical courses in II semester, but not repeat the same courses for the same students.
- [b] Practicals are only for Organic Chemistry students which are compulsory courses.
- [c] The candidate can study open elective course either in II or III semester.
- [d] Dissertation by research is compulsory for Organic chemistry students in IV semester only.

SCHEME OF STUDY AND EXAMINATION

FIRST SEMESTER

HARD CORE THEORY

Courses	Title	Contact Hours/ week	Credit	Max. Marks	Internal Assessment Marks		Semester End Exams (C_3)	
					C_1	C_2	Duration (Hrs)	Marks
OCI HCT: 1.1	Concepts and Models of Inorganic Chemistry	3	3	100	15	15	03	70
OCO HCT: 1.2	Stereochemistry and Reaction Mechanism	3	3	100	15	15	03	70
OCP HCT: 1.3	Basic Physical Chemistry	3	3	100	15	15	03	70
OCA HCT: 1.4	Fundamental Concepts of Analytical Chemistry	3	3	100	15	15	03	70

SOFT CORE THEORY

Courses	Title	Contact Hours/ week	Credit	Max. Marks	Internal Assessment Marks		Semester End Exams (C_3)	
					C_1	C_2	Duration (Hrs)	Marks
OCI SCT: 1.1	Chemistry of Selected Elements	2	2	100	15	15	3	70
OCO SCT: 1.2	Natural Products-I	2	2	100	15	15	3	70
OCP SCT: 1.3	Biophysical Chemistry	2	2	100	15	15	3	70
OCA SCT: 1.4	Titrimetric Analysis	2	2	100	15	15	3	70

PRACTICALS

Courses	Title	Contact Hours/ week	Credit	Max. Marks	Internal Assessment Marks		Semester End Exams (C_3)	
					C_1	C_2	Duration (Hrs)	Marks
OCI SCP: 1.1/2.1	Inorganic Practicals-I	8	4	100	15	15	6	70
OCO SCP: 1.2/2.2	Organic Practicals - I	8	4	100	15	15	6	70
OCP SCP: 1.3/2.3	Physical Practicals - I	8	4	100	15	15	6	70
OCA SCP: 1.4/2.4	Analytical Practicals - I	8	4	100	15	15	6	70

- **Note:** 50% of students will attend Analytical and Inorganic Practicals and the remaining 50% of students will attend Organic and Physical Practicals in I Semester and vice-versa in II Semester. Otherwise, department may offer Two practical courses in I semester and remaining Two practical courses in II semester, but not repeat the same courses for the same students.

SECOND SEMESTER

HARD CORE THEORY

Courses	Title	Contact Hours/ week	Credit	Max. Marks	Internal Assessment Marks		Semester End Exams (C_3)	
					C_1	C_2	Duration (Hrs)	Marks
OCI HCT: 2.1	Coordination Chemistry	3	3	100	15	15	03	70
OCO HCT: 2.2	Synthetic Organic Chemistry	3	3	100	15	15	03	70
OCP HCT: 2.3	Principles of Physical Chemistry	3	3	100	15	15	03	70
OCG HCT: 2.4	Molecular Symmetry and Spectroscopy-I	3	3	100	15	15	03	70

SOFT CORE THEORY

Courses	Title	Contact Hours/ week	Credit	Max. Marks	Internal Assessment Marks		Semester End Exams (C_3)	
					C_1	C_2	Duration (Hrs)	Marks
OCI SCT: 2.1	Basic Organometallic Chemistry	2	2	100	15	15	03	70
OCO SCT: 2.2	Food and Drugs Analysis	2	2	100	15	15	03	70
OCO SCT: 2.3	Surface Chemistry and Metal Finishing	2	2	100	15	15	03	70
OCO SCT: 2.4	Applied Analysis	2	2	100	15	15	03	70

NOTE:
Practicals: Same as that of I Semester. Students who have studied Analytical and Inorganic or Organic and Physical Practicals in the I Semester will get interchanged during II Semester.

OPEN ELECTIVE (for Non-Chemistry/Organic chemistry Students only)

Courses	Title	Contact Hours/ week	Credit	Max. Marks	Internal Assessment Marks		Semester End Exams (C_3)	
					C_1	C_2	Duration (Hrs)	Marks
OC OET: 2.1/3.1	Applications of Natural and Synthetic products	4	4	100	15	15	03	70

NOTE: The students can study this course either in II or III Semester

THIRD SEMESTER

HARD CORE THEORY

Courses	Title	Contact Hours/ week	Credit	Max. Marks	Internal Assessment Marks		Semester End Exams (C_3)	
					C_1	C_2	Duration (Hrs)	Marks
HCT: 3.1	Advanced Organic Chemistry	3	3	100	15	15	03	70
HCT: 3.2	Photochemistry, Pericyclic Reactions and Free radical chemistry	3	3	100	15	15	03	70
HCT: 3.3	Dyes, Insecticides and Polymer Chemistry	3	3	100	15	15	03	70
HCT: 3.4	Spectroscopy-II	3	3	100	15	15	03	70

SOFT CORE THEORY

Courses	Title	Contact Hours/ week	Credit	Max. Marks	Internal Assessment Marks		Semester End Exams (C_3)	
					C_1	C_2	Duration (Hrs)	Marks
SCOT: 3.1	Bioinorganic Chemistry	2	2	100	15	15	3	70
SCOT: 3.2	Enzymes Functions and Their Kinetics	2	2	100	15	15	3	70
SCOT: 3.3	Materials Chemistry	2	2	100	15	15	3	70
SCOT: 3.4	Quantum Chemistry and Biosensors	2	2	100	15	15	3	70

PRACTICALS

Courses	Title	Contact hours/ week	Credit	Max. Marks	Internal Assessment Marks		Semester end exams (C_3)	
					C_1	C_2	Duration (h)	Marks
OCP 3.1	Organic Chemistry Practicals - II	4	2	100	15	15	6	70
OCP 3.2	Organic Chemistry Practicals - III	4	2	100	15	15	6	70

OPEN ELECTIVE (for Non-Chemistry and Organic Chemistry Students only)

The course is same as described in II Semester

FOURTH SEMESTER

HARD CORE THEORY

Courses	Title	Contact Hours/ week	Credit	Max. Marks	Internal Assessment Marks		Semester End Exams (C_3)	
					C_1	C_2	Duration (Hrs)	Marks
HCT 4.1	Advanced Organometallic chemistry	3	3	100	15	15	03	70
HCT 4.2	Advanced Medicinal Chemistry	3	3	100	15	15	03	70
HCT 4.3	Natural Products-II	3	3	100	15	15	03	70
HCT 4.4	Heterocyclic and Bioorganic Chemistry	3	3	100	15	15	03	70

SOFT CORE COURSES

NOTE: **Soft Core Theory: All courses are same as that described in III Semester.**

Courses	Title	Contact Hours/ week	Credit	Max. Marks	Internal Assessment Marks		Semester End Exams (C_3)	
					C_1	C_2	Duration (Hrs)	Marks
DISSERTATION								
Dissertation/Project work		**8**	**04**	**100**	**15**	**15**	**-**	**70**

SCHEME OF EXAMINATION FOR C_1, C_2 AND C_3 COMPONENTS

Preamble

In view of the CBCS syllabus, following is the model distribution of marks for C_1, C_2 and C_3 Components. At a glance, the model includes HC, SC and OE courses for the assessment of marks.

The following is the scheme which will be followed for the assessment of marks for HC, SC and OE courses irrespective of the credits associated with each course. 30% of the marks will be assessed for the internals (C_1 and C_2) and remaining 70% will be for the Semester End Examinations (C_3). Each

course carries 100 marks and hence 30 marks will be allotted to internals and remaining 70 marks will be for Semester end Examinations. Out of 30 marks for internals, 15 marks will be allotted to each C_1 and C_2 components.

Each course (HC/SC/OE) consists of three components namely C_1, C_2 and C_3. C_1 and C_2 are designated as Internal Assessment (IA) and C_3 as Semester End Examination. Each course (HC/SC/OE) carries **100 Marks** and hence the allotment of marks to C_1, C_2 and C_3 Components will be 15, 15 and 70 marks, respectively. i.e.,

C_1 Component	15 Marks	Assessment Marks
C_2 Component	15 Marks	
C_3 Component	70 Marks	Semester End Examination
Total	**100 Marks**	

The above Scheme will be followed for all the HC, SC and OE courses in all the four semesters.

1. HARD CORE (03 CREDIT COURSES)

1.1. Distribution of Marks for C_1 and C_2 Components:

Assessment Marks (C_1 + C_2) consists of 30 marks. It will be divided into three parts *viz*., ***Internal Test, Home Assignment and Seminar***. Internal tests will be conducted during the 8th week of the semester for C_1 and 16th week of the semester for C_2. Home Assignment will be considered for C_1 Component and Seminar for C_2 Component only. Hence, a teacher from each unit of a course may be given one assignment (or in their personal interest one more may be given). Since each course has three units, the marks shall be divided equally. Allotment of marks for C_1 and C_2 is as follows: Out of 15 Marks for C_1, Internal test will be conducted for 30 Marks (10 Marks from each unit and reduced to 10 Marks) and Home Assignment will be given for 05 Marks (Each Home Assignment from every unit will be assessed for 05 Marks and finally reduced to 05 Marks). Assessment Marks for C_2 will be distributed as follows: Internal test will be conducted for 30 Marks (10 Marks from each unit and reduced to 10 Marks) and Seminar will be assessed for 20 Marks and finally its Marks will be distributed to each theory HC course. i.e.,

C_1		**C_2**	
Continuous Assessment (CA)	30 Marks (10+10+10) **Reduced to 10 Marks**	CA	30 Marks (10+10+10) **Reduced to 10 Marks**
Home Assignment	15 Marks (05+05+05) **Reduced to 5 Marks**	Seminar	20 Marks (05+05+05+05) **5 Marks will be distributed to each HC course**
Total	**15 Marks**	**Total**	**15 Marks**

1.2. Distribution of Marks for C_3 Component (Semester End Examination)

The question paper is of 3 hr duration with the Max. Marks 70. The following question paper pattern will be followed for all the theory courses (HC/SC/OE). Question paper will have FIVE main questions. All the questions will cover all the units of the course with equal marks distribution. Q. No. 1 is of Medium/ Short Answer Type questions which will have nine questions and each question carries two marks. A student has to answer any seven questions. Q. No. 2 to 5 carries 14 marks each and a student has to answer all the four questions (*No Choice*). Each main question will have three sub-sections a, b, c. An examiner may set the questions like (4+4+6) or (4+5+5) or as his/her wish. However, sub-section 'c' will have an internal choice. i.e.,

Model Question Paper Pattern

Max. Duration: 3 Hours **Max. Marks: 70**

Note: *Answer all the questions. Each question carries 14 marks.*
***Q. No.* 1**: Nine Medium/concept based/Short Answer Type Questions and **any seven** should be answered. Each question carries **TWO marks**. **(7 × 2 = 14)**

***Q. No.* 2 to 5:** All the four questions have to be answered (*No Choice*). Each question carries FOURTEEN marks. An examiner may set the questions like (4+4+6) or (4+5+5) or as his/her wish. However, sub-section c will have an internal choice. (*Two marks questions shall be avoided for 2 to 5*).
(4 × 14 = 56)

a)
b)
c) **OR** c)

2. SOFT CORE (02 CREDIT COURSES)

2.1. Distribution of Marks for C_1 and C_2 Components

Assessment Marks (C_1 + C_2) consists of 30 marks. It will be divided into two parts viz., ***Internal Test and Home Assignment***. Internal tests will be conducted during the 8th week of the semester for C_1 and 16th week of the semester for C_2. As far as Home Assignment is concerned, the concerned teacher will assign one or two Home Assignments to each student. Since each course has two units, the marks will be divided equally. Allotment of marks for C_1 and C_2 is as follows: Out of 15 Marks for IA, Internal tests will be conducted for 20 marks and reduced to 10 marks, whereas Home Assignment is for 05 Marks. i.e.,

C_1		**C_2**	
Continuous Assessment (CA)	20 Marks (10+10) **Reduced to 10**	CA	20 Marks (10+10) **Reduced to 10**
Home Assignment	10 Marks (05+05) **Reduced to 05**	Home Assignment	10 Marks (05+05) **Reduced to 05**
Total	**15 Marks**	**Total**	**15 Marks**

2.2. Distribution of Marks for C_3 Component (Semester End Examination)

The above discussed pattern (1.2) holds good in this case also.

3. PRACTICALS

The following Scheme will be applicable for all the four semesters (SC for chemistry students only).

Each practical consists of three components namely C_1, C_2 and C_3. C_1 and C_2 are designated as Internal Assessment (IA) and C_3 as Semester End Examination. Each practical carries **100 Marks** and hence the allotment of marks to C_1, C_2 and C_3 Components will be 15, 15 and 70 marks respectively. i.e.,

C_1 Component	15 Marks	Continuous Assessment (CA) Marks
C_2 Component	15 Marks	
C_3 Component	70 Marks	Semester End Examination
Total	**100 Marks**	

3.1. Distribution of Marks for C_1 and C_2 Components

IA consists of **15 Marks**; it will be divided into three parts *viz*., ***Internal Test, Continuous Assessment and Record***. Continuous assessment refers to the daily assessment of each student based on his/her attendance, skill, results obtained etc. Thus, 05 marks are allotted for Continuous

Assessment. Internal tests will be conducted for 05 Marks during the 8th week of the semester for C_1 and 16th week of the semester for C_2. Finally, remaining 05 Marks will be for the record. i.e.,

C_1		**C_2**	
Internal Test	05 Marks	Internal Test	05 Marks
Continuous Assessment	05 Marks	Continuous Assessment	05 Marks
Record	05 Marks	Record	05 Marks
Total	**15 Marks**	**Total**	**15 Marks**

3.2. Distribution of Marks for C_3 Component (Semester End Examination)

The end examination will be conducted for **70 Marks/course** with a maximum duration of 6 hours. Two experiments will be given to each student which carries 30 Marks each. Each student will be subjected to Viva-Voce Examination for which 10 Marks is allotted. i.e.,

Two Experiments	30+30 Marks
Viva-Voce	10 Marks
Total	**70 Marks**

Note: Examiners have to set at least one experiment from each part in the semester end Examination (C_3).

4. DISSERTATION/PROJECT WORK (04 CREDIT COURSE)

Each student is expected to undergo Dissertation/ Project Work under the guidance of the faculty of the department during the IV Semester.

4.1. Distribution of Marks for C_1 and C_2Components

IA consists of **30 (C_1 and C_2) Marks**; it will be divided into three parts viz., ***Attendance, Continuous Assessment and Work Progress***. Continuous assessment refers to the daily assessment of each student based on his or her skill, results obtained, literature survey etc. C_1will be assessed during the 8th week of the semester and C_2during the 16th week of the semester. Hence, the concerned guide will prepare the marks list based on the above said parameters for both C_1 and C_2 Components.

4.2. Distribution of Marks for C_3 Component (Semester End Examination)

The end examination will be conducted for **70 Marks**. Every student is supposed to prepare a hard copy of the findings of the work in the form of dissertation and submitted for evaluation. This part will be assessed for 50 Marks. Each student will be subjected to Viva- Voce Examination for which 20 Marks is allotted. i.e.,

Evaluation of Dissertation	: 50 Marks
Viva-Voce	: 20 Marks
Total	**: 70 Marks**

FIRST SEMESTER

HARD CORE THEORY

OCI HCT: 1.1. CONCEPTS AND MODELS OF INORGANIC CHEMISTRY

Objectives:

- To study the structures of ionic crystals and simple molecules through VSEPR model.
- To learn acid-base concepts and chemical reactions in non-aqueous, ionic liquids and supercritical fluids as media.
- To study the chemistry of f-block elements.

Course outcome:

- The periodic properties of the elements, structures of ionic solids and their lattice energy calculations. Further, the use of VSEPR concepts in analyzing structures of simple molecules.
- Various acid-base concepts and their applications in different fields. Also, understand the utility of various non-aqueous solvents in inorganic synthesis.
- Complete understanding of the chemistry of lanthanides, actinides and their applications.

Pedagogy:

- Familiarize the students with the periodic properties of the elements using modern periodic table.
- Teaching through conventional method such as black board and chalk, and modern methods like power point presentation.
- For teaching solids, crystal models (MX and MX2 types) can be utilized.

Course content:

UNIT-I

[16 HOURS]

Chemical Periodicity: Review of periodic properties

Structures and energetics of ionic crystals: Introduction, MX (NaCl, CsCl, ZnS) and MX_2 (fluorite, rutile, β-crystobalite, cadmium chloride and cadmium iodide) types. The perovskite and spinel structures. Thermodynamics of ionic crystal formation. Hydration energy and solubility of ionic compounds, Lattice energy, Born-Haber cycle, Born-Lande equation.The Kapustinskii's equation, Consequences of lattice enthalpies.Applications of lattice energetics. Ionic radii, factors affecting the ionic radii, radius ratio rules.

Structures and energetics of inorganic molecules: Introduction, Bent's rule, Energetics of hybridization. VSEPR model for explaining structure of molecules including fluxional molecule. M.O. treatment of homo-nuclear and heteronuclear diatomic molecules. M.O. treatment involving delocalized π-bonding (CO_3^{2-} , NO_3^- , NO_2^-, CO_2 and N_3^-), M.O. correlation diagrams (Walsh) for triatomic molecules.

UNIT-II

[16 HOURS]

Modern concept of acids and bases: Lux-Flood and Usanovich concepts, solvent system and leveling effect. Hard-Soft Acids and Bases, Classification and Theoretical backgrounds.

Non-aqueous solvents: Classification of solvents, Properties of solvents (dielectric constant, donor and acceptor properties) protic solvents (anhydrous H_2SO_4, HF and glacial acetic acid) aprotic solvents (liquid SO_2, BrF_3 and N_2O_4). Solutions of metals in liquid ammonia, hydrated electron. Super acids and super bases. Heterogeneous acid-base reactions.

Ionic liquids: Molten salt solvent systems, Ionic liquids at ambient temperature, Reactions in and applications of molten salt/ionic liquid media.

Supercritical fluids: Properties of supercritical fluids and their uses as solvents. Supercritical fluids as media for inorganic chemistry

UNIT-III

[16 HOURS]

Lanthanoid chemistry: General trends, Electronic, optical and magnetic properties. Abundance and extraction, **General principles**: conventional, solvent extraction and ion-exchange methods. Separation from monazite. Chemistry of principal oxidation states (II, III and IV). Stability of tetrahalides, dihalides and aqua ions of simple lanthanide compounds. Redox potentials. **Uses:** lanthanides as shift reagents, lanthanides as probes in biological systems. High temperature super conductors.

Actinoid chemistry: General trends and electronic spectra**.** Occurrence and preparation of elements, **Isolation of the elements**: thorium and uranium, enrichment of uranium for nuclear fuel, uranium hydrides, oxides and chlorides. Chemical reactivity and trend. Chemistry of trans-uranium elements.

Supramolecular Chemistry: Introduction, selectivity and Supramolecular Interactions.

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6. Introduction to Modern Inorganic Chemistry, K.M. Mackay and R.A. Mackay, Blackie Publication (1989).
7. Concepts and Models of Inorganic Chemistry 3rd edition. B.E. Douglas, D.H. McDaniel and Alexander, Wiley (2001).
8. Ionic liquids-Classes and Properties (Ed) by Scott T. Handy, Intech Publisher (2011).
9. Lanthanide and Actinide Chemistry, Simon Cotton, John Wiley and Sons Ltd., (2006).
10. Supramolecular Chemistry, Peter J. Cragg, Springer (2010).

