JSS Mahavidyapeetha

JSS COLLEGE FOR WOMEN

SARASWATHIPURAM, MYSORE – 570 009

POSTGRADUATE DEPARTMENT OF CHEMISTRY

SYLLABUS

PROGRAMME: M.Sc. in CHEMISTRY

Under

Choice Based Credit System (CBCS)

and

Continuous Assessment Grading Pattern (CAGP)

Effective from 2026-2027

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

Programme details

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

Programme Outcomes (POs):

After successful completion of the M.Sc. Chemistry programme, students will be able to:

PO1: Advanced Chemical Knowledge

Demonstrate comprehensive knowledge and understanding of fundamental concepts, theories, principles, and applications of organic, inorganic, physical, analytical, materials, bioinorganic, and medicinal chemistry.

PO2: Scientific Reasoning and Problem Solving

Apply chemical principles, mathematical approaches, and logical reasoning to analyze chemical problems, interpret experimental data, and develop appropriate solutions.

PO3: Experimental and Analytical Skills

Develop proficiency in laboratory techniques, instrumentation, quantitative analysis, synthesis, characterization, and interpretation of chemical data using modern analytical methods.

PO4: Research and Innovation Skills

Develop the ability to identify research problems, review scientific literature, design experiments, and apply innovative approaches in chemical research and development.

PO5: Instrumentation and Data Interpretation

Understand and apply advanced characterization techniques such as UV-Visible spectroscopy, IR, NMR, Mass spectrometry, XRD, electrochemical methods, and chromatographic techniques for structural and analytical investigations.

PO6: Interdisciplinary Applications

Apply chemical knowledge to interdisciplinary areas including medicinal chemistry, nanotechnology, environmental science, biotechnology, materials science, and pharmaceutical sciences.

PO7: Environmental and Sustainable Chemistry

Understand principles of green chemistry, environmental analysis, sustainable materials, pollution control, and responsible chemical practices.

PO8: Communication and Professional Skills

Communicate scientific concepts effectively through presentations, technical writing, research reports, seminars, and collaborative activities.

Programme Specific Outcomes (PSOs) :

After completion of the M.Sc. Chemistry programme, students will be able to:

PSO1: Synthesis and Characterization Skills

Design and perform chemical synthesis, purification, and characterization of organic molecules, coordination compounds, nanomaterials, polymers, and bioactive compounds using modern techniques.

PSO2: Application of Spectroscopic and Analytical Techniques

Interpret spectral and analytical data obtained from UV-Visible, IR, NMR, Mass spectroscopy, XRD, electrochemical, chromatographic, and thermal analysis techniques for structural elucidation and material characterization.

PSO3: Research-Oriented Skills in Emerging Areas

Apply knowledge of nanochemistry, bioinorganic chemistry, medicinal chemistry, photochemistry, catalysis, and materials chemistry for solving contemporary scientific problems.

PSO4: Global level research opportunities:

Global level research opportunities to pursue Ph.D. programme, targeted approach of CSIR – NET and competitive civil service examinations

PO–PSO Alignment

PSO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
PSO1	3	3	3	3	3	2	2	2
PSO2	2	3	3	2	3	3	1	2
PSO3	3	3	2	3	3	3	2	2
PSO4	2	2	3	2	2	3	3	3

Pedagogies used in the programme

- Conventional method such as black board and chalk, and modern methods like power point presentation and information and communications technology (ICT) are used in class room teaching.

- Molecular models are used to teach molecular symmetry, stereochemistry and solid state chemistry topics.
- 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 analyses. In addition to this, students will acquire skill to handle various instruments independently.
- Students will be presenting seminars in each semester.
- Each student will be subjected to viva-voce examinations in every semester.
- Every student will work for 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.
- Special lectures are delivered by eminent scholars from different intuitions.
- National/International conferences are organized to upgrade the subject knowledge.

GENERAL REQUIREMENTS

Scheme of Instructions

1. A Master's 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 Master's 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 and Open Elective
3. **Minimum for Pass:** In case a candidate secures 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 secures 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, 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 (III Semester) for the successful completion of the Master's Degree programme.
6. All other rules and regulations hold good which are governed by the JSS college for women

(Autonomous), Saraswathipuram, Mysore -570009 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	A	2 + 0 + 0 = 2*	0 + 0 + 4 = 4[a]	- -
	O	3 + 0 + 0 = 3	I	2 + 0 + 0 = 2*	0 + 0 + 4 = 4[a]	
	P	3 + 0 + 0 = 3	O	2 + 0 + 0 = 2*	0 + 0 + 4 = 4[a]	
	A	3 + 0 + 0 = 3	P	2 + 0 + 0 = 2*	0 + 0 + 4 = 4[a]	
II	I	3 + 0 + 0 = 3	A	2 + 0 + 0 = 2*	0 + 0 + 4 = 4[a]	--
	O	3 + 0 + 0 = 3	I	2 + 0 + 0 = 2*	0 + 0 + 4 = 4[a]	
	P	3 + 0 + 0 = 3	O	2 + 0 + 0 = 2*	0 + 0 + 4 = 4[a]	
	G	3 + 0 + 0 = 3	P	2 + 0 + 0 = 2*	0 + 0 + 4 = 4[a]	
III	I	3 + 0 + 0 = 3	A	2 + 0 + 0 = 2	0 + 0 + 2 = 2[a]	4 + 0 + 0 = 4
	O	3 + 0 + 0 = 3	I	2 + 0 + 0 = 2	0 + 0 + 2 = 2[a]	
	P	3 + 0 + 0 = 3	O	2 + 0 + 0 = 2	0 + 0 + 2 = 2[a]	
	G	3 + 0 + 0 = 3	P	2 + 0 + 0 = 2	0 + 0 + 2 = 2[a]	
IV	I	3 + 0 + 0 = 3	A	2 + 0 + 0 = 2	0 + 0 + 2 = 2[a]	- -
	O	3 + 0 + 0 = 3	I	2 + 0 + 0 = 2	0 + 0 + 2 = 2[a]	
	P	3 + 0 + 0 = 3	O	2 + 0 + 0 = 2	0 + 0 + 2 = 2[a]	
	D*	0 + 0 + 3 = 3	P	2 + 0 + 0 = 2	0 + 0 + 2 = 2[a]	
Total Credits	**48**		**24(48)**			**04**

Note:

A – Analytical; I – Inorganic; O – Organic; P – Physical; G – Spectroscopy; D-Dissertation work; e.g., (L + T + P): Theory + Tutorial + Practical.

*Courses are common for both first and second semesters.

[a] 50% of the students will attend Analytical/Inorganic Practical and remaining 50% students will attend Organic/Physical Practical in I or III Semester and vice-versa during II or IV Semester.

D* Dissertation work for the IV SEM students.

SCHEME OF STUDY AND EXAMINATION

FIRST SEMESTER

HARD CORE THEORY

Courses	Title	Contact Hours/Week	Credit	Max. Marks	IA C1	IA C2	Exam Duration (Hrs)	Exam Marks (C3)
CHI HCT: 1.1	Concepts and Models of Inorganic Chemistry	3	3	100	15	15	03	70
CHO HCT: 1.2	Stereochemistry and Reaction Mechanism	3	3	100	15	15	03	70
CHP HCT: 1.3	Basic Physical Chemistry	3	3	100	15	15	03	70
CHA HCT: 1.4	Fundamentals of Analytical Chemistry	3	3	100	15	15	03	70

SOFT CORE THEORY

Courses	Title	Contact Hours/Week	Credit	Max. Marks	IA C1	IA C2	Exam Duration (Hrs)	Exam Marks (C3)
CHA SCT: 1.1/2.1	Applied Analysis	2	2	100	15	15	3	70
CHI SCT: 1.2/2.2	Chemistry of Selected Elements	2	2	100	15	15	3	70
CHO SCT: 1.3/2.3	Chemistry of Natural Products-I	2	2	100	15	15	3	70
CHP SCT: 1.4/2.4	Biophysical Chemistry	2	2	100	15	15	3	70

PRACTICALS

Courses	Title	Contact Hours/Week	Credit	Max. Marks	IA C1	IA C2	Exam Duration (Hrs)	Exam Marks (C3)
CHA SCP: 1.1/2.1	Analytical Practicals - I	8	4	100	15	15	6	70
CHI SCP: 1.2/2.2	Inorganic Practicals - I	8	4	100	15	15	6	70
CHO SCP: 1.3/2.3	Organic Practicals - I	8	4	100	15	15	6	70
CHP SCP: 1.4/2.4	Physical 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.

SECOND SEMESTER

HARD CORE THEORY

Courses	Title	Contact Hours/Week	Credit	Max. Marks	IA C1	IA C2	Exam Duration (Hrs)	Exam Marks (C3)
CHI HCT: 2.1	Coordination Chemistry	3	3	100	15	15	03	70
CHO HCT: 2.2	Synthetic Organic Chemistry	3	3	100	15	15	03	70
CHP HCT: 2.3	Principles of Physical Chemistry	3	3	100	15	15	03	70
CHG HCT: 2.4	Molecular Symmetry and Spectroscopy	3	3	100	15	15	03	70

NOTE:

Soft Core Theory: All courses are same as that described in I Semester.

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 Students only)

Courses	**Title**	**Contact Hours/Week**	**Credit**	**Max. Marks**	**IA C1**	**IA C2**	**Exam Duration (Hrs)**	**Exam Marks (C3)**
CH OET: 2.1/3.1	General Chemistry	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	IA C1	IA C2	Exam Duration (Hrs)	Exam Marks (C3)
CHI HCT:3.1	Advanced Inorganic Chemistry	3	3	100	15	15	03	70
CHO HCT:3.2	Organometallic and Photochemistry	3	3	100	15	15	03	70
CHP HCT:3.3	Advanced Physical Chemistry	3	3	100	15	15	03	70
CHA HCT:3.4	Chemical Spectroscopy	3	3	100	15	15	03	70

SOFT CORE THEORY

Courses	**Title**	**Contact Hours/Week**	**Credit**	**Max. Marks**	**IA C1**	**IA C2**	**Exam Duration (Hrs)**	**Exam Marks (C3)**
CHA SCT:3.1	Electrochemical methods of chemical analysis	2	2	100	15	15	3	70
CHI SCT:3.2	Frontiers in Inorganic Chemistry	2	2	100	15	15	3	70
CHO SCT:3.3	Chemistry of Natural Products-II	2	2	100	15	15	3	70
CHP SCT:3.4	Materials Chemistry	2	2	100	15	15	3	70

PRACTICALS

Courses	**Title**	**Contact Hours/Week**	**Credit**	**Max. Marks**	**IA C1**	**IA C2**	**Exam Duration (Hrs)**	**Exam Marks (C3)**
CHA SCP:3.1/4.1	Analytical Practicals-II	4	2	100	15	15	6	70
CHI SCP:3.2/4.2	Inorganic Practicals-II	4	2	100	15	15	6	70
CHO SCP:3.3/4.3	Organic Practicals-II	4	2	100	15	15	6	70
CHP SCP:3.4/4.4	Physical Practicals-II	4	2	100	15	15	6	70

Note: 50% of students will attend Analytical and Inorganic Practicals and the remaining 50% will attend Organic and Physical Practicals in III Semester and vice-versa in IV Semester.

OPEN ELECTIVE (for Non-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	IA C1	IA C2	Exam Duration (Hrs)	Exam Marks (C3)
CHI HCT:4.1	Bioinorganic Chemistry	3	3	100	15	15	03	70
CHO HCT:4.2	Heterocyclic and Bioorganic Chemistry	3	3	100	15	15	03	70
CHP HCT:4.3	Nuclear, Radiation and Photochemistry	3	3	100	15	15	03	70
Courses	**Title**	**Contact Hours/Week**	**Credit**	**Max. Marks**	**IA C1**	**IA C2**	**Marks (C3)**	
CHPHCT:4.4	Dissertation	6 (Per batch)	3	100	15	15	70	

SOFT CORE THEORY

Courses	Title	Contact Hours/Week	Credit	Max. Marks	IA C1	IA C2	Exam Duration (Hrs)	Exam Marks (C3)
CHA SCT:4.1	Automated and methods of chemical analysis	2	2	100	15	15	3	70
CHI SCT:4.2	Bioinorganic Photochemistry	2	2	100	15	15	3	70
CHO SCT:4.3	Medicinal Chemistry	2	2	100	15	15	3	70
CHP SCT:4.4	Quantum Chemistry and Biosensors	2	2	100	15	15	3	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 10 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**	
Internal Test	30 Marks (10+10+10) **Reduced to 10 Marks**	Internal Test	30 Marks (10+10+10) **Reduced to 10 Marks**
Home Assignment	30 Marks (10+10+10) **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 Arks**

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 twelve questions and each question carries two marks. A student has to answer any ten questions. Q. No. 2 to 8 carries 10 marks each and a student has to answer any five questions. Each main question will have two sub-sections a and b An examiner may set the questions like (4+6) or (5+5) or as his/her wish.