OCO HCT: 1.2. STEREOCHEMISTRY AND REACTION MECHANISM

Objectives:

- To understand detailed molecular structures of organic compounds.
- To learn bonding and chemical reactions of organic compounds.
- To study the different chemical reactions involved in organic synthesis.

Course outcome:

- Optical and geometrical isomerism of Organic compounds. Application of stereochemistry in the study of regioselective and regiospecific reactions.
- The study of HMOT and its applications to simple organic molecules, and also understand the concept of aromaticity and methods of determining reaction mechanism.
- Nucleophilic, electrophilic and elimination reactions.

Pedagogy:

- Molecular models can be used to teach stereochemical aspects.
- Teaching through conventional method such as black board and chalk, and modern methods like power point presentation.

Course content:

UNIT-I

[16 HOURS]

Stereoisomerism: Projection formulae [flywedge, Fischer, Newman and sawhorse], enantiomers, diastereoisomers, mesomers, racemic mixture and their resolution, configurational notations of simple molecules, DL and RS configurational notations.

Optical isomerism: Conditions for optical isomerism: Elements of symmetry-plane of symmetry, centre of symmetry, alternating axis of symmetry (rotation-reflection symmetry). Optical isomerism due to chiral centers and molecular dissymmetry, allenes and biphenyls, criteria for optical purity.

Geometrical isomerism: Due to C=C, C=N and N=N bonds, *E*, *Z* conventions, determination of configuration by physical and chemical methods. Geometrical isomerism in cyclic systems.

Conformational analysis: Elementary account of conformational equilibria of ethane, butane and cyclohexane. Conformation of cyclic compounds such as cyclopentane, cyclohexane, cyclohexanones and decalins. Conformational analysis of 1,2-, 1,3- and 1,4- disubstituted cyclohexane derivatives and *D*-Glucose, Effect of conformation on the course and rate of reactions.

Stereoselectivity: Meaning and examples of stereospecific reactions, stereoselective reactions, diastereoselective reactions, regioselective, regiospecific reactions, enantioselective reactions and enantiospecific reactions.

UNIT-II

[16 HOURS]

Basics of organic reactions: Meaning and importance of reaction mechanism, classification and examples for each class.

Bonding in organic systems: Theories of bonding-molecular orbital approaches. Huckel molecular orbital theory and its application to simple π-systems: ethylene, allyl, cyclopropyl, butadienyl, cyclopentadienyl, pentadienyl, hexatrienyl, cyclohexatrienyl, heptatrienyl, cycloheptatrienyl systems. Calculation of the total π-energy, and M.O. coefficients of the systems.

Aromaticity: Concept of aromaticity, Huckel's rule, Polygon rule, annulenes, heteroannulenes and polycyclic systems.

Structure and reactivity: Brief discussion on effects of hydrogen bonding, resonance, inductive and hyperconjugation on strengths of acids and bases.

Methods of determining organic reaction mechanism: Thermodynamic and kinetic requirements for reactions, kinetic and thermodynamic control. Identification of products. Determination of reaction intermediates, isotope labeling and effects of cross over experiments. Kinetic and stereochemical evidence, solvent effect. Formation, structure, stability, detection and reactions of carbocations (classical and non-classical), carbanions, free radicals, carbenes, nitrenes, arynes and ylides (Sulphur, nitrogen and phosphorous).

UNIT-III

[16 HOURS]

Aliphatic Nuleophilic Substitution reactions: Kinetics, mechanism and stereochemical factor affecting the rate of S_N1, S_N2, S_{RN}^i, S_N^i, S_N1', S_N2', S_N1^i and $S_{RN}1$ reactions, Neighbouring group participation.

Electrophilic substitution reactions: Kinetics, mechanism and stereochemical factor affecting the rate of S_E1 & S_E2

Aromatic electrophilic substitution reactions: Mechanism of nitration, halogenation, sulphonation, Friedel-Crafts alkylation and acylation, Mannich reaction, chloromethylation, Vilsmeier Haack reaction, Diazonium coupling, Gattermann–Koch reaction, Mercuration reaction.

Aromatic nucleophilic substitution reactions: S_N1, S_N2 and benzyne mechanism, Bucherer reaction, von Richter reaction.

Addition reactions: Addition to C=C multiple bonds involving electrophiles, nucleophiles. Markownikoff's rule and anti-Markownikoff's rule. Additions to carbonyl compounds: Addition of water, alcohol, bisulphate, HCN and amino compounds. Hydrolysis of esters.

Elimination reactions: Mechanism and stereochemistry of eliminations - E_1, E_2, E_{1cB}. *cis* elimination, Hofmann and Saytzeff eliminations, competition between elimination and substitution reactions, decarboxylation reactions. Chugaev reaction.

References

1. Stereochemistry of carbon compounds, Ernest L. Eliel.
2. Stereochemistry: P. S. Kalsi.
3. Organic Chemistry, VI edition, Robert T. Morrison, Robert N. Boyd.
4. Organic Chemistry, Vol-I by I. L. Finar.
5. Advance Organic Chemistry, IV edition, Jerry March.
6. Advance Organic Chemistry, III edition, Part-A and Part-B, Francis A. Carey and Rechard J. Sundberg.
7. Organic Chemistry, III edition, V. K. Ahluwalia and Rakesh Kumar Parashar.
8. Reactive intermediates in Organic Chemistry, N. S. Isaacs.

OCP HCT: 1.3. BASIC PHYSICAL CHEMISTRY

Objectives:

- To understand thermal properties of chemical compounds.
- To study the rate of chemical reactions.
- To familiarize the concepts of electro chemistry. .

Course outcome:

- The completion of this course will enable the students to gain the knowledge on fundamentals and theoretical background on the concepts of chemical thermodynamics, chemical kinetics and electrochemistry of solutions.
- This helps in understanding the stability and energetics of reaction.

Pedagogy:

- Teaching through conventional method such as black board and chalk, and modern methods like power point presentation.

Course content:

UNIT-I

[16 HOURS]

Chemical Thermodynamics: Entropy: Physical significance, entropy changes in an ideal gas. Variation of entropy with temperature, pressure and volume. Entropy changes in reversible and irreversible processes.

Free energy: Helmholtz and Gibbs free energies, Gibbs-Helmholtz equation and its applications, Maxwell's relations and its applications. Nernst heat theorem: its consequences and applications. Third law of thermodynamics: statements, applications and comparison with Nernst heat theorem.

Partial molar properties: Physical significance, determination of partial molar volumes by intercept method and from density measurements. Chemical potential and its significance. Variation of chemical potential with temperature and pressure. Formulation of the Gibbs – Duhem equation. Derivation of Duhem-Margules equation.

Fugacity: Relation between fugacity and pressure, variation of fugacity with temperature and pressure. Determination of fugacity of gases.

Activity and activity coefficient: Variation of activity with temperature and pressure. Determination of activity co-efficient by vapour pressure, depression in freezing point, solubility measurements and by electrical methods.

Thermodynamics of dilute solutions: Raoult's law, Henry's law. Ideal and non-ideal solutions.

UNIT-II

[16 HOURS]

Chemical Kinetics: Complex reactions: Kinetics of parallel, consecutive and reversible reactions. Chain reactions: Branched chain reactions, general rate expression, Auto catalytic reactions (Hydrogen-Oxygen reaction), oscillatory reactions and explosion limits.

Theories of reaction rates: Collision theory and its limitations, Activated complex theory (postulates -derivation) and its applications to reactions in solution. Energy of activation, other activation parameters - determinations and their significance. Lindemann theory, Hinshelwood's theory of unimolecular reactions.

Potential energy surfaces: Features and construction, theoretical calculations of E_a.

Reactions in solution: Ionic reactions - salt effects, effect of dielectric constant (single and double sphere models). Effect of pressure, volume and entropy change on the rates of reactions. Cage effect with an example.

Fast reactions- Introduction, study of fast reactions by continuous and stopped flow techniques, relaxation methods (T-jump and P-jump methods), flash photolysis, pulse and shock tube methods.

UNIT-III

[16 HOURS]

Electrochemistry of solutions: Factor effecting electrolytic conductance. Debye-Huckel theory - Concept of ionic atmosphere. Debye-Huckel-Onsager equation of conductivity and its validity. Debye-Huckel limiting law (DHL), its modification for appreciable concentrations. A brief survey of Helmholtz-Perrin, Guoy-Chapman and Stern electrical double layer (no derivation). Transference number: True and apparent transference numbers, Abnormal transference numbers, effect of temperature on transference numbers. Liquid junction potential-determination and minimization.

Energetics of cell reactions: Effect of temperature, pressure and concentration on energetics of cell reactions (calculation of ΔG, ΔH and ΔS).

Irreversible electrode process: Introduction, reversible and irreversible electrodes, reversible and irreversible cells. Polarization, over voltage - concentration over voltage, activation over voltage and ohmic over voltage. Experimental determination of over voltage. Equations for concentration over potential, stationary and non-stationary surface. Butler-Volmer equation, Tafel equation. Hydrogen oxygen over voltage. Effect of temperature, current density and *p*H on over voltage. Polarography-Half wave potential, application in qualitative and quantitative analysis.

References

1. Thermodynamics for Chemists by S. Glasstone, Affiliated East-West Press, New Delhi, (1965).
2. Physical Chemistry by P.W. Atkins, ELBS, 5th edition, Oxford University Press (1995).
3. Text Book of Physical Chemistry by Samuel Glasstone, MacMillan Indian Ltd., 2nd edition (1974).
4. Elements of Physical Chemistry by Lewis and Glasstone, 2nd Edn. Macmillan & Co Ltd., New York.
5. Chemical Kinetics by K.J. Laidler, Tata McGraw-Hill Pub, Co Ltd, New Delhi.
6. Chemical Kinetics by Frost and Pearson.
7. Kinetics and Mechanism of Chemical Transformation by J. Rajaram and J.C. Kuriacose, Macmillan, New Delhi.
8. Chemical Kinetics by L.K. Jain.
9. Introduction to Electrochemistry by S. Glasstone, Affiliated East-West Press, New Delhi,
10. Electrochemistry –Principles and Applications by E.G. Potter, Cleaver-Hume press Ltd, London.
11. Modern Electrochemistry Vol. I and II by J.O.M. Bockris and A.K.N. Reddy, Pentium Press, New York (1970).
12. Chemical Kinetics and Reaction Dynamics-S. K. Upadhyay, Springer India, 2006.

OCA HCT: 1.4. FUNDAMENTAL CONCEPTS OF ANALYTICAL CHEMISTRY

Objectives:

- To familiarize statistical methods to validate analytical methods.
- To understand fundamentals and applications of separation techniques.
- To learn extraction and chromatographic methods for the separation and identification of different compounds.

Course outcome:

- Devise a scheme to be able to isolate organic acids, bases and neutrals through an extraction process.
- To apply methods of distillation, sublimation, chromatography, filtration (including buchner filtration), evaporation, decantation, using magnetism, sieving and skimming to separate mixtures.
- To understand the terms filtrate, residue, filtration, sediment, decant, distil, distillate, chromatogram and solvent front.
- To know that mixtures are composed of constituents which are not combined.

Pedagogy:

- Conventional method such as black board and chalk can be used.
- Modern methods like power point presentation can also be used in class room teaching.
- To evaluate validation parameters, MS-Office tools *viz* MS-Excel sheets can be used.

Course content:

UNIT-I

[16 HOURS]

Analytical chemistry: Its functions and applications; analytical problems and procedures, analytical techniques and methods, method validation.

Calibration and standards: Calibration, chemical standard and reference material.

Quality in analytical laboratories: quality control, quality assurance and accreditation system.

Errors in analytical measurements: measurement errors, absolute and relative errors, determinate and indeterminate errors and accumulated errors-sources, effects on results and control.

Assessment of accuracy and precision: Accuracy and precision, standard deviation, relative standard deviation, pooled standard deviation, variance, overall precision, and confidence interval.

Significance testing: Significance tests- Outlier, Q-test, F-test, t-test, and analysis of variance (ANOVA). Significant numbers.

Calibration and linear regression: Calibration, linear regression, standard addition, internal standardisation, internal normalization, external standardisation.

Figures of merit of Analytical methods: sensitivity and detection limit, linear dynamic range.

Quality control and chemometrics: Control charts, collaborative testing and multivariate statistics.

UNIT-II

[16 HOURS]

Principles of chromatography- Chromatographic separations and classification of principal chromatographic separations. Chromatographic mechanisms-sorption isotherms; adsorption systems-stationary and mobile phases, partition systems-stationary and mobile phases. Characterization of solutes-distribution ratio, retention factor, retention time and retardation factor.

Sorption processes- adsorption, partition, ion- exchange and size exclusion.

Chromatographic performance- Efficiency and resolution. Peak asymmetry- kinetic and temperature effects. Isolation of separated components.

Quantitative and qualitative analyses.

Thin layer chromatography (TLC) - Principles and procedures, stationary and mobile phases, solute- detection, alternative TLC procedures and applications of TLC.

Gas chromatography (GC) - Principles and types. Mobile phases, Sample injections, columns and stationary phases. Temperature control and solute detection; thermal conductivity detector (TCD), flame ionization detector (FID), nitrogen-phosphorus detector (NPD) and electron capture detector (ECD). Instrument control and data processing. GC-procedures- temperature programming and special procedures used in GC. Quantitative and qualitative analyses.

High Performance Liquid Chromatography (HPLC): Principles, mobile phases, solvent delivery systems, sample injection system, column and stationary phases. Solute

detection -UV-visible, fluorescence, refractive index and electrochemical detectors. Instrument control and data processing. Modes of HPLC. Optimisation of separations, qualitative and quantitative analyses.

UNIT-III

[16 HOURS]

Ion-exchange chromatography (IEC): Principles, apparatus and instrumentation, and applications.

Size-exclusion chromatography (SEC): Principles, apparatus and instrumentation, and applications.

Affinity chromatography (AFC): Principles, methodology and applications.

Supercritical fluid chromatography (SFC): Properties of supercritical fluids, instrumentation and operation variables, comparison of SFC with other chromatographic techniques,applications.

Supercritical fluid extraction (SFE): Advantages, instrumentation, choice of supercritical fluids, off-line and on-line extraction, applications.

Electrophoresis (EP) and electrochromatography(EC): Principles- high performance capillary electrophoresis and capillary electrochromatography, running buffers, supporting medium, sample injection, solutes- detection, instrument control and data processing. Modes of EP and EC- capillary zone electrophoresis (CZE), micellar electrokineticchromatography (MEKC), capillary gel electrophoresis (CZE), capillary isoelectric focusing (CIEF). Capillary electrochromatography (CEC), features, basis of separations. Qualitative analysis by CE and CEC and applications.

Solvent and solid phase extraction: Extraction techniques, extraction efficiency and selectivity. Solvent extraction (SE) - Extraction of organic acids and bases, extraction of metals. Methods of extraction and applications. Solvent phase sorbents, solid phase extraction (SPE) formats. Automated solid phase extraction. Solid phase micro extraction (SPME). Applications of SPE and SPME.

References

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch, 8th edition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry, G.D. Christian, 5th edition, 2001, John Wiley & Sons, Inc, India.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993, Prentice Hall, Inc. New Delhi.
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, 2003, Pearson Education Pvt. Ltd., New Delhi.
5. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993 prenticeHall, Inc. New Delhi.
6. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders CollegePublishing, California, 1990.
7. Principles and Practice of Analytical Chemistry, F.W. Fifield and Kealey, 3rd edition, 2000, Blackwell Sci., Ltd. Malden, USA.
8. Modern Analytical Chemistry, David Harvey, McGraw Hill, New Delhi, 2000.

OCI SCP: 1.1/2.1. INORGANIC CHEMISTRY PRACTICALS – I

[128 HOURS]

Objectives:

- To understand basic concepts by carrying out different experiments.
- To develop the skill for the qualitative and quantitative analysis of various samples.

Course outcome:

- Determination of various analytes presents in different ore samples by volumetric, gravimetric and spectrophotometric methods.
- The chemistry of redox, complexometric and indirect methods
- The principle in the semi-micro analysis of an inorganic salt mixture

Pedagogy:

- Each student performs experiments as per the protocol in practical classes.
- Handling the instrument and pyrolysis for quantitative determination of analyte.

Course Experiments

PART – A

1. Determination of iron in haematite using cerium(IV) solution (0.02M) as the titrant, and gravimetric estimation of insoluble residue.
2. Estimation of calcium and magnesium carbonates in dolomite using EDTA titration, and gravimetric analysis of insoluble residue.
3. Determination of manganese dioxide in pyrolusite using permanganate titration.
4. Quantitative analysis of copper-nickel in alloy/mixture:
    i. Copper volumetrically using KIO_3.
    ii. Nickel gravimetrically using DMG
5. Determination of lead and tin in a mixture: Analysis of solder using EDTA titration.
6. Quantitative analysis of chloride and iodide in a mixture:
    i. Iodide volumetrically using KIO_3
    ii. Total halide gravimetrically
7. Gravimetric analysis of molybdenum with 8-hydroxyquinoline.
8. Quantitative analysis of copper(II) and iron(II) in a mixture:
    i. Copper gravimetrically as CuSCN and
    ii. Iron volumetrically using cerium(IV) solution
9. Spectrophotometric determinations of:
    a. Titanium using hydrogen peroxide
    b. Chromium using diphenyl carbazide in industrial effluents
    c. Iron using thiocyanate/1,10-phenanthroline method in commercial samples
    d. Nickel using dimethylglyoxime in steel solution
10. Micro-titrimetric estimation of :
    a) Iron using cerium(IV)
    b) Calcium and magnesium using EDTA
11. Quantitative estimation of copper(II), calcium(II) and chloride in a mixture.
12. Circular paper chromatographic separation of: (Demonstration)
    a. Iron and nickel
    b. Copper and nickel

PART – B

Semimicro qualitative analysis of inorganic mixtures containing **TWO** anions and **TWO** cations (excluding sodium, potassium and ammonium cations) and **ONE** of the following less common cations: W, Mo, Ce, Ti, Zr, V and Li.

References

1. Vogel's Text Book of Quantitative Chemical Analysis – 5th edition, J. Basset, R.C. Denney, G.H. Jeffery and J. Mendhom.
2. A Text Book of Quantitative Inorganic Analysis by A.I. Vogel, 3rd edition.
3. Spectrophotometric Determination of Elements by Z. Marczenko.

4. Vogel's Qualitative Inorganic Analysis – Svelha.
5. Macro and SemimicroInorganicQualitative Analysis by A.I. Vogel.
6. Semimicro Qualitative Analysis by F.J. Welcher and R.B. Halin.
7. Quantitative Chemical Analysis by Daniel C. Harris, 7th edition, (2006).

OCO SCP: 1.2/2.2. ORGANIC CHEMISTRY PRACTICALS-I

[128 HOURS]

Objectives:

- To understand synthetic methods by carrying out different experiments.
- To develop the skill for the separation and qualitative analysis of binary mixtures of organic compounds.

Course outcome:

- Students are involved in the multi-step synthesis of different organic compounds.
- Understand the qualitative analysis of binary mixture of organic compounds through separation, identification of functional groups and preparation of some solid derivatives.