Model Question Paper Pattern

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

Note: *Answer all the questions. Each question carries two marks.*

***Q. N*o. 1**: Twelve Medium/ Short Answer Type Questions and any ten should be answered.

(10 × 2 = 20)

***Q. N*o. 2 to 8:** Any five questions have to be answered . Each question carries TEN marks. An examiner may set the questions like (4+6) or (5+5) or as his/her wish. (*Two marks questions shall be avoided for 2 to 8*). **(5 × 10 = 50)**

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**	
Internal Test	20 Marks (10+10) **Reduced to 10**	Internal Test	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 arks**

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	Internal Assessment 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**	**arks**

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**

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

4.Evaluation of Project Work/ Dissertation (Minor):

Each student can take up Project Work/ Dissertation under the guidance of the faculty of the department during the IV Semester as a Hard Core course.

4.1 Distribution of Marks for C_1 and C_2 Components:

IA consists of **fifteen Marks** for each components; 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. C1 will be assessed during the 8th Week of the semester and C2 during the 16th Week of the semester. Hence, the concerned guide will prepare the marks list based on the above said parameters for both C1 and C2 Components.

4.2 Distribution of Marks for C3 Component (Semester End Examination):

The semester end examination will be conducted for seventy Marks. Every student is suppose to prepare a hard copy of the findings of the work in the form of report and submitted for evaluation. This part will be assessed for fourth Marks. Each student will be subjected to Viva-Voce Examination for which thirty Marks is allotted. i.e.,

Evaluation of Report	: 40 Marks
Viva-Voce	: 30 Marks
Total	**: 70 Marks**

FIRST SEMESTER

CHI HCT: 1.1. CONCEPT AND MODELS OF INORGANIC CHEMISTRY

Course Description

This course provides an advanced understanding of inorganic chemistry by integrating the concepts of chemical periodicity, crystal structures, lattice energetics, molecular structure, acid-base theories, non-aqueous solvents, ionic liquids, supercritical fluids, lanthanoid and actinoid chemistry, and supramolecular chemistry. Students will develop a theoretical foundation for understanding the relationship between structure, bonding, energetics, and reactivity of inorganic compounds. The course also emphasizes modern applications of inorganic chemistry in materials science, catalysis, nuclear chemistry, green chemistry, and biological systems.

Course Outcomes (COs)

At the end of the course, students will be able to:

CO1: Explain periodic trends, crystal structures, lattice energetics, molecular orbital theory, and molecular geometry using modern theoretical models.

CO2: Analyse acid-base behaviour using contemporary theories and evaluate the role of non-aqueous solvents, ionic liquids, and supercritical fluids in inorganic reactions.

CO3: Interpret the chemistry of lanthanoids and actinoids, including extraction, separation, electronic properties, oxidation states, and their applications in advanced materials and nuclear science.

Pedagogy

- Interactive lectures supported by ICT-enabled tools, PowerPoint presentations, and multimedia resources to explain fundamental concepts.
- Problem-solving and tutorial sessions focusing on crystal structures, lattice energetics, molecular orbital theory, and numerical applications.
- Student-centered learning through seminars, group discussions, assignments, and case studies based on recent developments in inorganic chemistry.
- Research-oriented learning using scientific literature, journal articles, and presentations to develop critical thinking and analytical skills.

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	3	2	1	1	2	3	2	1
CO2	3	3	2	2	2	3	3	2	2	2	3	2
CO3	3	3	2	3	3	3	2	2	2	3	3	3

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 chemistr

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.

References

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

CHO HCT: 1.2. STEREOCHEMISTRY AND REACTION MECHANISM

Course Description

This course provides a comprehensive understanding of stereochemistry, reaction mechanisms, molecular orbital theory, aromaticity, reactive intermediates, and the mechanisms of organic reactions. It emphasizes the relationship between molecular structure, stereochemistry, and chemical reactivity while developing mechanistic reasoning for substitution, addition, elimination, and electrophilic/nucleophilic reactions. The course equips students with the theoretical knowledge required to analyze and predict the outcome of organic reactions and understand their applications in synthesis and research.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

CO1: Explain stereochemistry, conformational analysis, optical and geometrical isomerism, and apply stereochemical principles to determine molecular configuration and reaction stereochemistry.

CO2: Interpret bonding in organic molecules using molecular orbital theory, explain aromaticity and reactive intermediates, and evaluate factors influencing the structure and reactivity of organic compounds.

CO3: Analyze the mechanisms and stereochemical aspects of nucleophilic substitution, electrophilic substitution, addition, and elimination reactions using kinetic and thermodynamic principles.

Pedagogy

Molecular models are used to teach stereochemistry.

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

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	2	2	1	2	2	2	2	1
CO2	3	3	2	2	3	3	1	2	3	3	3	2
CO3	3	3	2	3	2	3	1	2	3	2	3	2

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_Ni, S_N1', S_N2', S_N1i 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.

Mechanism of 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.

CHP HCT: 1.3. BASIC PHYSICAL CHEMISTRY

Course Description

This course provides an advanced understanding of chemical thermodynamics, chemical kinetics, and electrochemistry. It focuses on the principles governing energy changes, equilibrium, reaction rates, and electrochemical processes. Students will develop the ability to interpret thermodynamic functions, analyze reaction mechanisms and kinetics, understand fast reaction techniques, and apply electrochemical concepts to real-world chemical systems. The course also highlights applications in materials science, catalysis, corrosion, energy storage, and industrial chemistry.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

CO1: Explain the principles of chemical thermodynamics, including entropy, free energy, chemical potential, fugacity, activity, and thermodynamic properties of solutions.

CO2: Analyze reaction kinetics by applying theories of reaction rates, mechanisms of complex and fast reactions, and evaluate the influence of experimental parameters on reaction rates.

CO3: Interpret the behavior of electrolytic solutions and electrochemical systems using theories of ionic conductance, electrode processes, and electrochemical thermodynamics.

Pedagogy

- Teaching through conventional method such as black board and chalk, and modern methods like power point presentation.
- To teach electrochemical aspects through animations.

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	2	2	2	1	2	2	2	2
CO2	3	3	3	3	2	2	1	2	2	2	3	2
CO3	3	3	3	2	3	2	2	2	2	3	2	3

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)

CHA HCT: 1.4. FUNDAMENTALS OF ANALYTICAL CHEMISTRY

Course Description

This course provides a comprehensive understanding of the principles and practices of analytical chemistry, emphasizing analytical methodology, statistical evaluation of data, validation of analytical methods, classical titrimetric techniques, chromatographic separations, and modern extraction methods. Students will develop theoretical knowledge and practical skills in quantitative and qualitative chemical analysis using conventional and instrumental techniques, with applications in pharmaceuticals, environmental monitoring, food analysis, forensic science, and industrial quality control.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

CO1: Explain the principles of analytical chemistry, statistical data analysis, error evaluation, and method validation for reliable chemical measurements.

CO2: Apply acid-base, precipitation, complexometric, and redox titrimetric methods for quantitative analysis and interpret titration data accurately.

CO3: Analyze the principles, instrumentation, and applications of chromatographic techniques, including GC, HPLC, and ion-exchange chromatography, for the separation and identification of chemical species.

Pedagogy

Lecture-cum-demonstration approach integrating analytical theory with demonstrations of titrimetric, chromatographic, and extraction techniques.

Problem-based learning through numerical exercises, statistical data analysis, method validation, and interpretation of analytical results.

Laboratory-integrated teaching emphasizing analytical method development, instrument familiarization, and quality assurance practices.

Research and case-study-based learning using scientific literature, industrial applications, and student presentations to enhance analytical thinking and problem-solving skills.

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	2	2	2	2	2	3	2	2
CO2	2	3	3	2	2	2	2	2	3	3	2	3
CO3	3	3	3	3	3	3	2	2	3	3	3	3

UNIT-1

[16 HOURS]

Analytical Chemistry: Meaning and analytical prospective, scope and function. Analytical Approach: Defining the problem , designing the analytical method and sampling.

Basic Statistics and Data Handling: Significant figures, accuracy and precision. Types of Errors: Determinate and indeterminate errors, definitions for statics. Quantifying and random error: Confidence limits and variance. Rejection of results.

Validation of analytical methods: Selectivity, linearity, accuracy, precision, sensitivity, range, LOD, LOQ and ruggedness or robustness.

Acid-base titrations: 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. Quantitative applications: inorganic and organic analysis. 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, the Volhard, the Mohr and the Fajan’s methods, typical applications.

Complexometric titrations: Chemistry and properties of EDTA, 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 and Organic analysis.

Chromatography: Definition, principles and mechanism of separation, classification of chromatographic techniques. General descriptions of column chromatography - frontal analysis, displacement analysis and elution analysis. General theory of column chromatography: characterizing a chromatogram - retention time, retention volume and baseline width. Chromatographic resolution, capacity factor, column selectivity. Column efficiency - band broadening - rate theory and plate theory. Peak capacity, non ideal behavior. Optimizing chromatographic separations using capacity factor, column selectivity and column efficiency - Van Deemter equation, and its modern versions, Golay equation and Huber-Knox equations.

UNIT – III

[16 HOURS]

Gas chromatography (GC): Principles, instrumentation - mobile phase, chromatographic columns, stationary phases, sample introduction, temperature control, and detectors for gas chromatography. Quantitative and qualitative applications.

High performance liquid chromatography (HPLC): Principles, instrumentation - columns (analytical and guard columns), stationary phases, mobile phases, choosing a mobile phase, isocratic *vs* gradient elution, HPLC plumbing, sample introduction. Detectors for HPLC - spectroscopic, electrochemical and others, quantitative applications.

Ion exchange chromatography (IEC): Definitions, requirements for ion-exchange resin, synthesis and types of ion-exchange resins, principle, basic features of ion-exchange reactions, resin-properties-ion-exchange capacity, resin selectivity and factors affecting the selectivity, applications of IEC in preparative, purification and recovery processes. IEC with eluent suppressor columns. Single Column Ion Chromatography.

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.

CHA SCP: 1.1/2.1. ANALYTICAL CHEMISTRY PRACTICALS-1

[128 HOURS].

Course Description

This laboratory course provides hands-on training in classical and instrumental analytical chemistry techniques. It enables students to develop practical skills in volumetric, non-aqueous, precipitation, complexometric, redox, potentiometric, conductometric, spectrophotometric, flame photometric, chromatographic, and extraction methods. The course emphasizes accuracy, precision, data interpretation, quality assurance, and safe laboratory practices for the quantitative analysis of pharmaceutical, environmental, food, and industrial samples.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

CO1: Perform acid-base, non-aqueous, precipitation, complexometric, and redox titrations accurately for the quantitative analysis of pharmaceutical, environmental, and industrial samples.

CO2: Apply instrumental analytical techniques such as pH-metry, conductometry, potentiometry, spectrophotometry, flame photometry, gas chromatography, HPLC, and ion-exchange chromatography for qualitative and quantitative analysis.

CO3: Analyze and interpret experimental data using appropriate calculations, evaluate analytical accuracy and precision, and prepare laboratory reports following good laboratory practices.

CO4: Demonstrate competency in analytical method selection, safe handling of chemicals and instruments, and quality control procedures for solving real-world analytical problems.

Pedagogy

Hands-on laboratory experiments emphasizing analytical techniques, instrument handling, calibration, and adherence to Good Laboratory Practices (GLP).

Demonstration-based learning through instructor-led demonstrations of analytical instruments, experimental procedures, and troubleshooting techniques.

Inquiry and problem-based laboratory learning involving analysis of unknown samples, data interpretation, error analysis, and preparation of laboratory reports.

Continuous assessment through laboratory performance, observation records, viva voce, practical assignments, and maintenance of laboratory notebooks.

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	2	2	2	2	2	3	3	2	3
CO2	2	3	3	3	3	3	2	2	3	3	3	3
CO3	2	3	3	2	3	2	2	3	2	3	2	3
CO4	2	3	3	3	3	3	3	3	3	3	3	3

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.

CHI SCP: 1.2/2.2.INORGANIC CHEMISTRY PRACTICALS-1

[128 HOURS}

Course Description

This laboratory course provides advanced training in quantitative and qualitative inorganic analysis using classical and instrumental analytical techniques. Students gain practical experience in volumetric, gravimetric, complexometric, spectrophotometric, chromatographic, and semimicro qualitative analyses. The course emphasizes analytical accuracy, precision, systematic identification of ions, interpretation of experimental results, and adherence to good laboratory practices for the analysis of ores, alloys, industrial samples, and environmental samples.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

CO1: Perform quantitative inorganic analysis using volumetric, gravimetric, and complexometric methods for the determination of metals and inorganic ions in ores, alloys, and commercial samples.

CO2: Apply spectrophotometric and chromatographic techniques for the quantitative estimation and separation of inorganic species in industrial and environmental samples.