Pedagogy:

- Each student performs experiments as per the protocol in practical classes.
- Experimental setup for the synthesis of organic compounds by every individual.

Course Experiments:

PART-A

1. Preparation *p*-nitroaniline from acetanilide**.**
2. Preparation of *n*-butyl bromide from *n*-butyl alcohol.
3. Preparation of chalcone.
4. Preparation of osazone
5. Preparation of phenoxyacetic acid
6. Preparation of 7-hydroxy-4-methyl coumarin
7. Preparation of hippuric acid from glycine
8. Preparation of aniline from nitrobenzene
9. Preparation of s-benzylisothiouronium chloride
10. Preparation of benzoic acid from benzaldehyde

PART-B

Qualitative analysis: Separation of binary mixtures, identification of functional groups and preparation of suitable solid derivatives.

References

1. Vogel' text book of practical organic chemistry, V edition, B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatehell.
2. Elementary practical organic chemistry, Part-I: Small scale preparations, Part-II: Qualitative organic analysis, By Arthur I, Vogel.
3. Hand book of organic analysis, H. T. Clarke and Norman Collie.
4. Experiments in Organic Chemistry, Louis F. Fieser.
5. Laboratory manual of Organic Chemistry by B. B. Dey and M. V. Sitaraman.
6. Practical Organic Chemistry by Mann F. G. and Saunders.

OCP SCP: 1.3/2.3. PHYSICAL CHEMISTRY PRACTICALS – I

[128 HOURS]

Objectives:

- To understand the rate of chemical reactions by carrying out kinetic experiments.
- To understand basic concepts of electrochemistry by carrying out several experiments.

Course outcome:

- After the completion of this course, the students can able to develop the experimental skill and theoretical interpretation of experimental results of many physical chemistry experiments of

chemical kinetics in solution phase, thermodynamics, electrochemistry and spectrophotometry.

- This helps in academics, research and industries.

Pedagogy:

- Each student performs experiments as per the protocol in practical classes.
- To optimize the reaction conditions for understanding the rate of chemical reactions.

Course Experiments:

PART - A

1. Study of kinetics of hydrolysis of methyl acetate in presence of two different concentrations of HCl/H_2SO_4 and report the relative catalytic strength.
2. Study of kinetics of reaction between $K_2S_2O_8$ and KI, first order, determination of rate constants at two different temperatures and E_a.
3. To study the kinetics of saponification of ethyl acetate by conductivity method at two different concentrations of NaOH and report the relative catalytic strength.
4. Determination of partial molar volume of salt-water system ($NaCl-H_2O/KCl-H_2O/KNO_3-H_2O$) systems.
5. To study the kinetics of reaction between acetone and iodine - determination of order of reaction with respect to iodine and acetone.
6. Study the kinetics of decomposition of diacetone alcohol by NaOH, determine the catalytic coefficient of the reaction and comparison of strength of alkali.
7. Determination of energy of activation for the bromide-bromate reaction.
8. Kinetics of reaction between sodium formate and iodine and determination of energy of activation.
9. Determination of heat of solution of organic acid (benzoic acid/salicylic acid) by variable temperature method (graphical method).
10. Determination of degree of association of benzoic acid in benzene by distribution method.
11. To determine the eutectic point of a two component system (Naphthalene-*m*-dinitrobenzene system).
12. Analysis of a binary mixture (Gylcerol & Water) by measurement of refractive index.
13. Determination of the molecular weight of a polymer material by viscosity measurements (cellulose acetate/methyl acrylate).

PART - B

1. Conductometric titration of a mixture of HCl and CH_3COOH against NaOH.
2. Conductometric titration of sodium sulphate against barium chloride.
3. pH titration of (a) HCl against NaOH (b) Copper sulphate against NaOH and (c) $CH_3COOH/HCOOH$ against NaOH - determination of K_a.
4. Determination of equivalent conductance of weak electrolyte (CH_3COOH) at infinite dilution following Kohlrausch law.
5. Determination of dissociation constant and mean ionic activity coefficient of weak acids ($CH_3COOH/HCOOH/ClCH_2COOH$) by conductivity method.
6. Potentiometric titration of KI *vs* $KMnO_4$ solution.
7. Determination of dissociation constant of a weak acid ($CH_3COOH/HCOOH/ClCH_2COOH$) by potentiometric method.
8. Potentiometric titration of a mixture of halides ($KCl+KI/KCl+KBr/KBr+KI$) against $AgNO_3$.
9. To obtain the absorption spectra of coloured complexes, verification of Beer's law and estimation of metal ions in solution using a spectrophotometer.
10. Potentiometric titration of $K_2Cr_2O_7$ against FAS determination of redox potential and concentration of Fe^{2+} ions.
11. Conductometric titration of oxalic acid against NaOH and NH_4OH.
12. Coulometric titration I_2 vs $Na_2S_2O_3$.

13. Determination of acidic and basic dissociation constant and isoelectric point of an amino acid by pH metric method.
14. Kinetics of photodegradation of indigocarmine (IC) using ZnO/TiO_2 as photocatalyst and study the effect of [ZnO/TiO_2] and [IC] on the rate of photodegradation.

References

1. Practical Physical Chemistry – A.J. Findlay.
2. Experimental Physical Chemistry – F. Daniels *et al*.
3. Selected Experiments in Physical Chemistry – Latham.
4. Experiments in Physical Chemistry – James and Prichard.
5. Experiments in Physical Chemistry – Shoemaker.
6. Advanced Physico-Chemical Experiments – J. Rose.
7. Practical Physical Chemistry – S.R. Palit.
8. Experiments in Physical Chemistry – Yadav, Geol Publishing House.
9. Experiments in Physical Chemistry – Palmer.
10. Experiments in Chemistry – D.V. Jahagirdar, Himalaya Publishing House, Bombay, (1994).
11. Experimental Physical Chemistry – R.C. Das and B. Behera, Tata Mc Graw Hill.

OCA SCP: 1.4/2.4. ANALYTICAL CHEMISTRY PRACTICALS-I

[128 HOURS]

Objectives:

- To understand basic concepts by carrying out analytical experiments.
- The experimental results are subjected to validation of analytical parameters.

Course outcome:

- Develop the skill to carry out acid-base titrimetric analysis, potentiometric and conductometric methods.
- Understand the chemistry of different chemical reactions involved in the determination of pharmaceutical, industrial and vegetable samples.

Pedagogy:

- Computer aided applications for the evaluation of experimental results.
- Each student performs experiments as per the protocol in practical classes.

Course Experiments:

PART-A

1. Determination of total acidity of vinegar and wines by acid-base titration.
2. Determination of purity of a commercial boric acid sample, and Na_2CO_3 content of washing soda.
3. Analysis of chromate-dichromate mixture by acid-base titration.
4. Determination of replaceable hydrogen and relative molecular mass of a weak organic acid by titration with NaOH.
5. Determination of ephedrine and aspirin in their tablet preparations by residual acid-base titrimetry.
6. Determination of purity of aniline and assay of chlorpromazine tablets by non-aqueous acid-base titration.
7. Periodate determination of ethylene glycol and glycerol (Malprade reaction).
8. Determination of carbonate and bicarbonate in a mixture by *p*H-metric titration and comparison with visual acid-base titration.
9. Determination of purity of a commercial sample of mercuric oxide by acid-base titration.
10. Determination of benzoic acid in food products by titration with methanolic KOH in chloroform medium using thymol blue as indicator.
11. Determination of the *p*H of hair shampoos and *p*H determination of an unknown soda ash.
12. Analysis of water/waste water for acidity by visual, *p*H metric and conductometric titrations.

13. Analysis of water/waste water for alkalinity by visual, *p*H metric and conductometric titrations.
14. Determination of carbonate and hydroxide-analysis of a commercial washing soda by visual and *p*H-titrimetry.
15. Determination of ammonia in house-hold cleaners by visual and conductometric titration.
16. Potentiometric determination of the equivalent weight and Ka for a pure unknown weak acid.
17. Spectrophotometric determination of creatinine and phosphorus in urine.
18. Flame emission spectrometric determination of sodium and potassium in river/lake water.
19. Spectrophotometric determination of *p*Ka of an acid-base indicator.

PART-B

1. Determination of percentage of chloride in a sample by precipitation titration-Mohr, Volhard and Fajan's methods.
2. Determination of silver in an alloy and Na_2CO_3 in soda ash by Volhard method.
3. Mercurimetric determination of blood or urinary chloride.
4. Determination of total hardness, calcium and magnesium hardness and carbonate and bicarbonate hardness of water by complexation titration using EDTA.
5. Determination of calcium in calcium gluconate/calcium carbonate tablets/injections and of calcium in milk powder by EDTA titration.
6. Analysis of commercial hypochlorite and peroxide solution by iodometric titration.
7. Determination of copper in an ore/an alloy by iodometry and tin in stibnite by iodimetry.
8. Determination of ascorbic acid in vitamin C tablets by titrations with KBrO3 and of vitamin C in citrus fruit juice by iodimetric titration.
9. Determination of iron in razor blade by visual and potentiometric titration using sodium metavanadate.
10. Determination of iron in pharmaceuticals by visual and potentiometric titration using cerium(IV) sulphate.
11. Determination of nickel in steel by synergic extraction and boron in river water/sewage using ferroin.
12. Determination of total cation concentration of tap water by ion-exchange chromatography.
13. Determination of magnesium in milk of magnesium tablets by ion-exchange chromatography.
14. Cation exchange chromatographic separation of cadmium and zinc and their estimation by EDTA titration.
15. Gas chromatographic determination of ethanol in beverages.
16. Determination of aspirin, phenacetin and caffeine in a mixture by HPLC.
17. Solvent extraction of zinc and its spectrophotometric determination.
18. Anion exchange chromatographic separation of zinc and magnesium followed by EDTA titration of the metals.
19. Separation and determination of chloride and bromide on an anion exchanger.
20. Thin layer chromatographic separation of amino acids.

References

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry, G.D. Christian, 5th edition, 2001 John Wiley & Sons, Inc, India.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993, Prentice Hall, Inc. New Delhi.
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, 2003, Pearson Education Pvt. Ltd., New Delhi.
5. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders College Publishing, California, 1990.

6. Practical Clinical biochemistry methods and interpretations, R. Chawla, J.P. Bothers Medical Publishers (P) Ltd., 1995.
7. Laboratory manual in biochemistry, J. Jayaraman, New Age International Publishers, New Delhi, 1981.
8. Practical Clinical Biochemistry by Harold Varley and Arnold.Heinmann, 4th edition.

SOFT CORE THEORY

OCI SCT: 1.1. CHEMISTRY OF SELECTED ELEMENTS

Objectives:

- To learn basic chemistry of some selected group elements from periodic table.
- To understand properties of metal-metal bonding and cluster compounds.

Course outcome:

- Understand the chemistry of hydrogen and group 2 elements.
- The chemistry of pseudohalogens, interhalogens and their halogen compounds.
- The chemistry of xenon and other noble gas compounds.

Pedagogy:

- Conventional method such as black board and chalk can be used.
- Modern methods like power point presentation can also be used in class room teaching.

Course content:

UNIT-I

[16 HOURS]

Compounds of hydrogen: The hydrogen and hydride ions, Dihydrogen and hydrogen bonding. Classes of binary hydrides: Molecular hydrides, saline hydrides and metallic hydrides.

The Group 1 elements: Occurrence, extraction and uses. Simple compounds: Hydrides, halides, oxides, hydroxides, oxoacids, nitrides, solubility and hydration and solutions in liquidammonia. Coordination and organometallic compounds. Applications.

The Group 2 elements: Occurrence, extraction and uses. General properties.Halides, hydrides and salts of oxo acids. Complex ion in aqueous solution and complexes with amido and alkoxy ligands.

The Group 15 elements: Introduction, oxides and oxoacids of nitrogen and phosphorus.

UNIT-II

[16 HOURS]

The Group 17 elements: Occurrence, recovery and uses. Trends in properties and pseudohalogens. **Interhalogens**: Physical properties and structures, chemical properties, cationic interhalogens. **Compounds with oxygen**: Halogen oxides, oxoacids and oxoanions**.** Trends in rates of redox reactions and redox properties of individual oxidation states**.**

Chemistry of astatine.

The Group 18 elements: Occurrence, recovery and uses. Synthesis and structure of xenon fluorides, Reaction of xenon fluorides, xenon-oxygen compounds, Organoxenon compounds, other compounds of noble gases.

M-M bonds: Multiple metal-metal bonds.

Cluster compounds: carbonyl and carbide clusters.

References

1. Basic Inorganic Chemistry – 3rd edition. F.A. Cotton, G. Wilkinson and P.L. Gaus, John
2. Wiley and Sons (2002).
3. Inorganic Chemistry, 3rd edition. James E. Huheey, Harper and Row Publishers (1983).
4. Inorganic Chemistry, 3rd edition. G.L. Miessler and D.A. Tarr, Pearson Education (2004).
5. Inorganic Chemistry, 4th edition. C.E. Housecroft and A.G. Sharpe, Pearson Education Ltd. (2012).

6. Chemistry of the Elements – N.N. Greenwood and A. Earnshaw, Pergamon Press (1985).
7. Inorganic Chemistry, 6th edition. D.F. Shriver, M. Weller. T. Overton, J. Rourke and F. Armastrong, Oxford University Press (2014).

OCO SCT: 1.2. NATURAL PRODUCTS-I

Objectives:

- To learn the nomenclature, classification, purification, structure and synthesis of some natural products.
- To understand the biological functions of bio molecules.

Course outcome:

- Acquire the knowledge of chemistry of lipids, prostaglandins and terpenoids.
- Understand the biological importance of chlorophyll and porphyrins.
- Chemistry of flavonoids and isoflavonoids.

Pedagogy:

- Conventional method such as black board and chalk can be used.
- Modern methods like power point presentation can also be used in class room teaching.

Course content:

UNIT-I

[16 HOURS]

Lipids: Nomenclature, classification, purification, structure and synthesis of fatty acids, phospholipids, sphingolipids. Biological importance of lipids (Lecithin, sphingolipids, oils and fats).
Prostaglandins: Introduction, classification and biological importance of PG's. Constitution of PGE1. Synthesis of PGE & F series.

UNIT-II

[16 HOURS]

Porphyrins: Introduction, structure and biological functions of haemin. Vitamin B12: structure and as coenzyme in molecular rearrangement reactions; Chlorophyll: structure and biological importance.
Flavonoids and Isoflavonoids: Occurrence, nomenclature and general methods of structure determination. Isolation and synthesis of Apigenin, Luteolin, Kaempferol, Quercetin, wedelolactone, Butein, Daidzein. Biosynthesis of flavonoids and isoflavonoids: Acetate Pathway and Shikimic acid Pathway. Biological importance of flavonoids and isoflavonoids

References

1. Organic Chemistry, VI edition, Robert T. Morrison, Robert N. Boyd.
2. Organic Chemistry, Vol-II by I. L. Finar.
3. Schaum's outline of theory and problems of Organic Chemistry, Harbert Meislich, Howard Nechamkin and Jocob Sharefkin.
4. Natural products: Their chemistry and biological significance, J. Mann, R. S. Davidson, J. B. Banthorpe and J. B. Harborne.
5. Synthetic drugs, Gurdeep R. Chatwal.
6. Heterocyclic chemistry by Achison.
7. Heterocyclic chemistry by Smith and Joule.
8. Heterocyclic chemistry by Pacquete.

OCP SCT: 1.3. BIOPHYSICAL CHEMISTRY

Objectives:

- To understand the physico-chemical principles of biological fluids.
- To learn the pharmaco kinetics, pharmaco dynamics, toxico kinetics of biological systems.

Course outcome:

- After the completion of this course, the students gain the knowledge on theory and principles of biophysical chemistry and pharmacokinetics.
- This course helps to understanding the bio-availability and different pharmacokinetic parameters of drugs in the living system.

Pedagogy:

- Conventional method such as black board and chalk can be used.
- Modern methods like power point presentation can also be used in class room teaching.

Course content:

UNIT-I

[16 HOURS]

Biophysical Chemistry: Electrophoresis - Principles of free electrophoresis, zone electrophoresis, gel electrophoresis and its applications in qualitative and quantitative study of proteins. Determination of isoelectric point of a protein. Electro-osmosis and streaming potential and its biological significance. Biological significance of Donnan membrane phenomenon. Micelles and its involvement during digestion and absorption of dietary lipids. Diffusion of solutes across bio-membranes and its application in the mechanism of respiratory exchange. "Salting In" and "Salting Out" of proteins. Osmotic behaviour of cells and osmo-regulation and its application in the evolution of excretory systems of organisms. Effect of temperature and *p*H on the viscosity of bio-molecules (albumin solution). Significance of viscosity in biological systems - mechanism of muscle contraction, polymerization of DNA and nature of blood flow through different vessels. Effect of temperature, solute concentration (amino acids) on surface tension. Biological significance of surface tension - stability of Alveoli in lungs, interfacial tension in living cells (Danielli and Davson model). Application of sedimentation velocity and sedimentation equilibrium method for molecular weight determination of proteins.

UNIT-II

[16 HOURS]

Pharmacokinetics: Introduction, biopharmaceutics, pharmacokinetics, clinical pharmacokinetics, pharmacodynamics, toxicokinetics and clinical toxicology. Measurement of drug concentration in blood, plasma or serum. Plasma level-time curve, significance of measuring plasma drug concentrations.

One compartment open model: Intravenous route of administration of drug, elimination rate constant, apparent volume of distribution and significance. Calculation of elimination rate constant from urinary excretion data, clinical application.

Two compartment model: Plasma level-time curve, relationship between tissue and plasma drug concentrations, Apparent volumes of distribution. Drug clearance, clinical example. Plasma level-time curve for a three compartment open model.

Drug absorption: Factors affecting the rate of drug absorption - nature of the cell membrane, Route of drug administration - Oral drug absorption, Intravenous infusion and intravenous solutions, Effect of food on gastrointestinal drug absorption rate.

References

1. Introduction to Physical Organic Chemistry, R.D. Gilliom, Madison – Wesley, USA (1970).
2. Physical Organic Chemistry- Reaction Rate and Equilibrium Mechanism – L.P. Hammett, McGraw HillBook, Co., (1970).
3. Biophysical Chemistry- Principle and Technique – A. Upadhyay, K. Upadhyay and N. Nath, Himalaya Publishing House, Bombay, (1998).
4. Essentials of Physical Chemistry and Pharmacy – H. J. Arnikar, S. S. Kadam, K.N. Gujan, Orient Longman, Bombay, (1992).
5. Applied Biopharmacokinetics and Pharmacokinetics - Leon Shargel, Andrew YuPrentice-Hall International, Inc (4th edition).

6. Essentials of Physical Chemistry and Pharmacy – H.J. Arnikar, S.S. Kadam, K.N. Gujan, Orient Longman, Bombay, (1992).

OCA SCT: 1.4. TITRIMETRIC ANALYSIS

Objectives:

- To familiarize statistical methods to validate analytical methods.
- To learn sampling techniques and conventional volumetric methods.

Course outcome:

- To enhance the skills on sampling, purification, characterizations and data analysis using instrumental techniques.
- Build a foundation of chemical principles for understanding the behavior of chemical constituents in samples.
- To understand the basic Principle of Instrumentation and analytical applications.

Pedagogy:

- Teaching through conventional method such as black board and chalk, and modern methods like power point presentation.
- To evaluate validation parameters, MS-Office tools *viz* MS-Excel sheets can be used.

Course Contents:

UNIT-I [16 HOURS]

Obtaining and preparing samples for analysis: Importance of sampling, designing a sample plan-random, judgement, systematic-judgement, stratified and convenience sampling. Type of sample to collect - grab and composite samples. Insitu sampling. Size of sample and number of samples. Implementing the sampling plan - solutions, gases and solids. Bringing solid samples into solution - digestion and decomposing.

Titrimetric analysis: An overview of titrimetry. Principles of titrimetric analysis. Titration curves. Titrations based on acid-base reactions - titration curves for strong acid and strong base, weak acid and strong base and weak base and strong acid titrations. Selecting and evaluating the end point. Finding the end point by visual indicators, monitoring *p*H and temperature.

Quantitative applications – selecting and standardizing a titrant, inorganic analysis - alkalinity, acidity and free CO_2 in water and waste waters, nitrogen, sulphur ammonium salts, nitrates and nitrites, carbonates and bicarbonates. Organic analysis - functional groups like carboxylic acid, sulphonic acid, amine, ester, hydroxyl, carbonyl. Air pollutants like SO_2. Quantitative calculations. Characterization applications - equivalent weights and equilibrium constants.

Acid-base titrations in non-aqueous media: Role of solvent in acid-base titrations, solvent systems, differentiating ability of a solvent, some selected solvents, titrants and standards, titration curves, effect of water, determining the equivalence point, typical applications - determination of carboxylic acids, phenols and amines.

UNIT-II

[16 HOURS]

Precipitation titrations: Titration curves, feasibility of precipitation titrations, factors affecting shape - titrant and analyte concentration, completeness of the reaction, titrants and standards, indicators for precipitation titrations involving silver nitrate, Volhard, Mohr and Fajan's methods, typical applications.

Complexometric titrations: Complex formation reactions, stability of complexes, stepwise formation constants, chelating agents, EDTA - acidic properties, complexes with metal ions, equilibrium calculations involving EDTA, conditional formation constants, derivation of EDTA titration curves, effect of other complexing agents, factors affecting the shape of titration curves - completeness of reaction, indicators for EDTA titrations - theory of common indicators, titration methods employing EDTA - direct, back and displacement titrations, indirect determinations, titration of mixtures.

Redox titrations: Balancing redox equations, calculation of the equilibrium constant of redox reactions, calculating titration curves, detection of end point, visual indicators and potentiometric end point detection. Quantitative applications-adjusting the analyte's oxidation state, selecting and standardizing a titrant. Inorganic analysis- chlorine residuals, dissolved oxygen in water, water in non-aqueous solvents. Organic analysis-chemical oxygen demand (COD) in natural and waste waters, titrations of mercaptans and ascorbic acid with I_3^- and titration of organic compounds using periodate.

References

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch, 8th edition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry, G.D. Christian, 5th edition, 2001, John Wiley & Sons, Inc, India.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993, Prentice Hall, Inc. New Delhi.
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, 2003, Pearson Education Pvt. Ltd., New Delhi.
5. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993 prenticeHall, Inc. New Delhi.
6. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders CollegePublishing, California, 1990.
7. Principles and Practice of Analytical Chemistry, F.W. Fifield and Kealey, 3rd edition, 2000, Blackwell Sci., Ltd. Malden, USA.
8. Modern Analytical Chemistry, David Harvey, McGraw Hill, New Delhi, 2000.

SECOND SEMESTER

HARD CORE THEORY

OCI HCT: 2.1. COORDINATION CHEMISTRY

Objectives:

- To understand the preparation, properties, electronic configuration and structural elucidation of coordination compounds.
- To learn the reaction mechanism, stereochemistry and photochemistry of coordination compounds.

Course outcome:

- Gain the knowledge of preparative methods of coordination compounds and geometries of different coordination numbers.
- Understand the CFT and MOT bonding theories to metal complexes.
- Electronic spectra, magnetic properties and infrared spectroscopy of coordination compounds. In addition, understand the reaction mechanism and photochemistry of coordination compounds.

Pedagogy:

- Conventional method such as black board and chalk can be used.
- Modern methods like power point presentation can also be used in class room teaching.

Course content:

UNIT-I

[16 HOURS]

Preparation of coordination compounds: Introduction, Preparative methods- simple addition reactions, substitution reactions, oxidation-reduction reactions, thermal dissociation reactions. Geometries of metal complexes of higher coordination numbers (2-12).

Stability of coordination compounds: Introduction, trends in stepwise stability constants, factors influencing the stability of metal complexes with reference to the nature of metal ion and ligands, the Irving-William series, chelate effect.

Determination of stability constants: Theoretical aspects of determination of stability constants of metal complexes by spectrophotometric and polarographic methods.

Crystal field theory: Salient features of CFT, d-orbital splitting in octahedral, tetrahedral, square planar and tetragonal complexes, Jahn-Teller distortions, measurement of 10 Dq and factors affecting it. Evidences for metal-ligand covalency.

Molecular Orbital Theory: MOT to octahedral, tetrahedral and square planar complexes without and with pi-bonding.

UNIT-II

[16 HOURS]

Electronic spectra: Introduction, selection rules and intensities, electronic spectra of octahedral and tetrahedral complexes, Term symbols for d^n ions, Orgel and Tanabe-Sugano diagrams, charge-transfer spectra. Ligand-field transition. Charge transfer and energy applications. Optical rotatory dispersion and Circular dichroism. Magnetic circular dichroism.

Magnetic properties: Introduction, magnetic susceptibility and its measurements, spin and orbital contributions to the magnetic moment, the effects of temperature on μeff, spin-cross over, ferromagnetism, anti-ferromagnetism and ferrimagnetism.

Applications of infrared spectroscopy of coordination compounds: Metal complexes of ammine, nitro, nitrito, hydroxo, carbonato, sulphato, cyano, cyanato and thiocyanato complexes.

UNIT-III

[16 HOURS]

Reactions and Mechanisms: Introduction. Substitution reactions- Inert and labile compounds, mechanisms of substitution. Kinetic consequences of Reaction pathways- Dissociation, interchange and association.Experimental evidence in octahedral substitution- Dissociation, associative mechanisms, the conjugate base mechanism, the kinetic chelate effect.

Stereochemistry of reactions- Substitution in *trans* and its complexes, isomerization of chelate rings. Substitution reactions of square-planar complexes-kinetics and stereochemistry of square-planar substitutions, evidence for associative reactions, explanations of the *trans* effect.

Electron-transfer processes: Inner-sphere mechanism and outer-sphere mechanism, conditions for high and low oxidation numbers.

Photochemistry of coordination compounds: Photochemistry of chromium(III) ammine compounds, Light-induced excited state spin trapping in iron(II) compounds and MLCT photochemistry in pentammineruthenium(II) compounds.

References

1. Physical Inorganic Chemistry- A Coordination Chemistry Approach- S.F.A. Kettle, Spektrum, Oxford, (1996).
2. Inorganic Chemistry-4th edition. C.E. Housecroft and A.G. Sharpe, Pearson Education Ltd. (2012).
3. Inorganic Chemistry-5th edition. G.L. Miessler, P. J. Fischer and D.A. Tarr, Pearson (2014).
4. Inorganic Chemistry-6th edition. D.F. Shriver, M. Weller. T. Overton, J. Rourke and F. Armastrong, Oxford University Press (2014).
5. Inorganic Chemistry- 3rd edition, James E. Huheey, Harper and Row Publishers, (1983).
6. Basic Inorganic Chemistry- 3rd edition, F.A. Cotton, G. Wilkinson and P.L. Gaus, John Wiley and Sons, (2002).
7. Infrared and Raman Spectra of Coordination Compounds, Part-B- 6th edition, K. Nakamoto, John Wiley and Sons (2009).

OCO HCT: 2.2. SYNTHETIC ORGANIC CHEMISTRY

Objectives:

- To understand the reactions of organic compounds involving various reagents.
- To learn the synthesis and retro-synthesis of different organic compounds.

Course outcome:

- Students are familiar about chemistry of oxidants, reductants and their applications in the organic synthesis.
- Understand the various catalysts in organic synthesis by known naming reactions.
- Retro-synthesis and molecular rearrangement.

Pedagogy:

- Conventional method such as black board and chalk can be used.
- Modern methods like power point presentation can also be used in class room teaching.

Course content:

UNIT-I

[16 HOURS]

Oxidation: Oxidation with chromium and manganese reagents (CrO_3, $K_2Cr_2O_7$, PCC, PDC, Sarret reagent, MnO_2, $KMnO_4$, ozone, peroxides and peracids, periodic acid, OsO_4, SeO_2, NBS, Oppenauer oxidation, Sharpless epoxidation.

Reduction: Catalytic hydrogenation (homogeneous and heterogeneous) – catalysts (Pt, Pd, Ra-C, Ni, Ru, Rh), solvents and reduction of functional groups, catalytic hydrogen transfer reactions. Wilkinson catalyst, $LiAlH_4$, $NaBH_4$, DIBAL-H, Sodium cyanoborohydride, dissolving metal reactions (Birch reduction). Leukart reaction (reductive amination), diborane as reducing agent, Meerwein-Ponndorf-Verley reduction, Wolff-Kishner reduction, Clemensen reduction, tributyl tinhydride, stannous chloride, Bakers yeast, Organoboron compounds: Introduction and preparations. Hydroboration and its applications. Reactions of organoboranes: isomerization reactions, oxidation, protonolysis, carbonylation, cyanidation. Reactions with aldehydes or ketones (*E* and *Z*-alkenes).

UNIT-II

[16 HOURS]

Reagents and reactions in organic synthesis: Use of following reagents in organic synthesis and functional group transformations: Lithium diisopropylamide (LDA), Gilmann reagent, dicyclohexyl carbodimide (DCC), dichlorodicyanoquinone (DDQ), Silane reagents-trialkylsilyl halides, trimethylsilyl cyanide, trimethyl silane, phase transfer catalyst, crown ethers, cyclodextrins, Ziegler-Natta catalyst, diazomethane, Woodward and Prevost hydroxylation, Stark enamine reaction, phosphorous ylides - Wittig and related reactions, sulphur ylides – reactions with aldehydes and ketones, 1,3-dithiane anions - Umpolung reaction, Peterson reaction. Palladium reagents: Suzuki coupling, Heck reaction, Negishi reaction. Green Chemistry: Definition and principles, planning green synthesis in the laboratory, green preparations- aqueous reactions, solid state (solvent free) reactions, photochemical reactions, enzymatic transformations and reactions in ionic liquids.

UNIT-III

[16 HOURS]

Molecular rearrangements: Introduction Carbon to carbon migration: Pinacol-pinacolone, Wagner-Meerwein, Benzidine, benzylic acid, Favorskii, Fries rearrangement, dienophile rearrangement. Carbon to nitrogen migration: Hofmann, Curtius, Lossen, Schmidt and Beckmann rearrangements. Miscellaneous rearrangements: Wittig, Smiles, Bayer-Villeger rearrangement and Barton reaction.

Retrosynthesis: Introduction to disconnection approach: Basic principles and terminologies used in disconnection approach. One group C-X and two group C-X disconnections. Synthons and synthetic equivalents. Retrosynthesis and synthesis of benzofurans, *p*-methoxy acetophenone, saccharine, α-bisabolene, nuciferal, tetralone, ibuprofen, functional group transformations in organic synthesis; nitro to keto, nitro to aniline, acid to alcohol etc..

References

1. Organic Chemistry, VI edition, Robert T. Morrison, Robert N. Boyd.
2. Organic Chemistry, Vol-I & II by I. L. Finar.
3. Advance Organic Chemistry, IV edition, Jerry March.
4. Advance Organic Chemistry, III edition, Part-A and Part-B, Francis A. Carey and Rechard J. Sundberg.
5. Organic Chemistry, III edition, V. K. Ahluwalia and Rakesh Kumar Parashar.
6. Organic named reactions and molecular rearrangements, Gudeep Raj.
7. Modern synthetic reactions, II edition, H. O. House.
8. Organic synthesis, Jagadamba Singh and L. D. S. Yadav.
9. Green Chemistry, K. R. Desai.
10. Principles of Organic synthesis, R. O. C. Norman and J. M. Coxon.
11. Organic synthesis II edition, V. K. Aluwalia and Renu Agarwal.
12. Organic synthesis, Robert E. Ireland.
13. Schaum's outline of theory and problems of Organic Chemistry, Harbert Meislich, Howard Nechamkin and Jocob Sharefkin.
14. Organic chemistry by Clayden, Greeves, Warren and Wothers.

OCP HCT: 2.3. PRINCIPLES OF PHYSICAL CHEMISTRY

Objectives:

- To understand the theoretical calculations of energies of simple molecules.
- To learn the calculation of different energies by statistical thermodynamics.
- To understand the basics of polymers, their kinetics and applications.

Course outcome:

- Principles of Quantum chemistry and theoretical calculations of energies of molecules and chemical reactions.
- Concepts and applicability of statistical thermodynamics in the calculations of different energies in the reacting system. Applications of phase rule for separation of the metals from ore.
- Fundamentals of polymers and their applications in controlling the quality and waste management of polymer product.

Pedagogy:

- Conventional method such as black board and chalk can be used.
- Modern methods like power point presentation can also be used in class room teaching.
- Assigning the students to solve the problems to understand the concepts.

Course content:

UNIT-I

[16 HOURS]

Quantum Chemistry: Introduction to quantum mechanics: Schrödinger wave equation, time-independent and time dependent Schrödinger wave equation and the relation between their solutions. Eigen functions and Eigen values. Physical interpretation of wave function. Concept of operators – Laplacian, Hamiltonian, Linear and Hermitian operators. Angular momentum operators and their properties. Commutative and non-commutative operators. Normalization, orthogonality and orthonormality of wave functions. Postulates of quantum mechanics. Solutions of Schrödinger wave equation for free particles, particle in a ring, particle in three dimensional box. Quantum mechanical degeneracy, tunnelling (no derivation). Wave equation for H-atom, separation and solution of R, ϕ and θ equations. Application of Schrodinger equation to rigid rotator and harmonic oscillator. Eigen functions and Eigen values of angular momentum. Ladder operator method for angular momentum.

UNIT-II

[16 HOURS]

Statistical thermodynamics: Objectives of statistical thermodynamics, concept of distribution, types of ensembles. Thermodynamic probability and most probable distribution law. Partition functions – definition, evaluation of translational, rotational and vibrational and electronic partition functions for monoatomic, diatomic and polyatomic gaseous molecules. Sackur-Tetrode equation for entropy of translation function. Calculation of thermodynamic functions and equilibrium constants in terms of partition functions. Different distribution laws (Types of statistics): Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac Statistics (derivation of the three distribution laws). Comparison of Bose-Einstein and Fermi-Dirac Statistics with Maxwell-Boltzmann statistics. Problems and their solutions.

Phase rule studies: Thermodynamic derivation of phase rule. Application of phase rule to the two component systems - compound formation with congruent melting point and incongruent melting points, Roozeboom's classification. Application of phase rule to three component systems- systems of three liquids and systems of two salts and water.

UNIT-III

[16 HOURS]

Polymers: Fundamentals of polymers - monomers, repeat units, degree of polymerization. Linear, branched and network polymers. Classification of polymers, Polymerization - condensation, addition, free radical, ionic, co-ordination polymerization and ring opening polymerization. Molecular weight and size, polydispersion. Average molecular weight concepts – number, weight and viscosity average molecular weight. Determination of molecular weights - viscosity method, osmotic pressure method, sedimentation and light scattering methods.

Kinetics of Polymerization - Condensation, addition, free radical, ionic, co-ordination polymerization.

Phase transitions in polymers and thermal characterization: Glass transition, crystallinity and melting- correlation with the polymer structure.

Polymers in solution: Criteria of polymer solubility, thermodynamics of polymer solutions.

Colloids: Types and classification, Micelles: Surface active agents, micellization, hydrophobic interaction, critical micellar concentration (CMC), factors affecting the CMC of surfactants, micellar catalysis.

References

1. Text Book of Physical Chemistry by Samuel Glasstone, MacMillan Indian Ltd., 2nd edition (1974).
2. Quantum Chemistry – A.K. Chandra. 2nd edition, Tata McGraw Hill Publishing Co. Ltd., (1983).
3. Quantum Chemistry – Eyring, Walter and Kimball. John Wiley and Sons, Inc., New York.
4. Quantum Chemistry – I.N. Levine. Pearson Education, New Delhi, (2000).
5. Theoretical Chemistry – S. Glasstone. East West Press, New Delhi, (1973).
6. Quantum Chemistry – R.K. Prasad, New Age International Publishers, (1996).
7. Text Book of Polymer Science, F.W. Billmeyer, Jr., John Wiley, London (1994).
8. Polymer Science. V. R. Gowrikar, N.V. Vishwanathan and J. Sreedhar, Wiley Eastern, New Delhi (1990).
9. Fundamentals of Polymer Science and Engineering. A. Kumar and S.K. Gupta, Tata –McGraw Hill New Delhi (1978).
10. Polymer Characterization, D. Campbell and J.R. White, Chapman and Hall, New York.
11. Fundamental Principles of Polymer Materials, R.L. Rosen, John Wiley and Sons, New York.

OCG HCT: 2.4. MOLECULAR SYMMETRY AND SPECTROSCOPY-I

Objectives:

- To understand the concepts of symmetry and symmetry operations and their application to CFT, hybridization, MOT and vibrational spectroscopy.
- To learn the theory and applications of microwave, vibration and Raman spectroscopy.
- To understand the principles and applications of UV-Visible and resonance Raman spectroscopy.

Course outcome:

- Molecular symmetry and applications of group theory to CFT, hybridization, MOT and vibrational spectroscopy.
- Theory and principles of Rotation, Vibration and Raman Spectroscopy.
- Theory and principles Electronic and Resonance Raman spectroscopy.

Pedagogy:

- Conventional method such as black board and chalk can be used.
- Molecular models can be used to teach symmetry aspects of molecules
- Modern methods like power point presentation can also be used in class room teaching.
- Students will be assigned to solve the numerical problems.

Course content:

UNIT-I

[16 HOURS]

Molecular symmetry and group theory: Symmetry elements and symmetry operations.

The Point Groups Used with Molecules: Concept of a group, definition of a point group. Classification of molecules into point groups. Subgroups.

Hermann-Maugin symbols for point groups. Multiplication tables (C_{2V}, C_{2h} and C_{3V}). Matrix notation for the symmetry elements. Classess and similarity transformation.

Representation of groups: The Great Orthogonality theorem and its consequences.

Character tables (C_s, C_i, C_2, C_{2v}, C_{2h} and C_{3v}). Symmetry and dipole moment.

Applications of group theory: Group theory and hybrid orbitals.

Symmetry in Chemical bonding: Group theory to Crystal fieldtheory and Molecular orbital theory (octahedral and tetrahedral complexes).

Symmetry in Vibrational Spectroscopy: Determining the symmetry groups of normal modes for non-linear molecules (H_2O, NH_3, CH_4, trans-N_2F_2) and linear molecules (CO, HCl, HCN and CO_2) (Integration method).