CO3: Systematically identify cations and anions in unknown inorganic mixtures using semimicro qualitative analysis and interpret analytical observations accurately.

CO4: Demonstrate proficiency in laboratory techniques, data analysis, quality assurance, and safe laboratory practices while preparing scientific laboratory records and reports.

Pedagogy

Hands-on laboratory training through quantitative and qualitative inorganic analysis using classical and instrumental techniques.

Demonstration and guided experimentation to develop skills in spectrophotometry, chromatography, semimicro analysis, and analytical instrumentation.

Problem-solving laboratory exercises involving analysis of unknown samples, data interpretation, error analysis, and preparation of laboratory reports.

Continuous practical assessment through laboratory performance, observation records, viva voce, analytical calculations, and adherence to Good Laboratory Practices (GLP) and laboratory safety protocols.

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	2	2	2	2	3	2	2	3
CO2	2	3	3	3	3	3	2	2	3	3	3	3
CO3	3	3	3	2	2	2	1	2	2	2	2	2
CO4	2	3	3	3	2	2	3	3	3	2	3	3

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:
5. Copper volumetrically using KIO_3.
6. Nickel gravimetrically using DMG
7. Determination of lead and tin in a mixture: Analysis of solder using EDTA titration.
8. Quantitative analysis of chloride and iodide in a mixture:
9. Iodide volumetrically using KIO_3
10. Total halide gravimetrically
11. Gravimetric analysis of molybdenum with 8-hydroxyquinoline.
12. Quantitative analysis of copper(II) and iron(II) in a mixture:
13. Copper gravimetrically as CuSCN and
14. Iron volumetrically using cerium(IV) solution
15. Spectrophotometric determinations of:
16. Titanium using hydrogen peroxide
17. Chromium using diphenyl carbazide in industrial effluents
18. Iron using thiocyanate/1,10-phenanthroline method in commercial samples
19. Nickel using dimethylglyoxime in steel solution
20. Micro-titrimetric estimation of :
21. Iron using cerium(IV)
22. Calcium and magnesium using EDTA
23. Quantitative estimation of copper (II), calcium (II) and chloride in a mixture.
24. 12.Circular paper chromatographic separation of: (Demonstration)
25. Iron and nickel
26. 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).

CHO SCP: 1.3/2.3. ORGANIC CHEMISTRY PRACTICALS-

[128 HOURS]

Course Description

This laboratory course provides practical training in organic synthesis and qualitative organic analysis. Students gain hands-on experience in multistep synthesis involving important organic transformations such as bromination, oxidation, esterification, diazotization, rearrangement, condensation, and nitration. The course also develops skills in the systematic separation, identification, and characterization of binary organic mixtures through functional group analysis and derivative preparation. Emphasis is placed on safe laboratory practices, reaction optimization, purification techniques, and interpretation of experimental results relevant to research and industrial applications.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

CO1: Perform multistep organic syntheses involving important organic reactions and demonstrate proficiency in purification and isolation of organic compounds.

CO2: Apply qualitative analytical methods to separate binary organic mixtures, identify functional groups, and prepare suitable solid derivatives for compound characterization.

CO3: Interpret experimental observations, calculate percentage yield, evaluate purity, and maintain accurate laboratory records following Good Laboratory Practices (GLP).

CO4: Demonstrate safe handling of chemicals, laboratory equipment, and waste disposal practices while developing problem-solving and experimental skills relevant to organic chemistry research and industry.

Pedagogy

Hands-on laboratory training through multistep organic synthesis, purification, recrystallization, and characterization experiments.

Demonstration-based learning on synthetic techniques, reaction monitoring, separation methods, and safe laboratory practices.

Inquiry-based laboratory exercises involving identification of unknown compounds, functional group analysis, and interpretation of experimental observations.

Continuous practical assessment through laboratory performance, observation records, viva voce, yield calculations, laboratory notebooks, and scientific report writing.

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	2	2	2	2	3	2	3	2
CO2	3	3	3	2	2	2	1	2	3	2	2	2
CO3	2	3	3	2	2	2	2	3	2	2	2	2
CO4	2	3	3	3	2	2	3	3	3	2	3	2

PART-A

1. Multistep synthesis
2. Preparation *p*-bromoaniline from acetanilide.
3. Preparation of *n*-butyl bromide from *n*-butyl alcohol.
4. Oxidation of cyclohexanol to adipic acid.
5. Esterification: Preparation of benzoccaine from *p*-nitrotoluene.
6. Diazotization (Sandmeyer‘s reaction): Preparation of *p*-chlorobenzoic acid from *p*- toluidine.
7. Preparation benzilic acid from benzoin.
8. Preparation of *o*-hydroxy benzophenone from phenyl benzoate *via* Fries rearrangement.
9. Preparation of benzanilide from benzophenone oxime *via* Beckmann rearrangement.
10. Preparation of benzoic acid from benzaldehyde (Cannizzaro Reaction).
11. Preparation of 2,4-dinitrophenylhydrazine from 2,4-dinitrochlorobenzene.
12. Preparation of *m*-nitrobenzoic acid from methylbenzoate.
13. Preparation of chalcone.

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.

CHP SCP: 1.4/2.4. PHYSICAL CHEMISTRY PRACTICALS -1

[128 HOURS]

Course Description

This laboratory course provides practical training in advanced physical chemistry through experiments in chemical kinetics, thermodynamics, phase equilibria, electrochemistry, spectroscopy, and physicochemical measurements. Students develop experimental skills in determining reaction kinetics, activation energy, equilibrium constants, dissociation constants, molecular properties, and electrochemical parameters using modern analytical techniques. The course emphasizes accurate data collection, quantitative analysis, scientific interpretation, and adherence to Good Laboratory Practices (GLP) for research and industrial applications.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

CO1: Perform experiments in chemical kinetics, thermodynamics, and phase equilibrium to determine reaction rates, activation energy, thermodynamic parameters, and physicochemical properties.

CO2: Apply electrochemical techniques such as conductometry, potentiometry, pH-metry, and coulometry for quantitative analysis and determination of equilibrium and dissociation constants.

CO3: Utilize spectrophotometric and physicochemical methods to analyze molecular systems, verify theoretical principles, and interpret experimental data with accuracy and precision.

CO4: Demonstrate proficiency in laboratory techniques, data analysis, scientific reporting, and safe laboratory practices while solving problems relevant to physical chemistry, materials science, and environmental research.

Pedagogy

Hands-on experimental learning through laboratory investigations in kinetics, thermodynamics, electrochemistry, spectroscopy, and physicochemical measurements.

Demonstration and instrument-based training to develop competency in the operation, calibration, and maintenance of analytical instruments such as pH meters, conductometers, potentiometers, spectrophotometers, and refractometers.

Data-driven learning involving graphical analysis, statistical treatment of experimental data, error analysis, interpretation of results, and preparation of scientific laboratory reports.

Continuous laboratory assessment through practical performance, laboratory records, viva voce examinations, analytical calculations, and adherence to laboratory safety and Good Laboratory Practices (GLP).

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	2	2	2	2	2	2	2	2
CO2	2	3	3	2	3	2	2	2	2	3	2	3
CO3	2	3	3	2	3	2	2	3	2	3	2	2
CO4	2	3	3	3	2	3	3	3	2	2	3	3

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 volumeof 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.

SOFT CORE PAPERS

CHA SCT: 1.1/2.1.APPLIED ANALYSIS

Course Description

This course provides a comprehensive understanding of analytical techniques used in environmental, agricultural, biomedical, forensic, and fuel analysis. It covers the principles and methods involved in soil nutrient analysis, fuel characterization, physiological fluid analysis, enzyme and hormone assays, and forensic toxicology. The course equips students with the knowledge to apply analytical methods for quality assessment, environmental monitoring, clinical diagnostics, forensic investigations, and industrial applications.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

CO1: Apply analytical techniques for the determination of physicochemical properties, nutrients, and contaminants in soil samples and evaluate their significance in agriculture and environmental management.

CO2: Analyze the properties and quality of solid, liquid, and gaseous fuels using standard analytical methods and interpret combustion and calorific value data for industrial applications.

Pedagogy

Interactive lectures integrating analytical principles with real-world applications in environmental, biomedical, forensic, and industrial chemistry.

Case-based learning through analysis of clinical reports, environmental monitoring data, forensic case studies, and fuel quality assessment.

Laboratory-oriented demonstrations emphasizing sample collection, preparation, analytical procedures, and interpretation of experimental results.

Collaborative and research-based learning through seminars, assignments, scientific literature review, and discussions on recent advances in analytical chemistry.

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	2	3	3	3	2	2	3	2	3
CO2	2	3	3	2	3	3	2	2	2	3	2	3

UNIT – I

[16 HOURS]

Soil Analysis: Inorganic and organic components of soil, collection and preparation of soil samples for analysis. Measurement of soil *p*H and conductivity. Determination of organic carbon, total nitrogen, 53 available nitrogen, ammonia nitrogen, nitrate nitrogen and nitrite nitrogen. Available phosphorus and sulphur-their determination. Analysis of soil for sodium, potassium and calcium and magnesium. Micronutrient elements and their analysis. Pesticide residues in soil, their separation and determination.

Fuel analysis- Fuels and their classification. Solid fuels and their classes - natural, artificial and industrial solid fuels. Coal and its analysis - proximate analysis and ultimate analysis. Liquid fuels and their types. Aniline point, flash point and fire point and their determination, octane number of liquid fuels. Gaseous fuels and their classes, advantages. Combustion of a carbonaceous fuel – flue gas. Analysis of flue gas or automobile exhaust for CO_2, CO, O_2 and N_2 by Orsat's apparatus. Calorific value of fuel - net and gross calorific values. Determination of calorific value of solid and liquid fuels by bomb calorimeter method.

UNIT – II

[16 HOURS]

Biomedical and forensic analysis: Composition of body fluids and detection of abnormal levels of certain constituents leading to diagnosis of disease. Sample collection and preservation of physiological fluids. Analytical methods for the constituents of physiological fluids (blood, serum, urine).

Blood - estimation of glucose, cholesterol, urea, haemoglobin and bilirubin.

Urine - urea, uric acid, creatinine, calcium phosphate, sodium, potassium and chloride.

Biological significance, analysis and assay of enzymes (pepsin, monoaminoxidase, tyrosinase); and hormones (progesterone, oxytocin, insulin). Chemical, instrumental and biological assays to be discussed wherever necessary.

Forensic analysis: General discussion of poisons with special reference to mode of action of cyanide, organophosphates and snake venom. Estimation of poisonous materials such as lead, mercury and arsenic in biological materials.

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.
3. India.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
5. and M.J.K. Thomas, 6th edition, Third Indian Reprint, 2003 Pearson Education Pvt. Ltd., New Delhi.
6. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders College Publishing, California, 1990.
7. Instrumental Methods of Analysis by H.H. Willard, L.L. Merritt and J.A. Dean, 7th edition, (1988).
8. Principles and Practice of Analytical Chemistry, F.W. Fifield and Kealey, 3rd edition, 2000, Blackwell Sci., Ltd. Malden, USA.
9. Modern Analytical Chemistry, David Harvey, McGraw Hill, New Delhi, 2000 Hill, New Delhi, 2000.

CHI SCT: 1.2/2.2. CHEMISTRY OF SELECTED ELEMENTS

Course Description

This course provides a comprehensive understanding of the chemistry of the s-block, p-block, and noble gas elements, emphasizing their occurrence, extraction, physical and chemical properties, structure, bonding, and applications. It also covers the chemistry of hydrogen and hydrides, interhalogen compounds, pseudohalogens, metal-metal bonding, and cluster compounds. The course enables students to understand periodic trends, structure-property relationships, and the role of inorganic compounds in modern materials, catalysis, and industrial applications.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

CO1: Explain the chemistry of hydrogen, hydrides, and the Group 1 and Group 2 elements, including their occurrence, extraction, properties, compounds, and industrial applications.

CO2: Analyze the chemistry of Group 15, Group 17, and Group 18 elements with emphasis on their structures, bonding, oxidation states, redox behavior, and reactivity.

Pedagogy

Concept-based lectures using molecular models, crystal structure illustrations, and ICT-enabled presentations to explain bonding, structure, and periodic trends.

Activity-oriented learning through problem-solving sessions, tutorials, and assignments focusing on inorganic structures, oxidation states, and reaction mechanisms.

Collaborative learning through student seminars, group discussions, and presentations on recent advances in inorganic and materials chemistry.

Research-integrated learning involving critical review of scientific literature, case studies, and applications of inorganic compounds in catalysis, energy, and advanced materials.

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	2	2	1	2	2	2	2	2
CO2	3	3	2	2	2	3	1	2	2	2	3	2

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.

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).