UNIT-II

[16 HOURS]

Microwave spectroscopy: Rotation spectra of diatomic Molecules - rigid and non rigid rotator model. Rotational quantum number and the selection rule. Effect of isotopic substitution on rotation spectra. Classification of polyatomic molecules based on moment of inertia. Rotation spectra of polyatomic molecules (OCS CH_3F and BCl_3). Moment of inertia expression for linear tri-atomic molecules. Applications - Principles of determination of Bond length and moment of inertia from rotational spectra. Stark effect in rotation spectra and determination of dipole moments.

Vibration spectroscopy*:* Vibration of diatomic molecules, vibrational energy curves for simple harmonic oscillator. Effects of anharmonic oscillation, expressions for fundamental and overtone frequencies. Vibration - rotation spectra of carbon monoxide. Vibration of polyatomic molecules – The number of degrees of freedom of vibration. Parallel and perpendicular vibrations (CO_2 and H_2O). Combination, difference and hot bands. Fermi resonance. Force constant and its significance. Theory of infrared absorption and theoretical group frequency. Intensity of absorption band and types of absorptions. Applications: Structures of small molecules: XY_2 – linear or bent, XY_3 – planar or pyramidal.

Raman spectroscopy: Introduction, Raman and Rayleigh scattering, Stokes and anti-Stokes lines, polarization of Raman lines, depolarization factor, polarizability ellipsoid. Theories of Raman spectra - classical and quantum theory. Rotation-Raman and vibration-Raman spectra. Raman activity of

vibrations, rule of mutual exclusion principle. Vibration modes of some simple molecules and their activity.

UNIT-III

[16 HOURS]

UV Visible spectroscopy: Quantitative aspects of absorption – Beer's law, Technology associated with absorption measurements. Limitations– real, chemical, instrumental and personal. Theory of molecular absorption. Vibration- rotation fine structure of electronic spectra. Types of absorption bands- n to π*, π to π*, n to σ* and σ to σ*, C-T and ligand field. Instrumentation.

Applications: Qualitative and quantitative analysis of binary mixtures, measurements of dissociation constants of acids and bases, determination of molecular weight. Woodwards empirical rules for predicting the wavelength of maximum absorption for olefins, conjugated dienes, cyclic trienes and polyenes, α,ß-unsaturated aldehydes and ketones, benzene and substituted benzene rings.

Resonance Raman Spectroscopy: Resonance Raman Effect and its applications. Non-linear Raman effects: Hyper, stimulated and inverse Raman effects. Coherent Anti-Stokes Raman Scattering and its applications.

References

1. Chemical Applications of Group Theory, 3rd edition, F.A. Cotton, John Wiley and
2. Sons (2006).
3. Molecular Symmetry and Group Theory – Robert L Carter, John Wiley and Sons (2005).
4. Symmetry in Chemistry - H. Jaffe and M. Orchin, John Wiley, New York (1965).
5. Molecular Symmetry – David J. Willock, John Wiley and Sons Ltd., (2009).
6. Group Theory and its Chemical Applications - P.K. Bhattacharya, HimalayaPublications, New Delhi (1998).
7. Fundamentals of Molecular Spectroscopy, C.N. Banwell and E.M. McCash. 4th edition, Tata McGraw Hill, New Delhi.
8. Fundamentals of molecular spectroscopy, G. M. Barrow, MgGraw Hill, New York (International students Edition), 1974.
9. Theoretical chemistry, S. Glasstone, affiliated East-West Press Pvt. Ltd, New Delhi, 1973.
10. Spectroscopy, B.P. Straughan and S. Walker, John Wiley & Sons Inc., New York, Vol. 1 and 2, 1976.
11. Vibration Spectroscopy Theory and Applications, D.N. Satyanarayana, New Age International, New Delhi (2004).
12. Spectroscopy, B.P. Straughan and S. Salker, John Wiley and Sons Inc., New York, Vol.2, 1976.
13. Organic Spectroscopy, William Kemp, English Language Book society, Macmillan, 1987.
14. Instrumental methods of analysis, H. H. Willard, L. L. Merritt and J. A. Dean, 7th Edition, 1988.

SOFT CORE THEORY

OCI SCT: 2.1. BASIC ORGANOMETALLIC CHEMISTRY

Objectives:

- To understand the fundamental concepts of organometallic chemistry and general principles of homogeneous and heterogeneous catalysis.
- To learn the concepts of metal clusters, silicates and silicones.

Course outcome:

- Fundamental concepts of organometallic chemistry and synthesis, structure and bonding in different organometallics and their applications.
- Homogeneous and heterogeneous catalysts and their applications in the synthesis of organic compounds in industries.
- Chemistry of main group elements, metal clusters, silicates and silicones and their applications in day to day life.

Pedagogy:

- Conventional method such as black board and chalk can be used.
- Modern methods like power point presentation can also be used in class room teaching.

Course content:

UNIT-I

[16 HOURS]

Fundamental concepts: Introduction, Classification of organometallic compounds by bond type, nomenclature, the effective atomic number rule, complexes that disobey the EAN rule, common reactions used in complex formation.

Organometallics of transition metals: Preparation, bonding and structures of nickel, cobalt, iron and manganese carbonyls. Preparation and structures of metal nitrosyls.

Ferrocene: Preparation, structure and bonding**. Metal-carbene and metal-carbyne complexes**.

Complexes containing alkene, alkyne, arene and allyl ligands: Preparation, structure and bonding.

UNIT-II

[16 HOURS]

General principles of Catalysis: Language of catalysis. Homogeneous and heterogeneous catalysts.

Homogeneous catalysis - Industrial Applications: Alkene hydrogenation and hydroformylation, The Wacker's process, Monsanto acetic acid process and L-DOPA synthesis, alkene oligomerizations, water-gas shift reactions. The Reppe reaction.

Heterogeneous catalysis –The nature of heterogeneous catalysts. Alkene polymerization: Ziegler-Natta catalysis, Fischer-Tropsch carbon chain growth. New directions in heterogeneous catalysis.

Zeolites as catalysts for organic transformation: Uses of ZSM – 5.

Alkene metathesis, hydroboration, arylation or vinylation of olefins (Heck reaction).

Biological and Medicinal Applications: Organomercury, organoboron, organosilicon and organoarsenic compounds.

References

1. Organometallic Chemistry, 2nd edition, R.C. Mehrothra and A. Singh, New Age International Publications (2006).
2. The Organometallic Chemistry of the Transition Metals, 4th edition, Robert H. Crabtree, Wiley Interscience, (2005).
3. Organometallics - A Concise Introduction, 2nd edition, ChistophElschenbroich and Albert Salzer VCH, (1992).
4. Inorganic Chemistry, 2nd edition, C.E. Housecroft and A.G. Sharpe, Pearson Education Ltd., (2005).
5. Inorganic Chemistry- 3rd edition, G.L. Miessler and D.A. Tarr, Pearson Education,(2004).
6. Basic Organometallic Chemistry - B.D. Gupta and A.J. Elias, Universities Press (2010).
7. Inorganic Chemistry Principles of Structure and Reactivity: James E. Huheey, Ellen A. Keiter, Richard L. Keiter, Okhil K. Medhi, Delhi University, New Delhi (2006)
8. Inorganic Chemistry, 6th edition. D.F. Shriver, M. Weller. T. Overton, J. Rourke and F. Armastrong, Oxford University Press (2014).
9. Organometallic Chemistry and Catalysis, Didier Astruc, Springer (2007).

OCO SCT: 2.2. FOOD AND DRUGS ANALYSIS

Objectives:

1. To study basic theories of analytical methods.
2. To learn principles and instrumentations of several analytical techniques to determine food and drugs.
3. To learn the several methods and their utilization in determinations.

Course Outcome:

After the completion of this course, the students gain the knowledge of;

1. Basic theories of pharmaceutical methods of analysis.
2. Principles and instrumentations of several analytical techniques to determine active genotoxic impurities.
3. Obtain the knowledge of analytical methods for the determinations of foods and APIs.

Pedagogy:

- Conventional method such as black board and chalk can be used.
- Modern methods like power point presentation can also be used in class room teaching.

Course contents:

UNIT-I

[16 Hours]

Food analysis: Objectives of food analysis. Sampling procedures. Detection and determination of sugars and starch. Methods for protein determination. Oils and fats and their analysis - iodine value, saponification value and acid value. Rancidity - detection and determination (peroxide number). Tests for common edible oils. Analysis of foods for minerals - phosphorus, sodium, potassium and calcium. General methods for the determination of moisture, crude fibre and ash contents of food. Analysis of milk for fat and added water. Non-alcoholic beverages -determination of chicory and caffeine in coffee; caffeine and tannin in tea. Alcoholic beverages -methanol in alcoholic drinks and chloral hydrate in toddy. Food additives - chemical, preservatives - inorganic preservatives - sulphur dioxide and sulphites, their detection and determination. Organic preservatives - benzoic acid and benzoates, their detection and determination. Flavouring agents - detection and determination of vanilla and vanillin. Coloring matters in foods - classification, certified colors, detection of water soluble dyes, color in citrus fruits, beet dye in tomato products, mineral color. Pesticide residues in foods - determination of chlorinated organic pesticides. Control food quality - codex alimentarius, Indian standards.

UNIT-II

[16 Hours]

Drugs and pharmaceutical analysis: Importance of quality control; drugs and pharmaceuticals.
Sources of impurities in pharmaceutical chemicals. Analytical quality control in finished/ final products. Brief introduction on common methods of assay and validation parameters.
Analysis of common drugs; Analgesics - aspirin, paracetamol; Anthelmintics - mebendazole; Antiallergies - chlorpheneramine malleate; Antibiotics - penicillin, chloromecytin; Anti-inflammatory agents - oxyphenbutazone; Antimalarials - primaquine phosphate; Antituberculosists - INH; Narcotics - nicotine, morphine; Expectorants - Benadryl; Sedative - diazepam; Vitamins - A. C, B1, B2, B6, niacin and folic acid.
Blood - estimation of glucose, cholesterol, urea, haemoglobin and bilirubin.
Urine - urea, uric acid, creatinine, calcium phosphate, sodium, potassium and chloride.

References:

1. Standard Methods of Chemical Analysis, A.J. Weleher (Part B), Robert E. Kriegor Publishing Co. USA, 1975.

2. Food Analysis, A.G. Woodman, McGraw Hill. 1971.

3. Chemical Analysis of Foods, H.E. Cox and Pearson.

4. Analysis of Foods and Food Products, J.B. Jacob.

5. A First Course in Food Analysis, A.Y. Sathe, New Age Internationals (P) Ltd., Publishers, Bangalore, 1999.

6. Analytical Agricultural Chemistry, S.L. Chopra and J.S. Kanwar, Kalyani Publishers, New Delhi, 1999.

7. Pharmaceutical Analysis, (Ed). T. Higuchi and E.B. Hanssen, John Wiley and Sons, New York, 1997.

8. Pharmaceutical Analysis - Modern Methods, Part A and B, (Ed). James W. Hunson.

9. Quantitative Analysis of Drugs in Pharmaceutical Formulations, P. D. Sethi, 3rd edition. CBS Publishers and Distributors, New Delhi, 1997.

OCO SCT: 2.3. SURFACE CHEMISTRY AND METAL FINISHING

Objectives:

- To study fundamentals and theoretical background on the concepts of surface chemistry, electron microscopic methods and electrochemical methods. This helps in understanding the electroplating and electrochemical synthesis.

Course Outcome:

- The completion of this course will enable the students to gain the knowledge on fundamentals and theoretical background on the concepts of surface chemistry, electron microscopic methods and electrochemical methods. This helps in understanding the electroplating and electrochemical synthesis.

Pedagogy:

- Teaching through black board and chalk and power point presentation.

Course content:

UNIT – I

[16 Hours]

Surface Chemistry: Review of adsorption curves, adsorption-desorption, adsorption forces, heat of adsorption and types. Measurement of heat of adsorption (Calorimetric and Clausius Clapeyron methods). Measurement of adsorption isotherms, (Volumetric and Gravimetric methods). Determination of entropy of adsorption, Electrostatic adsorption. Adsorption indicators and their applications. Volcanic curves, Applications of adsorption.

Adsorption Theories: Polanyi's potential theory and Polarization theory, Hysteresis of adsorption.

Surface Structure: Surface mobility, Surface heterogeneity, Surface area and its determination by point-B method. Harkins-Jura method. Radioactive tracer method and Benton and White method. Importance of surface area. Examination of surfaces by Interferometer method. Scanning electron microscopy (SEM), Low energy electron diffraction method (LEED method). Field Emission spectroscopy. Auger electron spectroscopy (AES), STM, and TEM.

UNIT – II

[16 Hours]

Metal finishing: Definition, important processes of metal f1nishing, technological importance of metal finishing.

Electroplating: Definition, theory and mechanism of electroplating, effect of plating variables on the properties of electrodeposits. Comparative account of complexing and non-complexing baths (general treatment), additives in the plating bath and their significance.
Metallic coating: Preparation of substrate surface, Electroplating of Cu and Cr, Applications of Au and Ag plantings.
Solar selective coatings: Characteristics, methods of preparation and applications.
Techniques of electroplating: Galvanizing, Anodizing, Phosphating, Chromating.
Electroless plating: Definition, advantages over electroplating, pre-treatment of substrates, an account of electroless plating of Ni including applications.
Testing of coats: Principles of measurement of coating thickness, adhesion, porosity, corrosion resistance, reflectance, and hardness. A brief account of surface analysis by XPS and AES techniques.
Industrial effluent treatment: An account of removal of toxicants like, CN, Cr, Pb and Cd from plating industrial effluent.
Electrochemical synthesis: Special features of electrochemical synthesis compared to conventional synthesis, reaction variables (electrode material, electrode potential, solvent, supporting electrolyte, temperature, agitation) in electrochemical synthesis. Examples for electro-organic, electro-inorganic and electrochemical nanoparticles synthesis with mechanism.

References

1. Physical Chemistry of Surfaces - A. W. Adamson, Interscience Publishers Inc., New York (1967).
2. Surface Chemistry: Theory and Applications - J. J Bikertman, Academic Press, New York (1972).
3. Physical Chemistry - R. J. Silbey. R. A. Alberty and M G Bawendi, Wiley (2009).
4. Physics at Surfaces – A. Zangwill, Cambridge University Press (1988).
5. Surface Crystallography - L. J Clarke, Wiley, Interscience (1985).
6. Fundamentals of Electrochemical Deposition - Milan Paunovic and Mordechay Schlesinger, Wiley-Inter Science publications, New York. I998.
7. Electrodeposition and Corrosion Control - J. M. West, J. Wiley, W. Revie (Ed): Corrosion Handbook, Electrochemical Society Series, John Wiley and Sons (2000).
8. Electrochemistry and Corrosion Science - Nestor Perez, Springer (India) Pvt. Ltd., 2004.
9. Synthetic Organic Electrochemistry – A. M. Fry, 2nd Edn, Wiley 1989.

OCA SCT: 2.4. APPLIED ANALYSIS

Objectives:

4. To study basic theories of air pollution, and water pollution methods.
5. To learn principles and instrumentations of several analytical techniques to determine pollutants.
6. To learn the several pollutants and their determinations.

Course Outcome:

After the completion of this course, the students gain the knowledge of;

4. Basic theories of air pollution, and water pollution methods.
5. Principles and instrumentations of several analytical techniques to determine pollutants.
6. Obtain the knowledge of public health significance of several pollutants and their determinations.

Pedagogy:

- Conventional method such as black board and chalk can be used.
- Modern methods like power point presentation can also be used in class room teaching.

Course content:

UNIT – I

[16 HOURS]

Air pollution, analysis and control: Historical overview - global implications of air pollution, sources of pollutants, classification of pollutants. Sources and effects of particulates, carbon monoxide, sulphur oxides, nitrogen oxides, hydrocarbons and photochemical oxidants on human health, vegetation and materials. Standards for air pollutants.

Air quality monitoring: Sampling methods and devices for particulates and gaseous pollutants. SO_2: ambient air measurements and stack gas measurements - Turbidimetric, colorimetric, conductometric and coulometric methods, NOX: Griess-ilosvay and Jacobs-Hockheiser colorimetric methods, chemiluminiscent technique, CO: NDIR, amperometric, FID and catalytic oxidation methods. Hydrocarbons: total and individual hydrocarbons by gas chromatography. Oxidants and ozone: colorimetric, coulometric, titrimetric and chemiluminescence methods.

Air Pollution control: Atmospheric cleaning processes, approaches to contaminant control-detection and control at source.

Control devices for particulates: Gravitational settlers, centrifugal collectors, wet collectors, electrostatic precipitation and fabric filtration.

Control devices for gaseous pollutants: adsorption, absorption, condensation and combustion processes. Automative emission control-catalytic converters.

UNIT - II

[16 HOURS]

Water pollution and analysis: Water resources, origin of wastewater, types of water pollutants; their sources and effects, chemical analysis for water pollution control - objectives of analysis, parameters of analysis, sample collection and preservation. Environmental and public health significance and measurement of colour, turbidity, total solids, acidity, alkalinity, hardness, chloride, residual chlorine, chlorine demand, sulphate, fluoride, phosphates and different forms of nitrogen in natural and waste/polluted waters, heavy metal pollution - public health significance of Pb, Cd, Cr, Hg, As, Cu, Zn and Mn, general survey of the instrumental techniques for the analysis of heavy metals in aquatic systems, organic loadings - significance and measurement of DO, BOD, COD, TOD, and TOC, phenols, pesticides, surfactants and tannin and lignin as water pollutants and their determination.

References

1. Standard Methods of Chemical Analysis, A.J. Weleher (Part B), Robert E. KriegorPublishing Co. USA, 1975.
2. Environmental Chemistry, S.E. Manahan Willard grant press, London, 1983.
3. Environmental Chemical Analysis, Iain L Marr and Malcolm S. Cresser, Blackie and Son Ltd., London, 1983.
4. Chemistry for Environmental Engineering, Chair N. Sawyer and Perry L.M Canty, Mcgraw Hill Book, Co., New York, 1975.
5. The Air Pollution Hand Book, Richard Mabey, Penguin, 1978.
6. The Pollution Hand Book, Richard Mabey, Ponguin 1978.
7. Soil Chemical Analysis, M.L. Jackson, Prentice Hall of India Pvt, Ltd., New Delhi, 1973.
8. Experiments in Environmental Chemistry, P.D. Vowler and D.W. Counel, Pergamon press, Oxford 1980.
9. Manual Soil Laboratory Testing, vol I, K.H. Head, Pentech Press, London 1980.
10. A Text Book of Environmental Chemistry and Pollution Control, S.S. Dara, S. Chand and co. Ltd. New Delhi 2004.
11. Air pollution Vol II edition by A.C. Stern, Academic Press New York, 1968.
12. Instrumental Methods for Automatic Air Monitoring Systems in Air Pollution Control, Part-III edition by W. Stranss, John-Wiley and Sons, New York, 1978.
13. Analysis of Air pollutants, P.O. Warner, John Wiley and Sons, New York, 1976.
14. The Chemical Analysis Air pollutants, Interscience, New York, 1960.
15. The Analysis of Air Pollutants, W. Liethe, Ann Arbor Science Pub. Inc. Michigan 1970.

16. Environmental Chemistry, A. K. De.

OPEN ELECTIVE (FOR NON-ORGANIC CHEMISTRY/CHEMISTRY STUDENTS ONLY)

OCO OET: 2.1/3.1 APPLICATIONS OF SYNTHETIC AND NATURAL PRODUCTS

Course outcome:

This course conveys the students to understand the spectroscopic and analytical tools to identify and purify the organic compounds.

And, also brings the students to gain knowledge in the area of chemical nature of natural and synthetic bioactive compounds

Pedagogy:

To introduce the basic concept in spectroscopic and analytical tools to identify and purify the organic compounds

Course content:

UNIT-I [16 Hours]

Acids and bases, electrophiles and nucleophiles, hybridization in carbon compounds, inductive effect, resonance effect, hydrogen bonding {types of hydrogen bonding, hydrogen bonding in HF, water, alcohols, acids, nitrophenols) bond angle and bond length. **Purification**: Crystallization, sublimation, fractional crystallization, distillation techniques (simple distillation, steam distillation, distillation under reduced pressure, fractional distillation).

Separation techniques: Solvent extraction, continuous extraction, chromatography (principles of TLC, PC, column, GC, ion exchange chromatography) and electrophoresis

Characterization: Detection of elements, estimation of carbon, hydrogen, halogens, sulphur, nitrogen and phosphourous. Detection of functional groups (hydroxyl, carboxyl, keto, ester, amino, nitro, amide, thiol, ether etc) in the unknown samples. Basic principles for the determination of hydroxyl, carboxyl, keto, ester, amino, nitro groups. Estimation of sugars, aminoacids and proteins.

UNIT-II [16 Hours]

Fats and oils: Isolation, purification, structure and biological importance.

Essential oils: Source, constituents, isolation & uses.

Phospholipids: Isolation, structure and biological significance of lecithin and cephalin

Sphingolipids: Examples with structure and biological importance.

Prostaglandins: Classification, source, structure, nomenclature and its significance.

Terpenoids: Introduction, classification, source, structure of biologically important terpenoids (antihelmentic, anticancer terpenoids, etc)

Steroids: Structure and biological significance of cholesterol, bile acids, androgen, estrone, progesterone and anabolic steroids.

UNIT-III [16 Hours]

Flavonoids and Isoflavonoids: Occurrence, nomenclature, structure and their biological importance.

Porphyrins: Introduction, structure and biological functions of haemin. Vitamin B12 : structure and as coenzyme in molecular rearrangement reactions; Chlorophyll: structure and biological importance.

Carotenoids: Methods of isolation, structure and their biological importance..

Alkaloids: Introduction, source, structure and biological significance of vinca alkaloids, chincona alkaloids, LSD, reserpine, morphine, codeine, strychnine, brucine, nicotine, yohimbine,

Vitamins: structure and biological functions of vitamin A, C, D, E, K, biotin, pyridoxine, thiamine.

UNIT-IV [16 Hours]

Soaps and detergents: Production and their cleansing action. Liquid crystals and their applications. Surfactants

Cosmetics: Detailed study of formulations and manufacturing of cream and lotions, lipstick and nail polish, shampoos, hair dyes and tooth pastes. Flavours: Natural and nail polish, shampoos, hair dyes and tooth pastes. Flavours: Natural flavouring materials and classification
Sweeteners: Natural and synthetic sweeteners.
Insecticides: Introduction, classification, applications and their effect on environment. **Pheromones:** Introduction, Sources, biological importance.
Explosives: Introduction, RDX, Gun powder, TNT.

References
1. I. L. Finar, Organic Chemistry, ELBS Longmann, Vol. I & II, 1984.
2. Essentials of physiological chemistry – Anderson, John Wiley & Sons, New York, 1953.
3. K. Albert, L. Lehninger, D. L. Nelson, M. M. Cox, Principles of Biochemistry, CBZ publishers, 1st edition, New Delhi, 1993.
4. Harper's Biochemistry, Ed. R.Harper, 22nd edition, Prentice Hall Press, New York, 1990.
5. Encyclopedia of Chemical technology – Kirck-Othmer series
6. Harper's review of biochemistry – P. W. Martin, P. A. Mayer & V. W. Rodfwell, 15th edition, Maurzen Asian Edition, California, 1981.

THIRD SEMESTER

HARD CORE THEORY

HCT 3.1: ADVANCED ORGANIC CHEMISTRY

Objectives:
- To familiarize with the green chemical concepts.
- To learn the structural elucidation and biological importance of some synthetic organics.

Course outcome:
- Structural elucidation by different physical methods.
- Synthesis and characterization of several organic compounds by multi-component system.

Pedagogy:
- Conventional method such as black board and chalk can be used.
- Modern methods like power point presentation can be used in class room teaching.

Course contents:

UNIT-I

[16 HOURS]

Asymmetric synthesis:
Definition, importance, mechanism, energy consideration, advantages and limitations, methods of determination of enantiomeric excess.
Topocity - Prochirality- Substrate selectivity - Diastereoselectivity and enantio-selectivity-Substrate controlled methods-use of chiral substrates - examples
Auxiliary controlled methods- Use of chiral auxiliaries-Chiral enolates-alkylation of chiral imines - Asymmetric Diels - Alder reaction
Reagent controlled methods- Use of chiral reagents - Asymmetric oxidation –Sharpless epoxidation - Asymmetric reduction - Use of lithium aluminium hydride and borate reagents.
Synthesis and applications of oxazaborolidines, IPC-BBN, IPC_2BH, (*S*)-BINAP-DIAMINE and (*R*)-BINAL-H. Use of (*R,R*)-DIPAMP, (*S,S*)-CHIRAPHOS, (*R,R*)-DIOP, SAMP, RAMP, *S*-Proline, S-PBMgCl, (-)-$BOAlCl_2$, (+) and (-)-DET.

UNIT-II

[16 Hours]

Synthetic molecular receptors: Definition and Significance. Structure and function of receptors with molecular clefts, molecular tweezers, Receptors with multiple hydrogen bonding sites, crown ether, cryptates; cyclodextrins, cyclophanes, calixarenes, ionophores, and micelles.

Use of ultrasound: Introduction, instrumentation, the phenomenon of cavitation. Sonochemical esterification, substitution, addition, alkylation, oxidation, reduction and coupling reactions.

Use of Microwaves: Introduction, concept, reaction vessel/medium, specific effects, atom efficiency (% atom utilization), advantages and limitations. N-alkylation and alkylation of active methylene compounds, condensation of active methylene compounds with aldehydes and amines. Diels-Alder reaction. Deprotection of esters and silyl ethers. Oxidation of alcohols and sulfides.

Electroorganic synthesis: Introduction, use of electricity in the construction of heterocycles – epoxides, aziridines, tetrahydrofuran derivatives, lactones, oxadiazole, thiadiazole, isoxazole and coumarin. Use of transition metal catalysts in electroorganic synthesis, electrogenerated iodine in synthesis. Cyclic voltammetry in the study of mechanisms.

UNIT-III

[16 Hours]

Polymer supported reagents in organic synthesis

Introduction- properties of polymer support, advantages of polymer supported reagents and choice of polymers.

Applications: Substrate covalently bound to the support: Synthesis of oligosachcharides, Dieckmann cyclisation. Preparation of polymer bound aldehyde and application in aldol and Wittig reactions. Synthesis of polystyryl boronic acid and use in diol protection reaction.

Reagent linked to a polymeric material: Preparation of sulfonazide polymer and application in diazotransfer reaction. Synthesis of polymer bound per acid and its applications.

Polymer supported catalytic reactions: Preparation of polymer supported $AlCl_3$ and application in etherification and acetal formation reactions.

Multi-component Reactions

Studies on the mechanistic aspects and use of the following reactions in organic synthesis: Passerini-Ugi; Hantsch; Biginelli; Doebner-Miller; Ritter; Jacobson; Betti; Robinson-Schopf; Barbier; Baylis-Hilmann; Ivanov and Suzuki coupling reaction.

References

1. Green Chemistry, environment friendly alternatives, R. Sanghi and M M Srivastava, Narosa, New Delhi, 2003
2. Green Chemistry-an introduction text, Royal Society of Chemistry, UK, 2002.
3. Organic chemistry Vol. 2, 6th Edn., I. L. Finar, Longman, 1992.
4. Crownethers & cryptands, G. W. Gokel, Monograph, The Royal Society of Chemistry, 1991.
5. Macrocyclic Polyether Chemistry, G. W. Gokel, S. M. Korzeniowski, Vol 1 to 3, Wiley, NY, 1978, 1981, 1987.
6. Phase Transfer Catalysis in Organic Synthesis, W. B. Weber, G. W. Gokel, Springer, Berlin, 1977.
7. Phase Transfer Catalysis, E. V. Dehmlov, S. S. Dehmlov, 2nd Edn., Verlagchemie, Wienheim, 1983.
8. Polymers as aids in Organic synthesis, N. K. Mathur, C. K. Narang and R. E. Williams, Academic Press, NY, 1980.
9. H. Pine, Hendrickson, Cram and Hammond, Organic Chemistry, Mac Grow Hill, New York, 1987.
10. Organic Chemistry - Morrison and Boyd
11. I.L. Finar, Organic Chemistry, ELBS Longmann, Vol. 1 & II, 1984.
12. J. March, Advanced Organic Chemistry, Wiley Interscience, 1994.

13. E.S. Gould, Mechanism and Structure in Organic Chemistry, Halt, Rinhart & Winston, New York, 1964.
14. F.A. Carey and Sundberg. Advanced Organic Chemistry – Part A & B, 3rd edition, Plenum Press, New York. 1990.
15. Principles of Organic Synthesis - ROC Norman and Coxon.
16. S.K. Ghosh, Advanced General Organic Chemistry, Book and Allied (P) Ltd. 1998.

HCT 3.2 PHOTOCHEMISTRY, PERICYCLIC REACTIONS AND FREE RADICAL CHEMISTRY

Objectives:

- To understand the fundamental concepts of photochemistry and pericyclic reactions.
- To learn the synthesis and reactions of some organic compounds.
- To learn the reaction mechanism of organic compounds.

Course outcome:

- Basic concepts of photochemistry and pericyclic reactions and their usefulness in the synthesis of many organic compounds.
- Synthesis of organic compounds using different organometallic compounds as catalysts.
- Synthesis of organic compounds by controlled methods.

Pedagogy:

- Conventional method such as black board and chalk can be used.
- Modern methods like power point presentation can also be used in class room teaching.

UNIT-I

[16 HOURS]

Photochemistry: General consideration: Activation in thermal and photochemical reactions. Light absorption and excitation. Singlet and triplet states. Morse curve, Franck-Condon principle.
Deexcitation: Physical process, Jablonski diagram. Photosensitization (donor acceptor concept, resonance and collision transfer). Chemical process, quantum efficiency, quantum and chemical yields.
Photochemistry of functional groups:
i. ***Olefins*****:** *Cis-trans* isomerism, [2+2] cycloaddition, rearrangements. Reaction of conjugated olefins; di-pi-methane rearrangement.
ii. ***Ketones*****:** Excited state of C=O. Norrish type-I and type-II cleavages. Paterno-Buchi reaction. α, β-unsaturated ketones. [2+2] addition, *cis-trans* isomerisation. Rearrangements of cyclohexadienones.
iii. ***Aromatic compounds*****:** Photo-rearrangement of benzene and its derivatives, cycloaddition of benzene.
iv. ***Photochemical oxidations and reductions*****:** Cycloaddition of singlet molecular oxygen. Oxidative coupling of aromatic compounds, photoreduction by hydrogen absorptions.
Photodegradation: Photocatalyst –ZnO, TiO2, principle, application of ZnO/TiO_2 in the phodegradation of dyes (IC), pesticides (DDT, HCCH0 and in industrial affluents. Effect of photodegradation on COD values.

UNIT-II

[16 HOURS]

Pericyclic reactions: Classification of pericyclic reactions. Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system.
Electrocyclic reactions: Woodward-Hofmann rules for electrocyclic reactions, FMO theory of electrocyclic reactions, correlation diagram for cyclobutadiene and cyclohexadiene systems.
Cycloaddition reactions: [2+2], [3+2] and [4+2] cycloadditions, analysis by FMO and correlation diagram method. Cycloadditions - antarafacial and suprafacial additions, [2+2] additions of ketenes.
1,3-dipolar cycloadditions: involving nitrile oxide, nitrile imine, nitrile ylide cycloaddition. Intra and intermolecular 3+2 cycloaddition and their application in organic synthesis.

[4+2] cycloaddition reactions: Deil's-Alder reaction, hetero Diel's-Alder reaction and their applications.

Sigmatropic rearrangements - Classification, stereochemistry and mechanisms. suprafacial and antarafacial shifts of H, sigmatropic shifts involving carbon moieties. [3,3]- and [5,5]- sigmatropic rearrangement, Claisen, Cope and aza-Cope rearrangements.

UNIT-III

[16 HOURS]

Generation of free-radicals: Thermal homolysis of peroxides, peresters and azo compounds, photochemical methods.

Free radical reactions: Free-radical mechanisms in general. Free-radical substitution mechanisms. Mechanisms at an aromatic substrate. Neighboring group assistance in free-radical reactions. Reactivity for aliphatic substrates, reactivity at a bridgehead, reactivity in aromatic substrates, reactivity in the attacking radical. Halogenation at an alkyl carbon and an allylic carbon, hydroxylation at an aliphatic carbon, hydroxylation at an aromatic carbon, oxidation of aldehydes to carboxylic acids, formation of hydroperoxides and peroxides, Gomberg-Bachmann reaction, Meerwein arylation, Sandmeyer reaction, Kolbe reaction and Hunsdiecker reaction.

References

1. F. A. Carey and Sundberg, Advanced Organic Chemistry – Part A & B, 3rd edition, Plenum Press, New York, 1990.
2. Dupey and Chapmann, Molecular reactions and Photochemistry, Prentic Hall- International, Tokyo, 1972.
3. Introduction to physical organic chemistry – Kosower
4. Molecular orbital calculations – J. D. Roberts
5. N. J. Turro, Modern molecular photochemistry, The Benzamin Cummings Publishing Co. Ltd, Menlo Park, 1978.
6. K. Yates, Huckel's Molecular Orbital Theory, Academic Press, New York, 1978.
7. T. L. Gilchrist & R. C. Storr, Organic reaction and orbital symmetry, Cambridge Univ. Press, London, 1979.

HCT: 3.3. DYES, INSECTICIDES AND POLYMER CHEMISTRY

Objectives:

- To understand the fundamental concepts of synthesis of dyes and insecticides.
- To learn the synthesis and reactions of various dye compounds.
- To learn the synthesis of polymeric organic compounds.

Course outcome:

- Synthetic reactions of dyes and insecticides and their usefulness in the synthesis of many organic compounds and other fields.
- Synthesis of organic polymers using different organometallic compounds as catalysts.
- Characterization of polymers by different physical methods.

Pedagogy:

- Conventional method such as black board and chalk can be used.
- Modern methods like power point presentation can also be used in class room teaching.

UNIT-I

[16 HOURS]

Dyes: Introduction, modern theories of colour and chemical constitution. A general study of the following: Direct azo dyes (congored, rosanthrene O, procion dyes), acid azo dyes (ponceau2R,

Naphthol blue black 6B), basic azo dyes (chrysoidin G, bismark brown), developed dyes, mordent dyes, vat dyes, disperse dyes, fibre reactive dyes, sulphur dyes and solvent dyes. Fluoroscent brightening agents (tinopal B.V), cyanine dyes (classification, application in photography, quinoline blue and sensitol), chemistry of colour developer, and instant colour processes.
Synthesis and applications of malachite green, rhodamine-B, phenolphthalein and methyl orange.
Triphenylmethane dyes: crystal violet, pararosaniline, aurin, chromeviolet.
Application of dyes: i. photography and ii. Biological studies.

UNIT-II **[16 HOURS]**

Insecticides: Introduction, classification, mode of action and synthesis of chlorinated insecticides (DDT, chlordane, heptachlor and hexachlorocyclohexane), Naturally occurring insecticides-pyrethroids-natural pyrethrins-isolation and structures, synthetic pyrethroids, allethrin, cypermethrin, phenvalerate.
Organophosphorous insecticides: Malathion, parathion, DDVP, diazenon.
Carbamate insecticides: Sevin, carbofluron, aldicab, beygon.
Insect Pheromones: Introduction, classification, use in insect pest control. Synthesis of disparlure, faranol, grandisol, brevicomin and bomykol.
Fungicides: Introduction, Inorganic & organic fungicides, Systemic fungicides-types & examples.
Herbicides: Introduction, study of sulfonyl ureas, heterocyclic sulfonamides, heterocyclic amines, dihydropyrano[2,3-*b*]pyridylimidazolinones,pyrrolopyridylimidazolinones,1,2,4-triazine- 3,5-diones, hydroxyoxazolidinones & hydroxypyrrolidinones, pyridine herbicides & 1,3,4-oxadiazoles. Mechanism of action and toxicities of insecticides, fungicides and herbicides.

UNIT-III

[16 HOURS]

Polymers: Importance of polymers. Basic concepts: Monomers, repeat units, degree of polymerization, linear, branched and network polymers. Classification and nomenclature of polymers. Properties of polymers (brief explanation of molecular weight, glass transition temperature - Tg , solubility and visco-elasticity). Methods of polymerization-addition and condensation polymerization, ionic and free-radical polymerization processes, polymerization with complex catalysts (Ziegler-Natta catalysis), co-polymerization and their mechanisms. Techniques of polymerization - bulk, emulsion etc.
Stereospecific Polymers: Preparation and significance- classification of polymers based on physical properties - Thermoplastics - Thermosetting plastics - Fibers and elastomers - General applications.
Preparation of Polymers: Preparation of Polymers based on different types of monomers - Industrial applications-olefin polymers - Diene polymers- nylons - Glyptal resins - Urea-formaldehyde, phenol - formaldehyde and melamine resins - Epoxy resins - Ion exchange resins, polycarbonates and its applications.

References

1. A Text Book of Fertilizers, Ranjan Kumar Basak.
2. Agronomy - Theory & Digest, Bidhan Chandra, Krishi Vishwavidyalaya, Mohanpur.
3. Fundamentals of Agronomy, S.S.Cheema, K.Dhaliwal, T.S. Shota, Punjab Agricultural University.
4. Principles and Practices of Agronomy, Shri.S.S.Singh, Allahabad Agricultural Institute.
5. Fertilizers, Organic Manures & Biofertilizers–A Product Quality Guide for Major & Micronutrients, HLS Tandon, Fertilizer Development and Consultation Organisation, New Delhi.
6. Handbook on Fertilizer Technology, Bham Swaminathan & Manish Goswami, The Fertilizer Association of India, New Delhi.
7. Outlines of Chemical Technology, Charles E. Dryden, Affiliated East-West Press, New Delhi.
8. Synthetic Organic Chemistry, G. R. Chatwal, Himalaya Publishing House.
9. Synthesis and Chemistry of Agrochemicals, Vol I & II, ACS, Wahington.
10. Chemistry of Pesticides, K H Buchel.

11. Advances in Pesticide Formulation Technology, ACS.
12. Chemicals for Crop Protection and Pest Managements, M B Green, G.S. Hartley West, Pergamon.
13. Chemistry of Insecticides and Fungicides, Sree Ramulu, Oxford & IBH, 1985.

HCT 3.4: SPECTROSCOPY – II

Objectives:

- To understand the basic concepts of spectroscopic techniques such as NMR, ESR and IR, spectroscopy.
- To familiarize with the IR and mass spectroscopy.