8. CHO SCT: 1.3/2.3. CHEMISTRY OF NATURAL PRODUCTS-I

Course Description

This course provides a comprehensive understanding of biologically important natural products, including lipids, prostaglandins, terpenoids, porphyrins, chlorophyll, vitamin B_{12}, flavonoids, and isoflavonoids. It focuses on their nomenclature, classification, structure, biosynthesis, chemical reactions, and biological functions. The course enables students to correlate the chemistry of natural products with their physiological roles, medicinal significance, and applications in pharmaceutical, biochemical, and agricultural sciences.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

CO1: Explain the classification, structure, synthesis, and biological significance of lipids, prostaglandins, and terpenoids, and relate their chemical properties to biological functions.

CO2: Analyze the chemistry, biosynthesis, and structural elucidation of terpenoids, flavonoids, and isoflavonoids using established organic chemistry principles.

Pedagogy

Interactive lectures supported by molecular structure visualization, reaction schemes, and multimedia presentations to explain the chemistry and biosynthesis of natural products.

Case study and discussion-based learning focusing on the biological roles, medicinal applications, and recent developments in natural product chemistry.

Student-centered learning through seminars, assignments, and literature review of research articles on natural products and phytochemicals.

Concept mapping and pathway-based learning emphasizing biosynthetic routes, structure–activity relationships, and interdisciplinary applications in pharmaceutical and biological sciences.

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	3	2	2	2	2	3	3
CO2	3	3	2	3	2	3	2	2	2	3	3	3

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.

Terpenoids: Introduction, classification and general methods of structural elucidation. Chemistry of pinene, camphor, caryophyllene, santonin. Biosynthesis of terpenoids.

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,
5. J. B. Banthorpe and J. B. Harborne.
6. Synthetic drugs, Gurdeep R. Chatwal.
7. Heterocyclic chemistry by Achison.
8. Heterocyclic chemistry by Smith and Joule.
9. Heterocyclic chemistry by Pacquete.

CHP SCT: 1.4/2.4. BIOPHYSICAL CHEMISTRY

Course Description

This course introduces the principles of biophysical chemistry and pharmacokinetics, emphasizing the application of physical chemistry concepts to biological systems and drug disposition. It covers electrophoretic techniques, membrane transport, osmotic and surface phenomena, protein properties, and sedimentation methods, along with the fundamental principles of pharmacokinetics, drug absorption, distribution, metabolism, elimination, and compartment models. The course enables students to understand the physicochemical basis of biological processes and the quantitative aspects of drug action essential for pharmaceutical, biomedical, and clinical sciences.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

CO1: Explain the physicochemical principles governing biological systems, including electrophoresis, membrane transport, osmotic phenomena, viscosity, surface tension, and sedimentation techniques.

CO2: Analyze the role of biophysical properties in biological functions such as protein separation, diffusion, respiration, muscle contraction, blood flow, and cellular membrane transport.

Pedagogy

Interactive lectures supported by ICT-enabled presentations, flow diagrams, and graphical interpretation of pharmacokinetic and biophysical concepts.

Case-based learning using clinical scenarios and biological applications to correlate pharmacokinetic principles with therapeutic drug monitoring and patient care.

Problem-solving sessions involving numerical calculations of pharmacokinetic parameters, compartment models, and interpretation of plasma concentration-time curves.

Research-oriented learning through seminars, journal article discussions, assignments, and presentations on recent advances in biophysical chemistry and pharmacokinetics.

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	3	2	2	2	2	3	2
CO2	3	3	2	2	2	3	2	2	2	2	3	3

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)

SECOND SEMESTER

CHI HCT: 2.1. COORDINATION CHEMISTRY

Course Description

This course provides a comprehensive understanding of coordination chemistry, emphasizing the synthesis, stability, electronic structure, magnetic properties, spectroscopy, reaction mechanisms, and photochemistry of coordination compounds. It covers crystal field theory, molecular orbital theory, ligand field theory, substitution and electron transfer mechanisms, and the application of modern spectroscopic techniques in elucidating the structure and properties of metal complexes. The course equips students with the theoretical knowledge required to understand the role of coordination compounds in catalysis, bioinorganic chemistry, materials science, and industrial applications.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

CO1: Explain the synthesis, geometries, stability, and bonding of coordination compounds using Crystal Field Theory and Molecular Orbital Theory.

CO2: Analyze the electronic spectra, magnetic properties, and infrared spectral characteristics of coordination compounds to interpret their electronic structure and bonding.

CO3: Evaluate substitution reactions, stereochemical changes, electron transfer processes, and reaction mechanisms in coordination complexes using kinetic and mechanistic principles.

Pedagogy

Interactive lectures supported by ICT-enabled presentations, molecular models, and spectroscopic illustrations to explain bonding, electronic structure, and reaction mechanisms of coordination compounds.

Problem-solving and tutorial sessions involving crystal field splitting, Tanabe–Sugano diagrams, magnetic moment calculations, stability constants, and mechanistic pathways.

Student-centered learning through seminars, group discussions, assignments, and case studies on coordination compounds in catalysis, medicine, bioinorganic chemistry, and materials science.

Research-oriented learning using scientific journal articles, literature review, and presentations on recent advances in coordination chemistry, photochemistry, and transition metal complexes.

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	3	2	1	2	3	3	2	2
CO2	3	3	2	2	3	2	1	2	2	3	3	2
CO3	3	3	2	3	3	3	1	2	2	3	3	3

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- 6^{th} edition, K. Nakamoto, John Wiley and Sons (2009)

CHO HCT: 2.2. SYNTHETIC ORGANIC CHEMISTRY

Course Description

This course provides an advanced understanding of modern organic synthesis with emphasis on oxidation, reduction, organoboron chemistry, synthetic reagents, molecular rearrangements, retrosynthetic analysis, and green chemistry. It focuses on the mechanisms, selectivity, and synthetic applications of important organic reagents and transformations used in the preparation of complex organic molecules. The course enables students to develop strategic approaches to organic synthesis while incorporating environmentally sustainable practices in chemical synthesis.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

CO1: Explain the mechanisms, selectivity, and synthetic applications of oxidation and reduction reactions using classical and modern organic reagents.

CO2: Apply the principles of organoboron chemistry, advanced synthetic reagents, and transition metal-catalyzed reactions for functional group transformations and carbon-carbon bond formation.

CO3: Evaluate green chemistry principles and sustainable synthetic methodologies for developing environmentally benign organic reactions and industrial processes.

Pedagogy

Interactive lectures supported by reaction mechanism illustrations, molecular visualization tools, and ICT-enabled presentations to explain synthetic transformations and reaction pathways.

Problem-solving and synthesis workshops focusing on retrosynthetic analysis, multistep synthesis planning, reagent selection, and mechanistic interpretation of organic reactions.

Student-centered learning through seminars, assignments, literature review, and discussion of research articles on modern synthetic methodologies and green chemistry.

Application-oriented learning using case studies from pharmaceutical, medicinal, agrochemical, and industrial organic synthesis to relate theoretical concepts with real-world applications.

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	2	3	2	2	3	2	3	3
CO2	3	3	3	3	2	3	2	2	3	2	3	3
CO3	2	3	2	3	2	3	3	2	2	2	3	3

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 liquid

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.

CHP HCT:2.3. PRINCIPLES OF PHYSICAL CHEMISTRY

Course Description

This course provides an advanced understanding of quantum chemistry, statistical thermodynamics, phase equilibria, polymer chemistry, and colloidal systems. It introduces the mathematical foundations of quantum mechanics, molecular energy distributions, phase rule applications, polymerization mechanisms, molecular weight determination, and the physicochemical properties of polymers and colloids. The course enables students to apply theoretical concepts to modern materials, nanotechnology, polymer science, and physicochemical research.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

CO1: Explain the fundamental principles of quantum mechanics, solve Schrödinger wave equations for simple systems, and interpret quantum mechanical models of atoms and molecules.

CO2: Apply the concepts of statistical thermodynamics and phase rule to evaluate thermodynamic properties, molecular distributions, equilibrium phenomena, and phase equilibria in chemical systems.

CO3: Analyze polymerization mechanisms, molecular weight determination methods, thermal behavior, and solution properties of polymers and relate them to material performance and industrial applications.

Pedagogy

Interactive lectures supported by mathematical derivations, ICT-enabled presentations, simulations, and graphical visualization to explain quantum, thermodynamic, and polymer concepts.

Problem-solving tutorials involving quantum mechanical calculations, statistical thermodynamics, phase rule applications, polymer molecular weight determination, and numerical exercises.

Application-based learning through case studies, seminars, and discussions on polymers, colloids, nanomaterials, and emerging applications in materials science and industry.

Research-oriented learning using scientific literature, computational tools, assignments, and student presentations to strengthen analytical, quantitative, and problem-solving skills.

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	3	2	1	2	2	3	2	2
CO2	3	3	2	2	2	2	2	2	2	2	2	2
CO3	3	3	2	3	2	3	2	2	3	2	3	3

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.

CHG HCT: 2.4. MOLECULAR SYMMETRY AND SPECTROSCOPY

Course Description

This course provides an in-depth understanding of molecular symmetry, group theory, and molecular spectroscopy with emphasis on their applications in chemical bonding, molecular structure, and characterization of inorganic and organic compounds. It covers symmetry operations, point groups, group representations, vibrational analysis, rotational, infrared, Raman, UV-Visible, and resonance Raman spectroscopy. The course enables students to apply spectroscopic and symmetry principles for structural elucidation, qualitative and quantitative analysis, and interpretation of molecular properties in chemical research and advanced materials.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

CO1: Explain molecular symmetry, point groups, group representations, and character tables, and apply group theory to chemical bonding, molecular orbitals, crystal field theory, and vibrational spectroscopy.

CO2: Analyze rotational, vibrational, infrared, and Raman spectra to determine molecular structure, bonding, symmetry, and molecular properties.

CO3: Interpret UV-Visible and resonance Raman spectra for qualitative and quantitative analysis, electronic transitions, and structural characterization of chemical compounds.

Pedagogy

Interactive lectures supported by symmetry models, character tables, spectroscopic illustrations, and ICT-enabled presentations to explain molecular symmetry and spectroscopic principles.

Problem-solving tutorials involving point group assignment, character table applications, spectral interpretation, numerical calculations, and structural determination.

Application-oriented learning through case studies, seminars, and discussions on the use of spectroscopic techniques in coordination chemistry, materials science, pharmaceuticals, and nanotechnology.

Research-based learning using scientific literature, computational visualization tools, spectral databases, and student presentations to enhance analytical, interpretative, and research skills.

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	3	2	1	2	2	3	2	2
CO2	3	3	2	2	3	2	1	2	2	3	2	2
CO3	3	3	3	2	3	3	1	2	2	3	3	3

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 field theory 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).
2. Molecular Symmetry and Group Theory – Robert L Carter, John Wiley and Sons (2005).
3. Symmetry in Chemistry - H. Jaffe and M. Orchin, John Wiley, New York (1965).
4. Molecular Symmetry – David J. Willock, John Wiley and Sons Ltd., (2009).
5. Group Theory and its Chemical Applications - P.K. Bhattacharya, HimalayaPublications, New Delhi (1998).
6. Fundamentals of Molecular Spectroscopy, C.N. Banwell and E.M. McCash. 4th edition, Tata McGraw Hill, New Delhi.
7. Fundamentals of molecular spectroscopy, G. M. Barrow, MgGraw Hill, New York (International students Edition), 1974.
8. Theoretical chemistry, S. Glasstone, affiliated East-West Press Pvt. Ltd, New Delhi, 1973.
9. Spectroscopy, B.P. Straughan and S. Walker, John Wiley & Sons Inc., New York, Vol. 1 and 2, 1976.
10. Vibration Spectroscopy Theory and Applications, D.N. Satyanarayana, New Age International, New Delh

OPEN ELECTIVE (FOR NON-CHEMISTRY STUDENTS ONLY)

CH OET: 2.1/3.1- CHEMISTRY

Course Description

This Open Elective course is designed to provide non-chemistry students with a fundamental understanding of chemistry and its applications in everyday life, science, technology, health, and the environment. The course introduces the concepts of atomic structure, chemical bonding, acids and bases, natural and synthetic products, thermodynamics, chemical kinetics, electrochemistry, analytical methods, and separation techniques. It aims to develop scientific reasoning and problem-solving skills while highlighting the interdisciplinary role of chemistry in biological, industrial, pharmaceutical, agricultural, and environmental systems.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

CO1: Explain the fundamental concepts of chemical periodicity, chemical bonding, molecular structure, acids and bases, and relate them to the properties and behavior of chemical substances.

CO2: Describe the structure, properties, and applications of important natural and synthetic compounds, and recognize the significance of chemistry in biological systems, healthcare, agriculture, and industry.

CO3: Apply the principles of thermodynamics, chemical kinetics, ionic equilibria, solutions, and electrochemistry to interpret simple chemical processes and solve basic quantitative problems.

Pedagogy

Interactive and activity-based lectures using multimedia presentations, models, animations, and real-life examples to explain fundamental chemical concepts.

Experiential learning through demonstrations, simple laboratory activities, case studies, and problem-solving exercises connecting chemistry with everyday life.

Collaborative learning through group discussions, seminars, assignments, quizzes, and presentations to promote scientific communication and critical thinking.

Application-oriented learning by integrating examples from environmental science, healthcare, agriculture, food technology, and industrial chemistry to illustrate the relevance of chemistry across disciplines.

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1	1	2	1	2	1	1	1	2
CO2	3	2	1	1	1	3	2	2	1	1	2	3
CO3	3	3	2	1	2	2	1	2	1	2	1	2

UNIT-I

[16 HOURS]

Periodic Table and chemical Periodicity: Periodic properties of elements, State of Matter, their resources. Important periodic properties of the elements, covalent radii, ionic radii, ionization potential, electron affinity and electronegativity.

Structure and Bonding: Properties of ionic compounds, structure of crystal lattices (NaCl, CsCl, ZnS, Wurtzite and rutile), Lattice energy, Born-Haber Cycle, radius ratio rules and their limitations.MO treatment for homo- and heteronuclear diatomic molecules. VSEPR model to simple molecules. Factors affecting the radii of ions, covalent character in ionic bonds, hydration energy and solubility of ionic compounds.

Concepts of Acids and Bases: Review of acid base concepts. Lux-Flood and solvent system concepts. Hard-soft acids and bases. Applications.

UNIT-II

[16 HOURS]

Bonding and molecular structure: Introduction to organic chemistry, atomic orbitals, sigma and pi bond formation-molecular orbital (MO) method, sp, sp^2 and sp^3 hybridization, bond length, bond dissociation energies and bond angles (open chain and cyclic compounds). Electronegativity and polarity of the bonds. Classifications and reactions of organic compounds (with examples).

Acids and bases: Hydrogen bonding, resonance and inductive effective on strengths of acids and bases.

Biological importance of natural products: Amino acids, proteins, carbohydrates (cellulose, starch, glycogen), lipids (fats and oils, phospholipids), prostaglandins, nucleic acids, steroids, alkaloids, vitamins, flavonoids.

Applications of synthetic products: Dyes, drugs, polymers (plastics), soaps and detergents, pesticides and pheromones.

UNIT-III

[16 HOURS]

Thermodynamics: First and second laws of thermodynamics. Concept of entropy and free energy, entropy as a measure of unavailable energy. Entropy and free energy changes and spontaneity of process.

Chemical kinetics: Rate and order of reaction. Factor affecting the rate of reaction. and determination Order of reaction. Energy of activation and its determination. Brief account of collision and activated complex theories.

Ionic equilibria: pH scale, buffer solutions, calculation of pH of buffer solutions, buffer capacity and buffer index, buffer mixtures.

Solutions: Concentration units, solutions of liquids in liquids, Raoult's law, ideal and non-ideal solutions.

Electrochemistry: Electrolytic conductance, specific, equivalent and molar conductance, ionic mobility and transference number, factors affecting the electrolytic conductance, Arrhenius theory of strong and weak electrolytes, assumptions of Debye- Huckel theory of strong electrolytes. Single electrode potential, reference electrodes, galvanic cells, emf of galvanic cells and construction of electrochemical cells.

UNIT-IV

[16 HOURS]

Basic Statistics and Data Handling: Significant figures, accuracy and precision. Types of errors: Determinate error and indeterminate error. Definitions for statistics. Quantifying random error: Confidence limits, variance. Rejection of results.

Applications of titrimetric methods: Introduction, theory and applications of acid base titrimetry, complexometric titrations and redox titrimetry

Separation techniques: Purification-Crystallization, sublimation, fractional crystallization, distillation techniques (simple distillation, steam distillation, distillation under reduced pressure, and fractional distillation), solvent extraction.

Chromatography: Thin layer chromatography and ion-exchange chromatography and their applications in the separation of the components from the mixture.

References

1. Text Book of Physical Chemistry by Samuel Glasstone, MacMillan Indian Ltd., 2nd edition (1974).
2. Elements of Physical Chemistry by Lewis and Glasstone, 2nd Edn. Macmillan & Co Ltd., New York.
3. Organic Chemistry, VI edition, Robert T. Morrison, Robert N. Boyd.
4. Organic Chemistry, Vol-I by I. L. Finar.
5. Vogel' text book of practical organic chemistry, V edition, B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatehell.
6. Laboratory manual of Organic Chemistry by B. B. Dey and M. V. Sitaraman.
7. Practical Organic Chemistry by Mann F. G. and Saunders.
8. Fundamentals of analytical chemistry, 8th Edition, D. A. Skoog, D. M. West, Holler and Crouch.
9. Principles and Practice of Analytical Chemistry, F.W. Fifield and Kealey, 3rd edition, 2000, Blackwell Sci., Ltd. Malden, USA.
10. Modern Analytical Chemistry, David Harvey, McGraw Hill, New Delhi, 2000

THIRD SEMESTER

CHI HCT: 3.1. ADVANCED INORGANIC CHEMISTRY

Course Description

This course provides a comprehensive understanding of organometallic chemistry, homogeneous and heterogeneous catalysis, cluster chemistry, and the chemistry of boron, phosphorus, silicon, and related main group elements. It focuses on the synthesis, structure, bonding, reactivity, and applications of organometallic compounds and metal clusters in catalysis, industrial processes, medicinal chemistry, and materials science. The course also introduces electron counting rules, cluster bonding theories, and the chemistry of silicates and silicones, enabling students to appreciate the role of inorganic chemistry in modern chemical research and technology.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

CO1: Explain the preparation, structure, bonding, and reactivity of organometallic compounds, transition metal carbonyls, ferrocene, metal-carbene complexes, and complexes containing π-bonded ligands.

CO2: Analyze the principles and mechanisms of homogeneous and heterogeneous catalysis and evaluate the applications of organometallic catalysts in industrial, biological, and medicinal chemistry.

CO3: Interpret the structure, bonding, electron counting, and applications of boranes, carboranes, phosphazenes, metal carbonyl clusters, silicates, and silicones using modern concepts of inorganic chemistry.

Pedagogy

Interactive lectures supported by molecular models, ICT-enabled presentations, and reaction mechanism illustrations to explain organometallic bonding, catalysis, and cluster chemistry.

Problem-solving and tutorial sessions focusing on electron counting, EAN rule, Wade–Mingos rules, isolobal analogy, catalytic cycles, and reaction mechanisms.

Student-centered learning through seminars, group discussions, assignments, and case studies on industrial catalysis, organometallic synthesis, and advanced inorganic materials.

Research-oriented learning using scientific journal articles, literature review, and presentations on recent advances in organometallic chemistry, catalysis, and main-group chemistry.

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	3	3	1	2	3	3	3	2
CO2	3	3	2	3	3	3	2	2	2	3	3	3
CO3	3	3	2	3	3	3	2	2	2	3	3	3

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.

UNIT-III

[16 HOURS]

Chemistry of main group elements: Diborane and its reactions, polyhedral boranes(preparation, properties, structure and bonding). Wade's rules, carboranes andmetallocarboranes. Borazines. Phosphazenes, S-N compounds.

Metal clusters: Evidences and factors favoring of M-M bonding, Wade's-Mingo's-Lauher rules, bi, tri, tetra, penta and hexa nuclear metal carbonyl clusters.

Low and high nuclearity carbonyl clusters. Electron counting schemes in carbonyl clusters. The isolobal analogy.

Silicates: Structure, classification - silicates with discrete anions, silicates containing chainanion, silicates with layer structure, silicones with three dimensional net-work and applications.

Silicones: General methods of preparation, properties. Silicone polymers - silicone fluids, silicone greases, silicone resins, silicone rubbers and their applications.

References

1. Organometallic Chemistry, 2nd edition, R.C. Mehrothra and A. Singh, New Age International Publications (2006).
2. Fundamental Transition Metal Organometallic Chemistry - Charles M. Lukehart, Brooks, Cole Publishing Company (1985).
3. The Organometallic Chemistry of the Transition Metals, 4th edition, Robert H. Crabtree, Wiley Interscience, (2005).
4. Organometallics - A Concise Introdution, 2nd edition, ChistophElschenbroich and Albert Salzer VCH, (1992).
5. Inorganic Chemistry, 2nd edition, C.E. Housecroft and A.G. Sharpe, Pearson Education Ltd., (2005).
6. Inorganic Chemistry- 3rd edition, G.L. Miessler and D.A. Tarr, Pearson Education,(2004).
7. Basic Organometallic Chemistry - B.D. Gupta and A.J. Elias, Universities Press (2010).
8. Inorganic Chemistry Principles of Structure and Reactivity: James E. Huheey, Ellen A. Keiter, Richard L. Keiter, Okhil K. Medhi, Delhi University, New Delhi (2006)
9. Chemistry of the Elements – N.N. Greenwood and A. Earnshaw, Pergamon Press (1985).
10. Inorganic Chemistry, 6th edition. D.F. Shriver, M. Weller. T. Overton, J. Rourke and F. Armastrong, Oxford University Press (2014).
11. Organometallic Chemistry and Catalysis, Didier Astruc, Springer (2007).
12. Transition Metal Organometallic Chemistry, Francois Mathey, Springer (2013).

CHO HCT: 3.2. ORGANOMETALLIC AND PHOTOCHEMISTRY

Course Description

This course provides an advanced understanding of photochemistry, pericyclic reactions, organometallic reagents, and asymmetric synthesis. It emphasizes the mechanistic and stereochemical aspects of photochemical and pericyclic transformations, the preparation and synthetic applications of organometallic reagents, and modern strategies for asymmetric synthesis.

The course enables students to design stereoselective synthetic routes and apply contemporary organic methodologies in pharmaceutical, medicinal, and fine chemical synthesis.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

CO1: Explain the principles, mechanisms, and stereochemical aspects of photochemical and pericyclic reactions, and predict the outcome of these reactions using orbital symmetry and frontier molecular orbital concepts.

CO2: Analyze the preparation, reactivity, and synthetic applications of organometallic reagents in carbon-carbon bond formation, functional group transformations, and natural product synthesis.

CO3: Apply the concepts of asymmetric synthesis, chiral auxiliaries, chiral reagents, and asymmetric catalysts to design enantioselective synthetic pathways and evaluate stereochemical outcomes in modern organic synthesis.

Pedagogy

Interactive lectures supported by ICT-enabled presentations, reaction mechanism illustrations, molecular orbital diagrams, and stereochemical models to explain advanced organic transformations.

Problem-solving and synthesis workshops focusing on reaction mechanisms, stereochemical predictions, retrosynthetic analysis, and reagent selection for complex organic synthesis.

Student-centered learning through seminars, journal article discussions, assignments, and presentations on recent advances in photochemistry, asymmetric synthesis, and organometallic chemistry.

Research-oriented learning using case studies from pharmaceutical, medicinal, and natural product synthesis to develop analytical thinking, problem-solving ability, and synthetic strategy design.

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	2	3	2	2	2	2	3	2
CO2	3	3	3	3	2	3	2	2	3	2	3	3
CO3	3	3	3	3	2	3	2	2	3	2	3	3

UNIT-I

[16 HOURS]

Photochemistry: Light absorption and electronic transitions, Jablonski diagram, intersystem crossing, energy transfer, sensitizers, quenchers. Photochemistry of olefins, conjugated dienes, aromatic compounds, ketones- Norrish type-I and Norrish type-II reactions, enones, Paterno-Buchi reaction, di-pi- rearrangements, photooxidations, photoreductions.

Pericyclic reactions:

Electrocyclic reactions: Stereochemistry, symmetry and Woodward-Hofmann rules for electrocyclic reactions, FMO theory of electrocyclic reactions, correlation diagram for butadiene to cyclobutene and hexatriene to cyclohexadiene systems.

Cycloaddition reactions: Classification, analysis by FMO and correlation diagram method. Cycloaddition reactions: [2+2] and [4+2] cycloadditions- FMO and correlation diagram method Deils-Alder reaction, hetero Diels-Alder reaction and their applications. Intra and intermolecular 1,3-dipolar cycloadditions: involving nitrile oxide, nitrile imine, nitrile ylide and their application in organic synthesis.

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

UNIT-II

[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: Gilmann reagent, preparation, reactions with aldehydes, ketones and imines. Application in the synthesis of brevicomin, 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. Organotin reagents: tributyltin hydride, Barton decarboxylation reaction, Barton deoxygenation reaction, Stille coupling, Stille-Kelley coupling reactions, Barton McCombie reaction, Keck stereoselective allylation and other applications.

UNIT-III

[16 HOURS]

Asymmetric synthesis: Definition, importance, mechanism, energy consideration, advantages and limitations, methods of determination of enantiomeric excess. Methods of asymmetric induction:

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, IPC2BH, (*S*)- BINAP-DIAMINE and (*R*)-BINAL-H. Use of (*R,R*)-DIPAMP, (*S,S*)-CHIRAPHOS, (*R,R*)-DIOP, SAMP, RAMP, *S*-Proline, *S*-PBMgCl, (-)-BOAlCl2, (+) and (-)-DET.