Course outcome:

- Describe the spectroscopic techniques (NMR, IR, UV, and MS) including the basic principles for recording of NMR, IR, UV, and MS spectra.
- The course related to understand the spectroscopic techniques for the charterization in organic chemistry.
- Analyze experimental NMR, IR, UV, and MS spectra. Profound knowledge in MS and NMR.
- Argue for a suggested molecular structure from analysis of the experimental spectra. This includes understanding various fragmentation reactions for organic molecules.
- Predict the NMR, IR, UV, and MS spectra from a given molecular structure, including fragment-ions in MS.

Pedagogy:

Conventional method such as black board and chalk can be used.

- Modern methods like power point presentation can also be used in class room teaching.

UNIT-I

[16 HOURS]

Nuclear magnetic resonance spectroscopy: General introduction and defination, magnetic properties of nuclei (magnetic moment, g factor) and theory of nuclear resonance. Larmor precession frequency, resonance condition and relaxation processes.

Chemical shift: Standards employed in NMR, factors affecting chemical shift, electronegativity, shielding and deshielding mechanism, Vander waals deshielding, H-bonding, diamagnetic and paramagnetic anisotropics. Spin-spin coupling, chemical shift values and correlation for protons bonded to carbon and other nuclei. Instrumentation and sample handling.

Equivalence and magnetic equivalence proton exchange reactions, effects of chiral center, complex spin-spin interaction, stereochemistry, hindered rotation, Karplus curve-variation of coupling constants with dihedral angles. Simplification of complex spectra: isotopic substitution, increasing magnetic field strength, double resonance, spin decoupling, constant shift reagents, solvent effect, Fourier-transfer technique, variable temperature profile, nuclear overhauser effect (NOE). ^{1}H NMR and ^{13}C NMR spectroscopy, Multiplicity-proton decoupling, noise decoupling, off resonance decoupling, selective proton decoupling. Applications of NMR: Structural diagnosis, conformational analysis, keto-enol tautomerism, hydrogen bonding. Two dimensional NMR spectroscopy: COSY, NOESY, MRI.

UNIT-II

[16 HOURS]

NMR spectroscopy of inorganic molecules: Proton NMR spectra of metal hydride complexes NMR spectra of nuclei other than hydrogen: ^{19}F, ^{31}P, ^{11}B NMR spectra of simple compounds, Proton/hydride interactions with ^{103}Rh, ^{183}W, ^{195}Pt and ^{207}Pb in metal complexes/organometallic compounds, Solid State NMR.

Electron Spin Resonance Spectroscopy: Introduction, Theory, ESR Absorption Positions: The *g* Factor, Instrumentation, Working of an ESR Spectrometer, Sample Handling, Sensitivity of an ESR Spectrometer, multiplet Structures in ESR Spectroscopy, Interpretation of ESR Spectra, Double Resonance (or Double Irradiation) in ESR Spectroscopy. Applications of ESR Spectroscopy. Comparison between NMR and ESR Spectroscopy.

Applications of Infrared Spectroscopy: Introduction, Sample Handling, Theory (Origin) of Infrared Spectroscopy, Number of Fundamental Vibrations, Calculation of Vibrational Frequencies, Factors Affecting Vibrational Frequencies, Characteristic Absorptions in Common Classes of organic Compounds, Fingerprint Region, Applications of Infrared Spectroscopy to different organic compounds and Interpretation of Infrared Spectra.

UNIT-III

[16 HOURS]

Mass spectrometry: Principles, instrumentation, different methods of ionization, EI, CI, FD and FAB, ion separators: single focusing separator with magnetic diffraction, focusing analyzer, time-of–flight separator and quadrupole analyzer. Mass spectra: molecular ion, base peak, meta-stable peak, nitrogen rule and McLafforty rearrangement. Mass spectral fragmentation of organic compounds and common functional groups: normal and branched alkanes, alkenes, cycloalkanes, benzene and its derivatives, alcohols, phenols, aldehydes and ketones, carboxylic acids, and their derivatives, amines, nitrocompounds. Determination of molecular formula by accurate molecular weight and isotopic abundance methods. Examples of mass spectral fragmentation of organic compounds with respect to their structure determination.

LC-MS, LC-MS/MS, GC-MS: Principles and applications

Composite problems: Problems involving the applications of the above spectroscopic techniques for structural elucidation of organic molecules.

References

1.Physical methods in Inorganic Chemistry, R.S. Drago, Affiliated East West Press Pvt. Ltd., New Delhi (1965).

2. Infrared spectra of Inorganic and Coordination Compounds, K. Nakamoto, Wiley Interscience, New York (1970).

3. Vibrational Spectroscopy: Theory and Applications, D.N. Sathyanarayana, New Age International Publishers, New Delhi (2000).

4. Organic Spectroscopy, L.D.S. Yadav, Springer-Science, 2005.

5. Spectroscopy by B. P. Straughan and S. Walker, John Wiley & Sons Inc., New York, Vol. 2, 1976.

6. Organic spectroscopy by William Kemp, ELBS Society, MacMillan, 1987.

7. Application of absorption spectroscopy of organic compounds by John R. Dyer, Prentic-Hall of India Private Ltd., New Delhi, 1974.

8. Organic spectroscopy by V. R. Dhani, Tata McGrow-Hall publishing company Ltd., New Delhi, 1995.

9. Spectrometric identification of organic compounds, 4th edition, Robert M. Silverstein, G. Clayton Bassler and Terence C. Morrill, John Wiley & Sons Inc., New York, Vol. 1, 1981.

10. Interpretation of carbon-13 NMR spectra, F. W. Wehrli and T. Wirthlin, Heyden, London, 1976.

OCP 3.1: ORGANIC CHEMISTRY PRACTICALS-II

[64 Hours]

Objectives:

- To understand the concepts of isolation and purification of natural products.
- To familiarize with the estimation of different functional groups in organic compounds.

Course outcome:

- The isolation of caffeine, carotene, lycopene, cincole, azeleic acid and piperine from respective natural product.
- Isolation followed by estimation of ketones, sugars, nitro and amino groups in natural products.
- Also, interpret UV, IR, NMR and MS data of different organic compounds.

Pedagogy:

- Each student performs experiments as per the protocol in practical classes.
- Spectroscopic tools will be applied for the characterization of isolated natural products.

Course Experiments:

PART-A

Isolation of natural products

1. Fractional crystallization: separation of mixture of naphthalene and biphenyl
2. Fractional distillation: Separation of mixture of benzene and toluene.
3. Thin layer chromatography: Separation of plant pigments
4. Column chromatography: Separation of mixture of o- and p-nitro anilines
5. Paper chromatography: Separation of amino acids
6. Isolation of piperine from pepper
7. Isolation of caffeine from tea
8. Isolation of azeleic acid from castor oil
9. Isolation of Lycopene from tomato
10. Isolation of carotene from carrot.

PART-B

Estimations

1. Determination of iodine value of oil and fats by chloramine-T
2. Saponification value of an oil or fats
3. Estimation of hydroxyl groups
4. Estimation of vicinal hydroxyl groups
5. Estimation of ketones by haloform method
6. Estimation of sugars by Bertrand's method
7. Estimation of nitro groups
8. Estimation of amino acids
9. Estimation of ketones by oxime method

References

1. Manual of Organic Chemistry - Dey and Seetharaman.
2. A Text Book of Practical Organic Chemistry – A.I. Vogel, Vol.III
3. Practical Organic Chemistry - Mann & Saunders
4. Modern Experimental Organic Chemistry by John H. Miller and E.F. Neugil, p 289.
3. An Introduction to Practical Organic Chemistry - Robert, Wingrove etc
2. Natural Products Chemistry by Raphel Ikhan

OCP 3.2: ORGANIC CHEMISTRY PRACTICALS-III

[64 HOURS]

Objectives:

- To understand synthetic methods by carrying out different experiments.
- To develop the skill for the preparation of organic compounds.

Course outcome:

- Students are involved in the multi-step synthesis of different organic compounds.
- Understand the qualitative analysis of binary mixture of organic compounds through separation, identification of functional groups and preparation of some solid derivatives.

Pedagogy:

- Each student performs experiments as per the protocol in practical classes.
- Experimental setup for the synthesis of organic compounds by every individual.

Course Experiments:

PART-A

MULTISTEP SYNTHESIS

1. Preparation of benzyl alcohol and benzoic acid *via* Cannizzaro reaction.
2. Oxidation of cyclohexanol to adipic acid via cyclohexanone
3. Esterification: Preparation of benzoccaine from p-nitrotoluene
4. Diazotization (Sandmeyer reaction): Preparation of p-chlorobenzoic acid from p- toluidine
5. Molecular rearrangement: Preparation of o-chlorobenzoic acid from phthalic anhydride
6. Preparation benzilic acid from benzaldehyde
7. Preparation of o-hydroxy benzophenone from phenyl benzoate via Fries rearrangement
8. Prepartion of benzanilide from benzophenone oxime via Beckmann rearrangement.
9. Synthesis of m-chloroiodobenzene from m-dinitrobenzene.
10. Synthesis if 2,4-dinitro phenyl hydrazine
11. Preparation of phenacetin from *p*-nitro phenol (*via* reduction, acetylation and ethylation)
12. Synthesis of Luminol
13. Grignard reaction: Synthesis of triphenyl carbinol from benzophenone/ethylbenzoate
14. Preparation of pyrazole from acetophenone

PART -B

Identification of the structures of the simple organic compounds using UV-visible, IR, NMR and Mass spectra.

References

1. Experiments in organic chemistry, III edition, Louis F. Fieser.
2. Vogel's Text book of practical organic chemistry, V edition, B. B Furniss, A.J. Hannaford, P.W.G. Smith.
3. Practical Organic chemistry-Mann and saunders.

SOFT CORE THEORY

SCOT-3.1: BIOINORGANIC CHEMISTRY

Objectives:

- To understand the structural parameters of metallo-proteins and their biological role.
- To learn the biological properties of metal complexes in chemo and radio therapeutics.

Course outcome:

- Structural building blocks of proteins, nucleic acids and their metal ion interactions. Biological role of Na/K channel, Ca, Vit B12, and coenzymes.
- Biochemical reactions of several metalloenzymes and oxygen transport proteins.
- The medicinal applications of metals and metal complexes, and also treatment of toxicity due to heavy metal ions.

Pedagogy:

- Conventional method such as black board and chalk can be used.
- Modern methods like power point presentation can be used in class room teaching.

Course content:

UNIT-I

[16 HOURS]

Structural and molecular biology: Introduction, The structural building blocks of proteins, the structural building block of nucleic acids. Metal ion interactions with nucleosides and nucleotides. General features of DNA - metal complex interaction.

Bioenergetics: Introduction, Redox reactions in metabolism, the central role of ATP in metabolism. Kinetic stability of ATP, Mitochondrial flow of electrons from NADH to O2. Phosphorylation and respiratory chain. Oxidative phosphorylation.

Vitamin B12 and Coenzymes: Structural feature, names of different forms, chemistry of cobalamin, biochemical functions of cobalamins, model compounds. Special characteristics of B12 co-enzyme. Photosystems.

Metal ion transport and storage: Iron storage and transport: Transferrin, ferritin, phosvitin and gastroferrin. Iron transport in microbes: siderophores, *in vivo* microbial transport of iron.

Oxygen transport and oxygen uptake proteins: Properties of dioxygen (O2): thermodynamic and kinetic aspects of dioxygen as an oxidant, activation of dioxygen through complexation with metal ions. Haemoglobin (Hb) and Myoglobin (Mb) in oxygen transport mechanism: Introduction to porphyrin system, substituent effects on porphyrin rings, functions of Hb and Mb. Characteristics of O2--binding interaction with Hb and Mb. Model compounds for oxygen carriers (Vaska's complex and cobalt(III) – Schiff base complexes). Hemerythrin and hemocyanin.

Electron transport proteins and redox enzymes: Iron – sulfur proteins (rubredoxins and ferredoxins) and cytochromes including cytochrome P450. Catalase and peroxidase: Structure and reactivity. **Superoxide dismutase**: Structure and reactivity.

UNIT-II

[16 HOURS]

Molybdenum containing enzymes: Aspects of molybdenum chemistry, Xanthine oxidase, aldehydes oxidase, sulfite oxidase, nitrogenase and nitrite reductase.

Non-redox metalloenzymes - Structure and reactivity: Carboxypeptidase-A, alcohol dehydrogenase, and carbonic anhydrase.

Medicinal Inorganic Chemistry: State of the Art, New Trends, and a Vision of the Future: Introduction, metals and human biochemistry, general requirements.

Disease due to metal deficiency and treatment: Iron, zinc, copper, sodium, potassium, magnesium, calcium and selenium.

Metal complexes as drugs and therapeutic agents: Introduction, Antibacterial agents, Antiviral agents, **Cancer Therapy**: Current Status and Mechanism of Action of Platinum-Based Anticancer Drugs. Non-platinum anticancer agents.

Gold-Based Therapeutic Agents: **A New Perspective**: Uses for the treatment of rheumatoid arthritis,

Metal-Based Radiopharmaceuticals: Metal complexes as radio diagnostic agents.

Treatment of toxicity due to inorganics: General aspects of mechanism of metal ion toxicity, Mechanism of antidote complex with poison, rendering it inert: arsenic, lead, cyanide and carbon monoxide.

References

1. The Inorganic Chemistry of Biological Process- 2nd edition, M. N. Hughes, John Wiley and Sons, (1988).
2. Bioinorganic Chemistry - R.W. Hay, Ellis Horwood Ltd., (1984).
3. Biological Inorganic Chemistry – An Introduction, R.R. Crichton, Elsevier, (2008).

4. Bioinorganic Chemistry - A.K. Das, Books and Allied (P) Ltd, (2007).
5. Bioinorganic Chemistry - K. Hussain Reddy, New Age International Ltd. (2003).
6. Bioinorganic Chemistry: A Survey - EiichiroOchiai, Academic Press, (2008).
7. Bioinorganic Chemistry: A Short Course - 2nd edition, R.M. Roat-Malone, Wiley Interscience, (2007).
8. Medicinal Applications of Coodination Chemistry - Chris Jones and John Thornback, RSC Publishing, (2007).
9. Transition Metal Complexes as Drugs and Chemotherapeutic Agents - N. Farrell, Kluwer Academic Publishers (1989).
10. The Biological Chemistry of the Elements: The Inorganic Chemistry of Life - 2nd edition, J.J.R. Frausto da Silva and R.J.P. Williams, Oxford University Press, (2001).
11. Essentials of Inorganic Chemistry, K. A. Strohfeldt, John Wiley and Sons Ltd.,(2015).
12. Bioinorganic Medicinal Chemistry (Ed) EnzoAlessio, Wiley-VCH Verlag and Co., (2011).

SCOT: 3.2. ENZYMES FUNCTIONS AND THEIR KINETICS

Course outcome:
This course conveys to deal with the understanding of functional and kinetic property of enzymes
Pedagogy:
To introduce the basic concept in enzyme chemistry

Course content:

UNIT-I

[16 Hours]

Enzymes: Introduction, nomenclature, classification with examples and their functions.
The mechanistic role of the following co-enzymes in the living systems:
i. Thiamine pyrophosphate (TPP) in oxidative and non-oxidative decarboxylation of -keto acids and formation of ketols.
ii. Pyridoxal phosphate:- transamination, decarboxylation, dealdolization and elimination reactions of amino acids
iii. Lipoic acid in the transfer of acyl group and oxidation reactions
iv. Co-enzyme A: generation and ternsfer of acyl groups
v. Biotin – in the addition of carboxyl groups to saturated carbon atoms and in transcarboxylation reactions; tetrahydrofolic acid – in one carbon transfer reactions at all oxidation levels except that of CO_2; Nicotenamide and flavin coenzymes – in biological oxidation-reduction reactions. Biogenesis of fatty acids, terpenoids (mono and sesquiterpenoids), steroids, aminoacids, alkaloids.

UNIT-II

[16 Hours]

Enzyme kinetics: Effect of substrate concentration, Effect of pH, effect of catalysts and inhibitors (substrate, zeolites, Cr^{3+}, Fe^{2+} ZnO, U.V light) and effect of temperature. A brief kinetic and mechanistic applications of glucose oxidase and L-amino oxidase in the oxidation of glucose and L-amino acids. Biological significance of Donnan membrane phenomenon. Micelles and involvement during digestion and absorption of dietary lipids. Diffusion of solutes across bio-membranes and its application in the mechanism of respiratory Exchange. “Salting In” and “Salting out” of proteins. Osmotic behaviour of cells and osmo-regulation and its application in the evolution of excretory systems of organisms. Significance of visulity in biological systems-mechanism of muscle contraction, detection of in trastrand disulfide bonds in proteins, polymerization of DNA and nature of blood flow tarongu different vessels. Effect of temperature solute concentration (amino acids) in surface tension. Biological significance of surface tension, stability of Alveoli in lungs, interfacial tension in living cells (Danielle and Davson model). In metabolism studies; Radio immuno assay (cabeling of antigens) Immune radiometry.

References

1. Thermodynamics for chemists by S. Glasstone, Affiliated East-west press, New Delhi, (1965).
2. Chemical Thrmodynamics by I.M. Klotz, W.A. Benzamin Inc. New York, Amsterdam, (1964).
3. Basic Physical Chemistry by W.J. Moore, Prentice Hall of India Pvt. Ltd., New Delhi, (1986).

4. Text book of Physical Chemistry by Samuel Glasstone, MacMillan Indian Ltd., (II edition), (1974).
5. Theoretical chemistry by S. Glasstone.
6. Statistical themodynamics by B.C. Meclelland, Chapman and Hall, London (1973).
7. Elementary statistical thermodynamics by N.D. Smith Plenum Press, NY (1982).
8. Elements of classical and statistical thermodynamics by L.K. Nash, Addison-Wesley (1970).
9. Statistical thermodynamics by I.M. Klotz.
10. Introduction to Statistical Thermodynamics by M. Dole, Prantice-Hall, (1962).

SCOT: 3.3. MATERIALS CHEMISTRY

Objectives:

- To familiarize with the preparation and characterization different types of nanomaterials.
- To learn the properties and applications of semiconductor and superconductor materials.

Course outcome:

- Students can able to understand the fundamentals and importance of different types of nanomaterials, their methods of preparation and characterization by different technique.
- Basic aspects of semiconductor and superconductor materials, their properties and applications.

Pedagogy:

- Conventional method such as black board and chalk can be used.
- Modern methods like power point presentation can be used in class room teaching.

Course content:

UNIT-I

[16 HOURS]

Chemistry of Nanomaterials: Fundamentals and importance, metal nanoclusters, magic numbers, theoretical modelling of nanoparticles, geometric structure, electronic structure, reactivity, fluctuations, magnetic clusters, bulk to nano transitions. Semiconducting nanoparticles: optical properties, photo fragmentation, Coulombic explosion.

Carbon nanoparticles: Introduction, carbon molecules, nature of carbon bond, new carbon structure. Carbon clusters: Small carbon clusters, C_{60}: Discovery, structure, alkali doping, super conductivity. Fullerenes and other bulky balls. Carbon nano-tubes: Fabrication structure, electrical properties, vibrational properties, mechanical properties. Quantum dots, Graphene, and applications of nanomaterials.

Methods of preparation: Plasma arc, Chemical vapour deposition (CVD), sol-gel, silica-gel, hydrolysis, condensation, polymerization of monomers to form nanoparticles, solvothermal, and hydrothermal methods, electrochemical, ball milling and pulsed laser methods. Characterization of nanomaterials (X- ray, IR, UV and SEM).