References

1. Organic Chemistry, VI edition, Robert T. Morrison, Robert N. Boyd.
2. Advance Organic Chemistry, IV edition, Jerry March.
3. Advance Organic Chemistry, III edition, Part-A and Part-B, Francis A. Carey and Rechard J. Sundberg.
4. Organic Chemistry, III edition, V. K. Ahluwalia and Rakesh Kumar Parashar.
5. Schaum's outline of theory and problems of Organic Chemistry, Harbert Meislich, Howard Nechamkin and Jocob Sharefkin.
6. Asymmetric synthesis, Garry Procter.
7. Mechanism in Organic Chemistry, VI edition, Peter Sykes.
8. Molecular reactions and photochemistry, Charles H. Depuy, Orville L. Chopman.
9. Modern methods of Organic synthesis, III edition, W. Carruthers.
10. Organometallics in Organic synthesis, J. M. Swan and D. Stc Black.
11. Organic chemistry by Clayden, Greeves, Warren and Wothers.

CHP HCT: 3.3. ADVANCED PHYSICAL CHEMISTRY

Course Description

This course provides an advanced understanding of homogeneous catalysis, enzyme kinetics, electrochemical systems, corrosion science, and X-ray crystallography. It emphasizes the principles governing catalytic processes, linear free energy relationships, kinetic isotope effects, electrochemical cells, batteries, electroplating, corrosion mechanisms, crystal structure determination, and crystal defects. The course enables students to correlate fundamental physicochemical principles with applications in catalysis, energy storage, corrosion control, materials characterization, and solid-state chemistry.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

CO1: Explain the principles of homogeneous catalysis, enzyme kinetics, linear free energy relationships, and kinetic isotope effects, and interpret their applications in chemical and biochemical processes.

CO2: Analyze electrochemical systems, batteries, electroplating, and corrosion mechanisms, and evaluate methods for corrosion prevention and electrochemical energy conversion.

CO3: Apply the principles of X-ray crystallography and crystal defect analysis to determine crystal structures and correlate crystal imperfections with the physical properties of materials.

Pedagogy

Interactive lectures supported by ICT-enabled presentations, crystallographic models, electrochemical cell diagrams, and catalytic cycle illustrations to explain theoretical concepts.

Problem-solving and numerical tutorials involving kinetic equations, electrochemical calculations, corrosion analysis, crystallographic indexing, and structure determination.

Application-based learning through case studies, seminars, and discussions on industrial catalysis, battery technologies, corrosion engineering, and advanced functional materials.

Research-oriented learning using scientific literature, journal presentations, computational visualization tools, and assignments to develop analytical, interpretative, and research skills.

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3	2	3	2	2	2	2	3	2
CO2	3	3	3	3	3	3	3	2	2	3	3	3
CO3	3	3	3	3	3	3	2	2	3	3	3	3

UNIT-I

[16 HOURS]

Homogeneous Catalysis: Electronic and structural effects on acidity and basicity. Hard and soft acids and bases. Acidity functions: Hammet acidity function, Zucker-Hammet hypothesis, Bonnett hypothesis. Industrial catalysis: Catalyst carrier, promoter, inhibitor and catalyst poison.

Enzyme kinetics: Effect of substrate concentration (Michaelis - Menton equation), Effect of pH, effect of catalysts and inhibitors (substrate, zeolite, Cr^{3+}, Fe^{2+} ZnO, U.V light), effect of temperature. A brief kinetic and mechanistic applications of glucose oxidase in the oxidation of glucose.

Linear Free Energy Relationship: Hammett equation, Taft equation, Okemoto Brown equation and its application to oxidation of amino acids and aromatic amines. Swain- Scott and Edward equation. Winstein - Grunwald relationship. Isokinetic relationship and significance of isokinetic temperature, Exner criterion.

Kinetic Isotope Effect: Theory of kinetic isotope effect - normal and inverse isotope effect, primary isotope effect, secondary isotope effect, solvent isotope effect.

UNIT-II

[16 HOURS]

Electrochemical cells and batteries: Introduction, galvanic and electrolytic cells, schematic representation of cells. Faradays's law, mass transfer in cells. Batteries: Classification, characteristics, primary, secondary and lithium batteries, fuel cells.

Electroplating: Definition, theory and mechanism of electroplating, effect of plating variables on the properties of electro deposits, comparative account of complexing and non-complexing baths (general treatment), additives on plating baths and their significance.

Metallic coating: Preparation of substrate surface, electroplating of Cu and Cr. Application of Au and Ag plating.

Corrosion: Types of corrosion, basis of electrochemical corrosion, theories and mechanism of wet corrosion. Thermodynamic aspects of corrosion. Current – potential relations (Evan diagram) in corrosion cells. Factors influencing the rate of corrosion: Metal and environmental factors. Kinetic aspects corrosion: Corrosion rate measurement by different methods – chemical and electrochemical methods. General aspects of corrosion prevention and control – designing aspects, effect of allying and surface modification. Corrosion prevention by painting, phosphating and anodic (passivation) and cathodic protection. Corrosion inhibitors: Introduction, classification, Characteristics and requirements of efficient corrosion inhibitors, Green inhibitors and their significance, Corrosion inhibition mechanism.

UNIT-III

[16 HOURS]

Fundamentals of X-ray crystallography: Law of interfacial angles, laws of symmetry, Miller indices, Bragg equation (No derivation), Experimental methods – powder and rotating crystal methods, indexing of powder and rotating crystal photographs. Atomic scattering factor, structure factor, Fourier synthesis and electron density diagrams. Electron diffraction of gases, experimental technique, Scattering-Intensity curves, Wierl equation (no derivation), Radial distribution method determination of bond lengths and bond angles.

Imperfections in atomic packing: Types of imperfections, classification of imperfections, point defects, Schottky defects, Frenkel defects, disordered crystals, line defects, dislocation types, plane defects, small-angle and large-angle boundaries, stacking faults, crystal growth and twinning, non-stoichiometry.

Imperfections and physical properties: electrical, optical, magnetic, thermal and mechanical properties.

References

1. Chemical Kinetics by K.J. Laidler, Tata McGraw-Hill Pub, Co Ltd, New Delhi.
2. Fundamentals of Chemical Kinetics, M. R. Wright, Harwood publishing, Chichesrer, 1999.
3. Kinetics and Mechanism of Chemical Transformation by J. Rajaram and J.C. Kuriacose, Macmillan, New Delhi.
4. Electrochemistry –Principles and Applications by E.G. Potter, Cleaver-Hume press Ltd, London.
5. Chemical and Electrochemical energy systems, R. Narayan and B. Viswanathan (University Press), 1998.
6. Industrial Electrochemistry, D. Pletcher and F. C. Walsh, Chapman and Hall, 2nd Edn, 1984.
7. An Introduction to Metallic Corrosion and its Prevention, Raj Narayan (Oxford – IBH, New Delhi), 1983.
8. Fundamentals of metallic corrosion, Philips A. Schweitzer, CRC press Taylor and Francis group, New York.
9. Corrosion prevention and control, Baldev Raj, U Kamachi Mudali & S. Rangarajan, Narora Publishing House, India.
10. Solid State Chemistry and its applications – A.R. West, John Wiley & Sons.
11. New Directions in Solid State Chemistry – CNR Rao and J. Gopalakrishna, Cambridge University Press.
12. Solid state chemistry, N. B. Hannay, PHI, New Delhi.
13. Principles of the Solid State – H.V. Keer, Wiley Eastern.

CHG HCT: 3.4. CHEMICAL SPECTROSCOPY

Course Description

This course provides an advanced understanding of modern spectroscopic techniques used for the structural characterization of organic, inorganic, and coordination compounds. It covers the principles, instrumentation, spectral interpretation, and applications of NMR, ESR, NQR, Mössbauer, photoelectron, IR, and mass spectrometry. The course emphasizes the integration of multiple spectroscopic methods for molecular structure determination, conformational analysis, and investigation of chemical bonding, making it an essential foundation for research in chemistry, materials science, pharmaceuticals, and nanotechnology.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

CO1: Explain the principles, instrumentation, and spectral features of NMR, ESR, NQR, Mössbauer, photoelectron, IR, and mass spectroscopic techniques for molecular characterization.

CO2: Interpret and correlate spectroscopic data to determine molecular structure, bonding, stereochemistry, functional groups, oxidation states, and conformational behavior of organic, inorganic, and coordination compounds.

CO3: Integrate information obtained from multiple spectroscopic techniques to solve complex structural elucidation problems and evaluate their applications in chemical research, pharmaceuticals, materials science, and analytical chemistry.

Pedagogy

Interactive lectures supported by ICT-enabled presentations, spectral databases, molecular visualization software, and instrumentation videos to explain the principles and applications of modern spectroscopic techniques.

Problem-solving and spectral interpretation sessions involving analysis of NMR, IR, ESR, Mössbauer, UV-Visible, and mass spectra for qualitative and quantitative structural determination.

Application-oriented learning through case studies, seminars, and assignments on the use of spectroscopy in pharmaceuticals, coordination chemistry, forensic science, materials characterization, and chemical research.

Research-based learning using scientific literature, journal discussions, computational tools, and composite spectral analysis exercises to develop advanced analytical and structural elucidation skills.

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	3	2	1	2	2	3	2	2
CO2	3	3	2	2	3	2	1	2	2	3	2	2
CO3	3	3	3	3	3	3	2	2	3	3	3	3

UNIT-I

[16 HOURS]

NMR Spectroscopy: Magnetic properties of nuclei (magnetic moment, g factor, nuclear spin), effect of external magnetic field on spinning nuclei, Larmor precession frequency, resonance conditions, population of nuclear magnetic energy levels, relaxation processes, relaxation time, line width and other factors affecting line width. Chemical Shift: Standards employed in NMR, factors influencing chemical shift: electronegativity, shielding and deshielding, van der Walls deshielding magnetic anisotropy, H-bonding, diamagnetic and paramagnetic anisotropies, spin-spin coupling, chemical shift values and correlation for protons bonded to carbon and other nuclei, Instrumentation. Chemical shift equivalence and magnetic equivalence, effects of chiral centre, Karplus curve-variation of coupling constants with dihedral angle. Complex NMR Spectra: Simplification of complex spectra-isotopic substitution, increased magnetic field strength, double resonance and lanthanide shift reagents, Nuclear Overhauser Effect (NOE), FT-NMR, Spectroscopy and advantages. ^{13}C-NMR Spectroscopy, multiplicity- Proton decoupling-Noise decoupling-Off resonance decoupling-Selective proton decoupling - Chemical shift, application of ^{13}C, ^{19}F, ^{31}P, ^{11}B and ^{15}N.

Applications of NMR: Structural diagnosis, conformational analysis, keto-enol tautomerism, H bonding. Solid state NMR and its applications.

Multiple resonance spectroscopy: Introduction to 2D-techniques: DEPT, COSY and NOESY.

UNIT-II

[16 HOURS]

Electron Spin Resonance Spectroscopy: Basic principles, hyperfine couplings, the ‘g’ values, factors affecting ‘g’ values, isotropic and anisotropic hyperfine coupling constants, Zero Field splitting and Kramer’s degeneracy. Measurement techniques and Applications to simple inorganic and organic free radicals and to inorganic complexes.

NQR Spectroscopy: Introduction, Principles, Quadrupolar nuclei, electric field gradient, nuclear quadrupole couplingconstants, energies of quadrupolar transitions, effect of magnetic field. Applications.

Mössbauer spectroscopy: The Mössbauer effect, chemical isomer shifts, quadrupole interactions,magnetic splitting, measurement techniques and spectrum display, application to the study of $Fe^{2+}$and Fe $^{3+}$compounds; iron in very high oxidation states- Fe(V) and Fe(VI) nitride complexes; $Sn^{2+}$and Sn^{4+}compounds, nature of M-L bond, coordination numberand structure, detection of oxidation states and aninterhalogen compound $I_2Br_2Cl_4$.

Photoelectron Spectroscopy: Introduction, principles, chemical shifts, photoelectron spectra of simple molecules. X-ray photoelectron and Auger electron spectroscopy- Principles and applications.

UNIT-III

[16 HOURS]

IR spectroscopy: Introduction, instrumentation, sample handling, Characteristic group frequencies and skeletal frequencies. Finger print region, Correlation chart. Identification of functional groups- alkanes, alkenes, alkynes, aromatics, carbonyl compounds (aldehydes, ketones, esters and lactones), halogen compounds, sulphur and phosphours compounds, amides, lactums, amino acids and amines, Factors affecting group frequencies and band shapes, conjugation, resonance and inductance, hydrogen bonding and ring strain. tautomerism, *Cis-trans* isomerism. Applications of IR spectroscopy.