UNIT-II

[16 HOURS]

Semiconductors: Metals, insulators and semiconductors. Band theory, energy bands, intrinsic and extrinsic semiconductors. Conductivity: electrons and holes, temperature dependence on conductivity, Optical properties: absorption spectrum, photoconductivity, photovoltaic effect and luminescence. Junction properties: metal-metal junctions, metal-semiconductor junctions, p-n junctions, transistors, industrial applications of semiconductors: Mixed oxides, spinels and other magnetic materials.

Superconductors: Introduction, critical temperature and zero resistivity, Meissner effect, critical magnetic field and its variation with temperature. Type - I and II super conductors, specific heat, isotope effect, basic concepts of BCS theory. High temperature (Tc) superconductors and its applications.

References

1. Introduction to Nanotechnology, Charles P. Poole. Jr. and Frank J. Owens, Wiley-Interscience, Joh Wiley and Sons Inc, 2006.
2. Nanotechnology, Richard Booker and Earl Boysen, Wiley.
3. Nanometerials, A.K. Bandopadhyay, New Age International, 2nd edition.
4. Nanotechnology - Importance and Applications, M. H. Fulekar, Ink International publishing.
5. Solid State Chemistry – N.B. Hannay.
6. Introduction to Solids – Azaroff.
7. Solid State Chemistry and its applications – A.R. West.
8. Principles of the Solid State – H.V. Keer.
9. Basic Solid State Chemistry, 2nd edition, Anthony R. West.
10. Solid State Chemistry: An Introduction, 3rd edition, Lesley E. Smart and Elaine A. Moore.
11. Introduction to Solid state Physics—C. Kittel, 5th edition, Wiley Eastern, Limited.
12. C.N.R. Rao and J. Gopalakrishna "New Directions in solid state chemistry" Cambridge University Press, Cambridge (1999).

SCOT- 4.4: QUANTUM CHEMISTRY AND BIOSENSORS

Objectives:

- To understand the applications of quantum mechanics to HMO theory.
- To learn the basics of biosensors and their applications.

Course outcome:

- Applications of quantum chemical methods in the theoretical evaluation of energies of molecules and reactions.
- Development of chemical and biochemical sensors and their applications in the determination of biomolecules.

Pedagogy:

- Conventional method such as black board and chalk can be used.
- Modern methods like power point presentation can be used in class room teaching.
- Students will be assigned to solve the numerical problems.

Course contents:

UNIT-I

[16 HOURS]

Applications of quantum mechanics: Variation theorem: Statement and proof, application of variation theorem to a particle in one dimensional box, linear oscillator, H and He-atoms. Molecular orbital theory, LCAO-MO approximation, application to hydrogen molecule ion (H^{2+}), energy levels of H^{2+}, bonding and anti-bonding molecular orbitals, energy distribution, potential energy diagrams. Valence bond theory (VB), theory of H_2 molecule, Heitler-London method, energy levels, various modifications of Heitler-London wave function. Comparison of MO and VB theories. SCF method for many electron atoms. Slater Orbitals –Effective nuclear charge (ENC), expressions for Slater orbitals for 1s, 2s, 3s, 2p and 3d electrons (no derivation), Slater's rules for calculation of ENC. Theories of valence – Introduction, linear and non-linear variation functions, secular equations, coulombic, exchange, normalization and overlap integrals, secular determinants.

UNIT-II

[16 HOURS]

Biosensors: Introduction, electrochemical biosensors: Amperometric, potentiometric and conductometric biosensors. Optical based biosensors: Surface plasma resonance, chemiluminesence, fibre optic biosensors, piozoelectronic sensors, mass selective and thermal sensors. Bio-recognition elements in biosensors, immobilization methods, principles of biorecognition, natural, semi-synthetic and synthetic biorecognition elements. Metabolism sensors: Glucose sensors, galactose sensors.

Determination alcohol, ascorbic acid, D-isocitrate, oxalate, oxaloacetate, nitrite, nitrate, corbon monoxide, glycerol, triglycerides and sucrose. Biosensors using coupled enzyme reactions.
Applications of biosensors: Determination of glucose in blood, survey of biosensor methods for the determination of glucose. Determination of copper (I) in water using anodic stripping voltammetry.

References

1. Introductory Quantum Chemistry – A.K. Chandra. Second Edition, Tata McGraw Hill Publishing Co. Ltd., (1983).
2. Quantum Chemistry – Eyring, Walter and Kimball. John Wiley and Sons, Inc., New York.
3. Quantum Chemistry –I.N. Levine. Pearson Education, New Delhi, (2000).
4. Theoretical Chemistry – S. Glasstone. East West Press, New Delhi, (1973).
5. Quantum Chemistry – R.K. Prasad, New Age International Publishers, (1996).
6. Valence Theory – Tedder, Murel and Kettle.
7. Text Bok of Physical Chemistry, S. Glasston, McMillan India Ltd., 2nd Edn. (1986).
8. Physics at Surfaces, A. Zangwill, Combridge University Press (1988).
9. Surface Crystallography, L. J. Clarke, Wiley-Interscience (1985).
10. Biosensors: Fundamentals and Applications, Bansi Dhar Malhotra and Chandra Mouli Pandey, Smither Group Co., 2017, UK.
11. Biosensors: Techniques and Instrumentations in Analytical Chemistry, Frieder Scheller and Florian Schubert, Vol. 11, Elsevier Sci. Publishers, 1992.
12. Chemical Sensors and Biosensors, Brian R. Eggins, John Wiley & Sons Ltd, UK, 2004.

FOURTH SEMESTER

HARD CORE THEORY

HCT: 4.1. ADVANCED ORGANOMETALLIC CHEMISTRY

Objectives:

- To understand the concepts of organometallics.
- To learn the synthesis and reactions of organo-metallic compounds.
- To learn the asymmetric synthesis of organic compounds.

Course outcome:

- Basic concepts of organometallics and their usefulness in the synthesis of many organic compounds.
- Synthesis of organic compounds using different organometallic compounds as catalysts.
- Synthesis of organic compounds by controlled methods.

Pedagogy:

- Conventional method such as black board and chalk can be used.
- Modern methods like power point presentation can also be used in class room teaching.

Course content:

UNIT-I

[16 HOURS]

Chemistry of organometallic compounds: Synthesis and reactions of organolithium (n-BuLi, PhLi}, organocadmium, organomagnesium (Grignard reagent), organoselenium and organotellurium.

Organoaluminium reagents: Preparation, site selective and stereoselctive additions of nucleophiles mediated by organoaluminum reagents, reaction with acid chlorides, allyl vinyl ethers, 1,2-addition to imines and application in the synthesis of natural products.

Organocopper reagents: Gilman reagent, preparation, reactions with aldehydes, ketones and imines. Application in the synthesis of brevicomin.

UNIT-II

[16 Hours]

Organozinc reagents: Preparation - oxidative addition and transmetallation, addition reactions of alkyl, aryl, allylic and propargylic zinc reagents, diastereoselective and enantioselective addition reaction with aldehydes, Reformatsky reaction.
Organosamarium reagents: Reactions promoted by samarium diiodide and dicyclopentadienyl samarium – Barbier type reaction, Reformatsky type reactions, ketyl-alkene coupling reactions, pinacolic coupling reactions, acyl anion reactions.
Organomanganese and iron reagents: Preparation and applications in organic synthesis.

Organocobalt and nickel reagents: Preparation and applications in organic synthesis.

UNIT-III

[16 Hours]

Organotin reagents: tributyltin hydride, Barton decarboxylation reaction, Barton deoxygenation reaction (Barton McCombie reaction), Stille coupling, Stille-Kelley coupling reactions, Keck stereoselective allylation and other applications.

Organosulphur compounds: Introduction. Preparations, reactions, mechanism and synthetic applications of important sulphur containing reagents like dithiane, sulphur ylides etc.

Organosilicon compounds: Introduction, preparations and reactions, Peterson reaction.
Organophosphorous compounds: Nomenclature, synthesis and reactions of trialkyl phosphine, triarylphosphine, trialkyl phosphite, triaryl phosphite, trialkyl phosphate, triaryl phosphates. Wittig reaction and Wittig-Horner reactions: - mechanisms and synthetic uses. Arbasov reaction, transesterification. Organofluorine compounds.

References

1. J. March, Advanced Organic Chemistry, Willey Interscience, 1994.
2. F. A. Carey and Sundberg, Advanced Organic Chemistry – Part A & B, 3rd edition, Plenum Press, New York, 1990.
3. Comprehensive Organic Chemistry, Pergamon Press, New York, Vol 1, 1996,
4. H. Pine, Hendrickson, Cram and Hammond, Organic Chemistry, Mac Grow Hill, New York, 1987.
5. I. I. Finar, Organic Chemistry, ELBS Longmann, Vol. I & II, 1984

6. Comprehensive Organic Synthesis – B. M. Trost and I. Fleming series, Pergamon Press, New York, 1991.
7. S. K. Ghosh, Advanced General Organic Chemistry, Book and Alleied (P) Ltd, 1998
8. Heterocyclic Chemistry –Joule & Smith
9. Applications of Organometallic Compounds, Iwao Omae. John Wiley & Sons, 1998.
10. Basic Principles of heterocyclic chemistry – L. A. Pacquette

HCT: 4.2. ADVANCED MEDICINAL CHEMISTRY

Objectives:

- To understand the fundamental concepts of chemotherapy.
- To learn the synthesis and reactions of synthetic drugs.
- To learn usefulness of organic compounds as pharmacuetics.

Course outcome:

- Basic concepts of chemotherapy and the usefulness drugs of organic compounds.
- Synthesis of organic molecules by different methods.
- Synthetic drugs and their actions in the body.
- **Pedagogy:**
- Conventional method such as black board and chalk can be used.
- Modern methods like power point presentation can also be used in class room teaching.

Course content:

UNIT-I

[16 Hours]

Medicinal Chemistry-Chemotherapy: Definition, History, and Evolution of Chemotherapy. Classification of drugs on the basis of therapeutic action, pharmacophonic, API (active pharmaceutical ingredient) chiral drugs, development of new drugs, procedures followed in drug design, concept of lead and lead compounds and lead modifications, molecular modeling, concept of pro-drug and soft drug, factor affecting bioactivity. Theories of drug activity, occupancy-theory, rate theory, induced-fit theory. Quantitative structure-activity relationship, history and development of QSAR, concept of drug receptors, elementary treatment of drug receptor interactions. Physiochemical parameters: lipophilicity, partition-coefficient, electronic ionization constant, steric, Shelton and surface activity parameters and redox potential. Evaluation methods: Free-Wilson analysis, Hansch-analysis, relationship between FreeWilson analysis and Hansch-analysis – LD_{50}, ED_{50}, ID_{50}, IC_{50} (mathematical derivation of equation excluded).

Synthetic drugs: Introduction, pharmacodynamics, pharmacokinetics, pharmatherapeutics, chemotherapy, metabolites antimetabolites, agonists and antiagonists. Routes of drug administration, factors affecting choice of routes.

A general study of following class of drugs:

Antipyretics: aspirin, paracetamol, phenacetin, novalgin and their mechanism of action.

Hypnotics, analgesics and sedatives: phenosorbitol, chlordiazepoxide, mebrobamide.

Stimulants: structure and action of caffeine

UNIT-II

[16 Hours]

Antineoplastic Agents: Introduction, cancer chemotherapy, role of alkylating agents and antimetabolites in treatment of cancer. Mention of carcinolytic antibiotics and mitotic inhibitors. Synthesis of mechlorethamine, cyclophosphamide, melphalan, mustards and mercaptopurine. Recent development in cancer chemothery – podophyllotoxin and its derivatives, taxol. 5-flouro uracil, Chlorambucil and cisplatin.

Cardiovascular drugs: Introduction, cardiovascular diseases, drug inhibitors of peripheral symphatetic function, central intervention of cardiovascular output direct acting arteriolar dilators, synthesis of dithiazem, verapamil, methyldopa, atenolol, oxprenolol, antihypertensive drugs, lipid lowering agents (atorvastatin, statin derivatives).
Local antiinfective drugs: Introduction and general mode of action, structure of sulphonamides, forazalidione, nalidixic acid, ciprofloxacin, norfloxicin, dapsone, aminosalicylic acid, isoniazid, ethionamide, ethambutal, fluconazole, griseofulvin, Chloroquineand primoquine.

UNIT-III

[16 Hours]

Antibiotics: Introduction, cell wall biosynthesis, inhibitors, -lactum group of antibiotics- Penicillin, Ampicillin and Amoxycillin, amoxicillin, chloramphenicol, cephalosporin analogs, Erythromycin analogs and Ciprofloxacin. Structure elucidation of tetracycline and streptomycin.
Antihelmenthics-Mebendazole/albendazole
Antivirals- Azothymidine (AZT), Acyclovir
Histamines-Histamine antagonists, -H1 blockers - Chlorpheneramine, -H_2 blockers - Ranitidine-5-HT Seratonin, 5-HT receptor antagonist – Metaclopramide Computational chemistry and combinatorial chemistry.
Molecular modelling: Docking studies. Journey of drug development process

References

1. Introduction to medicinal chemistry, A Gringuage, Wiley-VCH.
2. Wilson and Gisvold's Text Book of organic medicinal and pharmaceutical chemistry, Ed Robert F. Dorge.
3. An introduction to drug design, S.S. Pandey and J.R. Dimmock, New Age International.
4. Burger's medicinal chemistry and drug discovery, Vol-1 (Chapter-9 and Ch-14), Ed. M.E. Wolff, John Wiley.
5. Goodman and Gilman's pharmacological basis of therapeutics, McGraw-Hill.
6. The organic chemistry of drug design and drug action, R. B. Silverman, AcademicPress.
7. Strategies for organic drug synthesis and design, D. Lednicer, John Wiley
8. Medicinal Chemistry, A Kar, Wiley, 2000.

HCT 4.3: NATURAL PRODUCTS – II

Objectives:

- To familiarize with the chemical concepts of alkaloids and steroids.
- To learn the structural elucidation and biological importance of alkaloids and steroids.

Course outcome:

- Chemistry of alkaloids and their biological significances.
- Synthesis and characterization of several alkaloids and steroids.

Pedagogy:

- Conventional method such as black board and chalk can be used.
- Modern methods like power point presentation can be used in class room teaching.

Course contents:

UNIT- I

[16 Hours]

Alkaloids: Introduction, classification, isolation and general methods of structural elucidation. Biological importance of alkaloids. Structure and synthesis of nicotine, papavarine, quinine, morphine, LSD and reserpine.
Vitamins: Structure elucidation and biological functions of vitamin A, C, D, E, K, biotin, pyridoxine, thiamine and Vitamin B_{12}.

UNIT-II

[16 Hours]
Steroids: Introduction, structural elucidation of cholesterol and bile acids. Ergosterol and its irradiation products. Sex hormones and corticosteroids: Synthesis of estrone, progesterone, androsterone, testosterone. Barton reaction for the synthesis of aldosterone. Brief discussion of homosteroids, norsteroids and oral contraceptives. Biological significance of anabolic steroids.

UNIT-III

[16 Hours]
Terpenoids: Introduction, classification and general methods of structural elucidation. Structure elucidation of pinene, camphor, caryophyllene, santonin, abietic acid and vetivone. Biological importance of terpenoids.
Carotenoids: Methods of isolation. Structure elucidation and synthesis of β-carotenes. Structural relationship of α-,β-, and γ-carotenes.

References
1. I. L. Finar, Organic chemistry, ELBS Longman, Vol. I and II, 1984.
2. Introduction to Alkoloids-G. A. Swan.
3. The Alkoloids- K. W. Bently.
4. Steroids-L. Fiescher and M. Fiescher.
5. Steroids-Shoppe.

HCT. 4.4: HETEROCYCLIC AND BIOORGANIC CHEMISTRY

Objectives:
- To familiarize with the chemistry of heterocyclic compounds.
- To learn the synthesis and biological importance of carbohydrates, proteins and nucleic acid.

Course outcome:
- Structure, Reactivity and synthesis of several heterocyclic compounds.
- Synthesis, industrial and biological importance of carbohydrates.
- General synthesis of amino acids, peptides, nucleic acids and their biological significance.

Pedagogy:
- Conventional method such as black board and chalk can be used.
- Modern methods like power point presentation can be used in class room teaching.

Course content:

UNIT-I

[16 HOURS]

Nomenclature of heterocyclic compounds. Structure, reactivity, synthesis and reactions of furan, pyrrole, thiophene, indole, pyridine, quinoline, isoquinoline, pyrazole, imidazole, pyrone, coumarin, chromones, pyrimidines, purines. Synthesis and synthetic applications of azirines & aziridines, azetidines, oxazolines, isoxazolines, isoxazole, triazole and azepines and benzodiazepines.

UNIT-II

[16 HOURS]

Carbohydrates: Carbohydrates: Introduction, Ring size determination of monosaccharides, configuration and conformations of monosaccharides, anomeric effect, Hudson's rules, epimerization and mutarotation. Synthesis, industrial and biological importance of glycosides, amino sugars, sucrose, maltose and lactose. Polysaccharides: General methods of structure elucidation. Industrial importance and biological importance of cellulose, starch, glycogen, dextran, hemicellulose, pectin, agar- agar. Photosynthesis and biosynthesis of carbohydrates.

UNIT-III

[16 HOURS]

Amino Acids: General structure, physiological properties, protection of functional groups.
Protecting groups: Protection of hydroxyl, carboxyl, carbonyl, thiol and amino groups. Illustration of protection and deprotection in synthesis.
Peptides: Structure and conformation of peptide bond, peptide synthesis: Solution phase and Merrifield's solid phase synthesis, Racemization and use of HOBt, Synthesis of oxytocin and vasopressin, biological importance of insulin, selective cleavage of polypeptide bonds (chemical and enzymatic). Proteins: Structure determination: *C* and *N* terminal residue determination, primary, secondary, tertiary and quartenary structure determination, denaturing and renaturing of proteins.
Nucleic acids: Introduction, structure and synthesis of nucleosides and nucleotides, protecting groups for hydroxy group in sugar, amino group in the base and phosphate functions. Methods of formation of internucleotide bonds: DCC, phosphodiester approach and phosphoramide methods. Solid phase synthesis of oligonucleotides. Structure of RNA and DNA, Crick-Watson model, role of nucleic acids in the biosynthesis of proteins.

References

1. Organic Chemistry, VI edition, Robert T. Morrison, Robert N. Boyd.
2. Organic Chemistry, Vol-II by I. L. Finar.
3. Schaum's outline of theory and problems of Organic Chemistry, Harbert Meislich, Howard Nechamkin and Jocob Sharefkin.
4. Natural products: Their chemistry and biological significance, J. Mann, R. S. Davidson, J. B. Banthorpe and J. B. Harborne.
5. A text book of synthetic drugs, O. D. Tyagi and M. Yadav.
6. Synthetic drugs, Gurdeep R. Chatwal.
7. Carbohydrate Chemistry and applications of carbohydrates, K. M. Lokanatha Rai.
8. Heterocyclic chemistry by Achison.
9. Heterocyclic chemistry by Smith and Joule.
10. Heterocyclic chemistry by Pacquete.

NOTE:
Soft core Theory: All courses are same as that described in III semester.
No repetition of the same courses in the IV semester for the same students.

DISSERTATION/POJECT WORK

Dissertation work should be carryout compulsorily by the students under the guidance of Faculty members of the department independently.