Mass Spectrometry: Basic principles, Instrumentation -Mass spectrometer, interpretation of mass spectra, resolution, exact masses of nuclides, molecular ions, meta-stable ions and isotope ions. Different methods of ionization (chemical ionization, electron impact, field ionization, MALDI etc.). Fragmentation processes-representation of fragmentation, basic fragmentation types and rules. Factors influencing fragmentations and reaction pathways. McLafferty rearrangement. Fragmentations (fragmentation of organic compounds with respect to their structure determination) associated with functional groups- alkanes, alkenes, cycloalkanes, aromatic hydrocarbons, halides, alcohols, phenols, ethers, acetals, ketals, aldehydes, ketones, quinines, carboxylic acids, esters, amides, acid chlorides, nitro compounds, amines & nitrogen heterocycles. Fragmentation patterns of glucose, myrcene, nicotine, retro Diels-Alder fragmentation. Application in structure elucidiation and evaluation of heats of sublimation & ionization potential. Nitrogen rule. LC-MS and GC-MS, High resolution mass spectroscopy. Composite problems involving the applications of UV, IR, ^{1}H and ^{13}C-NMR and mass spectroscopic techniques. Structural elucidation of organic and inorganic compounds.

References

1. Organic Spectroscopy-3rd Ed.-W. Kemp (Pagrave Publishers, New York), 1991.
2. Spectrometric Identification of Organic Compounds - Silverstein, Bassler & Monnill (Wiley) 1981.
3. Spectroscopy of Organic Compounds-3rd Ed.-P.S. Kalsi (New Age, New Delhi) 2000.
4. E.A.V. Ebsworth, D.W.H. Ranklin and S. Cradock: Structural Methods in Inorganic Chemistry, Blackwell Scientific, 1991.
5. J. A. Iggo: NMR Spectroscopy in Inorganic Chemistry, Oxford University Press, 1999.

6. C. N. R. Rao and J. R. Ferraro: Spectroscopy in Inorganic Chemistry, Vol I & II (Academic) 1970.
7. Spectroscopy, B. P. Straughan and S. Salker, John Wiley and Sons Inc., New Yourk, Vol.2, 1976.
8. Application of Absorption Spectroscopy of Organic Compounds, John R. Dyer, Prentice/Hall of India Private Limited, New Delhi, 1974.
9. Organic Spectroscopy, V. R. Dani, Tata McGraw-Hall Publishing Company Limited, New Delhi. 1995.
10. Interpretation of Carbon-13 NMR Spectra, F.W. Wehrli and T. Wirthin, Heyden, London, 1976.
11. NMR spectroscopy-Powai

CHA SCP: 3.1/4.1. ANALYTICAL CHEMISTRY PRACTICALS-II

[64 HOURS]

Course Description

This laboratory course provides hands-on training in advanced quantitative analytical techniques used in chemical, environmental, pharmaceutical, clinical, and agricultural analysis. Students gain practical experience in volumetric, potentiometric, conductometric, spectrophotometric, polarographic, coulometric, and complexometric methods for the analysis of metals, pharmaceuticals, biological samples, soil, and water. The course develops experimental skills, data interpretation, analytical accuracy, quality assurance practices, and laboratory safety, preparing students for research and industrial analytical laboratories.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

CO1: Perform quantitative chemical analyses using classical and instrumental analytical techniques, including titrimetry, spectrophotometry, potentiometry, conductometry, polarography, and coulometry, following standard laboratory procedures.

CO2: Analyze environmental, pharmaceutical, biological, and agricultural samples, interpret experimental results, evaluate analytical accuracy and precision, and prepare scientific laboratory reports.

Pedagogy

Laboratory-based experiential learning through supervised practical experiments emphasizing analytical techniques, precision, accuracy, laboratory safety, and standard operating procedures.

Demonstration and hands-on training on modern analytical instruments such as spectrophotometers, potentiometers, conductometers, polarographs, and electrochemical analysis systems.

Inquiry-based learning through experimental data analysis, error estimation, laboratory record maintenance, interpretation of analytical results, and preparation of scientific reports.

Collaborative and application-oriented learning using problem-based experiments, sample analysis from environmental and pharmaceutical sources, peer discussions, viva-voce examinations, and continuous laboratory assessment.

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	3	3	2	2	2	3	3	2	3
CO2	2	3	3	3	3	3	3	3	2	3	3	3

PART-A

1. Determination of calcium in limestone by redox, acid-base and complexation titrations.
2. Determination of vitamin C in orange juice by titration with cerium(IV) and with 2,6-dichlorophenol indophenols.
3. Determination of aluminium and magnesium in antacids by EDTA titration.
4. Analysis of a copper-nickel alloy sample for copper and nickel by EDTA titration using masking and selective demasking reactions.
5. Determination of saccharin in tablets by precipitation titration.
6. Determination of ascorbic acid in goose berry/bitter gourd by titrimetry and spectrophotometry using *N*-bromosuccinimide (NBS).
7. Analysis of a mixture of iron(II) and iron(III) by EDTA titration using *p*H control.
8. Potentiometric titration of a mixture of chloride and iodide.
9. Determination of sulpha drugs by potentiometry using $NaNO_2$ and iodometric assay of penicillin.
10. Polarographic determination of copper and zinc in brass.
11. Determination of manganese in steel by extraction-free spectrophotometry and molybdenum in steel by extractive spectrophotometry.
12. Determination of iron in mustard seeds and phosphorous in peas by spectrophotometry.

PART-B

1. Analysis of waste waters for DO and COD by titrimetry.

2. Analysis of a ground water sample for sulphate by titrimetry (EDTA) and turbidimetry.
3. Potentiometric determination of formula and stability constant of a silver- ammonia complex ion.
4. Photometric and potentiometric titration of iron(III)/copper with EDTA.
5. Analysis of brackish water for chloride content by a) spectrophotometry (mercuric thiocyanate method), b) conductometry (silver nitrate) and c) potentiometry (silver nitrate).
6. Ascorbic acid determination in natural orange juice by coulometry.
7. Analysis of waste water for:

   a.Phosphate by molybdenum blue method

   b.Ammonia-nitrogen by Nessler's method

   c.Nitrite-nitrogen by NEDA method
8. Analysis of a soil sample for:

   Calcium carbonate and organic carbon by titrimetry.
9. Analysis of a soil sample for:
10. Available phosphorus by spectrophotometry.

    Nitrate-nitrogen/nitrite nitrogen/ammonia nitrogen by spectrophotometry.
11. Analysis of urine for:
    a. Urea and uric acid by titrimetry snd spectrophotometry.
    b. Sulphate by precipitation titration after ion-exchange separation.
    c. Sugar by Benedict's reagent.
12. Analysis of blood for:
    a. Cholesterol by spectrophotometry
    b. Bicarbonate by acid-base titration.

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.
5. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, 2003 Pearson Education Pvt. Ltd., New Delhi.

6. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders College Publishing, California, 1990.
7. Pharmaceutical Drug Analysis by Ashutoshkar, New AgeInternational Publishers, New Delhi, 2005.
8. Practical Pharmaceutical Chemistry, Ed. A. H. Geckett, J. B. Stenlake, 4th edition. Part I and II, CBS Publishers, New Delhi.
9. Quantitative Analysis of Drugs in Pharmaceutical Formulations, P. D. Sethi, 3rd edition, CBS Publishers & Distributors, New Delhi, 1997.
10. Practical Clinical biochemistry methods and interpretations, R. Chawla, J.P. Bothers Medical Publishers (P) Ltd., 1995.
11. Laboratory Manual in Biochemistry, J. Jayaraman, New Age International Publishers, New Delhi, 1981.
12. Practical Clinical Biochemistry, Harold Varley and Arnold.Hein mann, 4th edition.
13. Environmental Science: Laboratory Manual, Maurice A. Strabbe, The C.V. Mosbey Co. Saint Loucs, 1972.
14. Experiments on Water Pollution, D.I. Williams and D. Anglesia, Wayland Publishers Ltd., England, 1978.
15. Experiments on Land Pollution, D.I. Williams and D. Anglesia, Wayland Publishers Ltd., England, 1978.
16. Experiments in Environmental Chemistry, P.D. Vowler and D.W. Counel, Pergamon Press, Oxford 1980.
17. Manual Soil Laboratory Testing, vol. I, K.H. Head, Pentech Press, London 1980.

CHI SCP:3.2/4.2. INORGANIC CHEMISTRY PRACTICALS-II

[64 HOURS]

Course Description

This practical course provides advanced laboratory training in quantitative inorganic analysis, coordination chemistry, instrumental methods, and characterization of metal complexes. Students acquire hands-on experience in electrogravimetry, spectrophotometry, flame photometry, polarography, magnetic susceptibility measurements, stability constant determination, and synthesis of coordination compounds. The course emphasizes experimental design, analytical precision, instrumental operation, interpretation of physicochemical data, and correlation of theoretical concepts with practical applications in inorganic, coordination, and analytical chemistry.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

CO1: Perform quantitative inorganic analyses using classical and instrumental techniques, including electrogravimetry, spectrophotometry, flame photometry, polarography, and solvent extraction with accuracy and precision.

CO2: Synthesize, characterize, and evaluate coordination compounds using spectroscopic, magnetic, conductometric, and analytical methods, and interpret their structural and bonding properties.

Pedagogy

Experiential laboratory learning through guided practical experiments emphasizing quantitative analysis, synthesis of coordination compounds, instrumental techniques, and adherence to laboratory safety and quality assurance practices.

Demonstration and hands-on training using modern analytical instruments such as UV-Visible spectrophotometers, flame photometers, polarographs, conductivity meters, magnetic susceptibility apparatus, IR, and NMR spectrometers for characterization studies.

Inquiry-based and problem-solving approach involving experimental planning, data interpretation, error analysis, calculation of stability constants, magnetic moments, and spectroscopic parameters to strengthen analytical reasoning.

Research-oriented collaborative learning through laboratory discussions, viva-voce, maintenance of laboratory records, interpretation of experimental results, and mini-projects/case studies connecting coordination chemistry with catalysis, bioinorganic chemistry, and materials science.

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	3	2	2	2	3	3	2	3
CO2	3	3	3	3	3	3	2	2	3	3	3	3

PART-A

1. Determination of bismuth, cadmium and lead in a mixture: Analysis of a low melting alloy (Wood's alloy).
2. Simultaneous spectrophotometric determination of chromium and manganese in a steel solution.
3. Determination of chromium(III) and iron(III) in a mixture: Kinetic masking method
4. Electrogravimetric determination of:
   a. Copper in copper sulphate
   b. Nickel in nickel suphate

c. Copper and nickel in alloy solution

d. Lead in lead nitrate.

5. Flame photometric determination of the following metal ions from different samples:

   a) sodium b) potassium and c) sodium and potassium in a mixture.

6. Polarographic estimation of cadmium and zinc.
7. Determination of iron as the 8-hydroxyquinolate by solvent extraction method.
8. Quantitative determination of nickel using dithizone and 1,10-phenanthroline by synergistic extraction.
9. Spectrophotometric determination of the *p*Ka value of methyl red.
10. Semimicro gravimetric determination of aluminium,

PART-B

11. Preparation and characterization of:

    a. Chloropentammine cobalt(III) chloride

    b. Estimation of chloride in a complex by potentiometric or ion-exchange method

    c. Record the electronic absorption spectrum of a complex and verify TanabeSugano diagram.

12. Preparation of *cis*- and *trans*- dichlorobis(ethylenediammine) cobalt(III)chloride. Record the UV-Vis spectra and compare it with *cis*-form. Measure the molar conductance.
13. Preparation of hexammine cobalt(III) chloride and estimate cobalt ion.
14. Determination of magnetic susceptibility of any two compounds/complexes by Gouy method.
15. Determination of the composition of iron-phenanthroline complex by:

    Job's method, mole-ratio method and Slope-ratio method.

16. Determine the stability constant of iron-tiron/iron-phenanthroline by Turner- Anderson method.
17. Preparation of potassium tris(oxalato)ferrate(III) and estimate the metal ion.
18. Preparation of acetyl acetonatomanganese(III) complex.
19. Preparation of tris(en)nickel(II) chloride and hexamine nickel(II) chloride complexes. Record electronic spectra and evaluate spectrochemical series.
20. Using chloropentammine cobalt(III) chloride, prepare nitro and nitritopentammine cobalt(III) chloride. Record the IR spectra of the isomers and interpret.
21. Estimate the chloride ion in a given complex by silver nitrate titration after ion- exchange separation.
22. Demonstration Experiments:

    a. Recording and interpretation of IR and NMR spectra of complexes.

b. Spectrochemical series- Evaluation of Dq value.

c. DNA interaction with metal complexes by UV-visible absorption and viscosity methods.

References

1. Advanced Physico-Chemical Experiments – J. Rose.
2. Instrumental Analysis Manual - Modern Experiments for Laboratory – G.G. Guilbault and L.G. Hargis.
3. A Text Book of Quantitative Inorganic Analysis – A.I. Vogel, 5th edition.
4. Experimental Inorganic Chemistry – G. Palmer.
5. Inorganic Synthesis – O. Glemser.
6. Experimental Inorganic/Physical Chemistry- Mounir A. Malati.
7. Quantitative Chemical Analysis – Daniel C. Harris, (2006) 7th edition.
8. Spectrophotometric Determination of Elements – Z. Marczenko.

CHO SCP: 3.3/4.3. ORGANIC CHEMISTRY PRACTICALS-II

[64 HOURS]

Course Description

This practical course provides comprehensive training in the isolation, purification, estimation, and characterization of organic and natural products using classical and modern analytical techniques. Students gain hands-on experience in separation methods, quantitative organic analysis, and spectroscopic interpretation (UV, IR, NMR, and Mass spectrometry) for structural elucidation. The course enhances laboratory competence, analytical reasoning, and problem-solving skills essential for research, pharmaceutical, food, and natural product chemistry.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

CO1: Perform the isolation, purification, and quantitative estimation of natural products and organic compounds using appropriate extraction, chromatographic, and analytical techniques.

CO2: Interpret UV, IR, NMR, and Mass spectra for the structural elucidation and identification of organic compounds and correlate spectroscopic data with molecular structure.

Pedagogy

Experiential laboratory learning through hands-on experiments involving extraction, purification, chromatography, quantitative organic analysis, and spectroscopic interpretation while following laboratory safety and good laboratory practices.

Demonstration and instrument-based training using chromatographic and spectroscopic techniques, including TLC, UV-Visible, IR, NMR, and Mass spectrometry, to strengthen analytical and characterization skills.

Problem-based and inquiry-driven learning through interpretation of experimental data, structural elucidation exercises, calculation-based analysis, laboratory record maintenance, and scientific report preparation.

Collaborative and research-oriented learning through discussions, viva-voce, case studies, and mini-projects connecting natural product chemistry, analytical chemistry, pharmaceuticals, food chemistry, and quality control applications.

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	2	3	2	2	3	2	3	3
CO2	3	3	3	3	3	3	2	2	2	3	3	3

PART-A

1. Fractional crystallization: separation of mixture of naphthalene and biphenyl.
2. Thin layer chromatography: Separation of plant pigments.
3. Isolation of piperine from pepper.
4. Isolation of caffeine from tea.
5. Isolation of azeleic acid from castor oil.
6. Isolation of carotene from carrot.
7. Isolation of lycopene from tomato.
8. Isolation of cincole from eucalyptus leaves.

PART-B

Isolation of natural products & estimations:

1. Estimation of ketones by haloform reaction.
2. Estimation of sugars by Bertrand's method.
3. Estimation of nitro groups.
4. Estimation of amino group.
5. Determination of iodine value of an oil or fat.
6. Determination of saponification value of oil.
7. Determination of equivalent weight of carboxylic acid by silver salt method

Interpretation of Spectra: Structural elucidation of some simple organic compounds by UV, IR, NMR and mass. Spectra have to be provided by the Examiners.

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-III: Quantitative organic analysis, By Arthur I, Vogel.
3. Laboratory manual of Organic Chemistry by B. B. Dey and M. V. Sitaraman.
4. Practical Organic Chemistry by Mann F. G. and Saunders.
5. Natural products: A laboratory guide by Raphael Ikan.

CHP SCP: 3.4/4.4. PHYSICAL CHEMISTRY PRACTICALS

[64 HOURS]

Course Description

This practical course provides advanced laboratory training in chemical kinetics, electrochemistry, corrosion science, phase equilibria, and instrumental analytical techniques. Students perform experiments to investigate reaction kinetics, activation parameters, corrosion behavior, conductometric and potentiometric titrations, pH measurements, spectrophotometric analyses, and complex formation studies. The course develops experimental proficiency, quantitative analytical skills, scientific interpretation, and problem-solving abilities essential for research, industrial, and academic laboratories.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

CO1: Perform experiments involving chemical kinetics, electrochemistry, phase equilibria, and corrosion studies to determine reaction orders, activation parameters, equilibrium constants, and corrosion inhibition efficiency using appropriate experimental methods.

CO2: Apply conductometric, potentiometric, pH-metric, and spectrophotometric techniques for quantitative chemical analysis, evaluate experimental data, and interpret physicochemical properties of chemical systems.

Pedagogy

Experiential laboratory learning through guided practical experiments emphasizing chemical kinetics, electrochemical measurements, spectrophotometric analysis, corrosion studies, and adherence to laboratory safety and good laboratory practices.

Demonstration and hands-on training using analytical instruments such as conductivity meters, potentiometers, pH meters, UV–Visible spectrophotometers, and electrochemical systems to strengthen experimental and instrumental skills.

Problem-based and inquiry-driven learning through data analysis, kinetic calculations, graphical interpretation, error analysis, laboratory record maintenance, and scientific report writing to enhance critical thinking.

Research-oriented collaborative learning through laboratory discussions, viva-voce examinations, case studies, and mini-projects connecting physical chemistry concepts with industrial processes, materials science, corrosion engineering, and environmental applications.

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	2	3	2	2	2	2	3	3
CO2	2	3	3	2	3	2	2	2	2	3	2	3

PART-A

1. Determination of order of reaction for the acid hydrolysis of methyl acetate and evaluation of activation parameters.
2. Evaluation of Arrhenius parameters for the reaction between $K_2S_2O_8$ and KI (First order reaction).
3. Study of kinetics of autocatalytic reaction between oxalic acid and $KMnO_4$ and determine the order of reaction with respect to $KMnO_4$.
4. Kinetics of saponification of ethyl acetate by conductivity method and study the
5. effect of dielectric constant of the medium (using CH_3OH).
6. Study of effect of salt (ionic strength) on the kinetics of reaction between potassium persulphate and potassium iodide (second order reaction).
7. Spectrophotometric kinetics of oxidation of indigocarmine (IC) by chloramine-T (CAT) – Determination of order of reaction with respect to [CAT] and [IC].
8. To study the acid catalysed kinetics of oxidation of glycine by chloramine-T (CAT) - determination of order of reaction with respect to [CAT] and [glycine].
9. Study the phase diagram of three component system (Glacial acetic acid-Chloroform- water system / Glacial acetic acid-Acetone-Water system).
10. Study the rate of corrosion and inhibition efficiency of an inhibitor (thiourea) on mild steel/Al/Cu by weight loss method.

PART-B

1. Conductometric titration of orthophosphoric acid against NaOH.
2. Conductometric titration of a mixture of HCl, CH_3COOH and $CuSO_4$ against NaOH.
3. Conductometric titration of thorium nitrate with potassium tartarate.
4. Potentiometric titration of mixture of weak acids (Acetic acid and Monochloacetic acid) against NaOH.
5. Dwtermination of pK_a values of phosphoric acid by potentiometric / pH metric method.
6. Potentiometric titration of mixture of KCl+KBr+KI against $AgNO_3$.
7. Potentiometric titration of FAS against Ceric sulphate and sodium metavenadate, determine the concentration of FAS and redox potential.
8. Potentiometric titration of lead nitrate against EDTA and determine the concentration of lead nitrate solution.
9. Determination of *p*K value of an indicator (methyl orange/methyl red).
10. Spectrophotometric analysis of a mixture of (a) $KMnO_4$ and $K_2Cr_2O_7$.
11. Study of complex formation between ferric salt and salicylic acid.

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.

SOFT CORE PAPERS

CHA SCT: 3.1. ELECTROCHEMICAL METHODS OF CHEMICAL ANALYSIS

Course Description

This course provides a comprehensive understanding of modern electroanalytical techniques used for qualitative and quantitative chemical analysis. It covers the principles, instrumentation, and applications of potentiometry, coulometry, electrogravimetry, voltammetry, polarography, stripping analysis, electrochemical sensors, and biosensors. The course enables students to understand electrode processes, electrochemical measurements, and advanced analytical methods used in environmental, pharmaceutical, industrial, biomedical, and research laboratories.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

CO1: Explain the principles, instrumentation, and working of electroanalytical techniques including potentiometry, coulometry, electrogravimetry, voltammetry, and polarography, and evaluate their applications in qualitative and quantitative chemical analysis.

CO2: Apply electrochemical methods, sensors, and biosensors for the analysis of chemical, environmental, pharmaceutical, and biological samples, and interpret electroanalytical data for research and industrial applications.

Pedagogy

Conventional method such as black board and chalk is used.

Modern methods like power point presentation and information and communications technology are used in class room teaching.

Students will be assigned to solve the numerical problems to understand electrochemical concepts.

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	3	2	2	2	2	3	2	3
CO2	2	3	3	3	3	3	3	2	2	3	3	3

UNIT-I

[16 HOURS]

Introduction to electrochemical methods and types: Definitions-electrochemical, galvanic and electrolytic cells, half-cell reactions, anode and cathode, reversible cell, standard hydrogen electrode (SHE), electrode potential (E), standard electrode potential (E^0), theoretical cell potential, liquid junction potential, ohmic drop, IR, overvoltage, concentration over potential.

Activity-dependence of electrode potentials- the Nernst equation, reference electrode- calomel and Ag-AgCl electrodes.

Potentiometry: Electrode systems, metallic indicator electrodes. Membrane electrodes, Ion-selective electrodes-electrode response and selectivity of glass electrode for pH measurement, errors in the use of glass electrode. Glass electrodes for the measurement of cations other than hydrogen -Solid state electrodes, liquid membrane electrodes. Ion- selective field effect transistors (ISFETS). Gas sensing electrodes. Direct potentiometry: Chemical and environmental applications. Potentiometric biosensors. Potentiometric titrations- acid-base, precipitation and redox titrations. Null-point potentiometry.

Coulometric methods of analysis: Basis, Faraday's law and current efficiency. Characterizing coulometric methods. Controlled-potential coulometry- selecting a constant potential, minimising electrolysis time. Instrumentation and applications. Characterisation applications: determining the number of electrons involved (n) in a reaction. Controlled-current coulometry-minimising current efficiency, detecting the end point.

Instrumentation: current sources and cells. Comparing conductometric and conventional titrations. Applications. Automated coulometric titrations.

UNIT-II

[16 HOURS]

Electrogravimetric analysis: Theory, applications, cell processes, deposition and separation, electrolytic separation of metals, applications

Voltammetry and polarography: Introduction. Electrodes. Polarographic principles- polarographic current, polarographic potential, polarographic maxima, oxygen removal. Qualitative and quantitative analyses. AC polarography. Pulse polarography. Differential pulse polarography and square wave polarography. Trace analysis by pulse polarography. Inorganic, organic, clinical and environmental applications. Characterisation applications- electrochemical reversibility and determination of ‘n'. Determination of equilibrium constants for coupled chemical reactions. Voltammetric principles- Voltammetry at solid electrodes- hydrodynamic voltammetry, triangular voltammetry or cyclic voltammetry. Modified electrodes. Amperometry, amperometric titration. Biamperometry.

Stripping methods-anodic and cathodic stripping methods. Electrodeposition step and voltammetric deposition step. Applications of stripping methods. Voltammetry with micro electrodes.

Chemical sensors and biosensors: Sensors, electrochemical sensors, optial sensors, thermal and mass-sensitive sensors, sensor arrays.

References

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch 8^{th} edition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry, G.D. Christian, 5^{th} edition, 2001 John Wiley & Sons, Inc. India.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6^{th} edition, 1993 Prentice Hall, Inc. New Delhi.
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D.
5. Barnes and M.J.K. Thomas, 6^{th} edition, Third Indian Reprint, 2003 Pearson Education Pvt. Ltd., New Delhi.
6. Analytical Chemistry Principles, John H. Kennedy, 2^{nd} edition, Saunders College Publishing, California, 1990.
7. Instrumental Methods of Analysis by H.H. Willard, L.L. Merritt and J.A. Dean, 7^{th} Edition, CBS Publishers, New Delhi, 1988.
8. Principles and Practice of Analytical Chemistry, F.W. Fifield and Kealey, 3^{rd} edition, 2000, Blackwell Sci., Ltd. Malden, USA.
9. Modern Analytical Chemistry, David Harvey, McGraw Hill, New Delhi, 2000.
10. Introduction to Instrumental Analysis, Braun, Pharm. Med. Press. India.
11. Instant Notes of Analytical Chemistry, Kealey and Haines, Viva Books Pvt. Ltd., New Delhi, 2002.

CHI SCT: 3.2. FRONTIERS IN INORGANIC CHEMISTRY

Course Description

This course introduces the principles of materials chemistry with emphasis on the synthesis, structure, properties, characterization, and applications of advanced functional materials. It covers crystal defects, ion transport, ceramics, silicates, inorganic pigments, molecular materials, nanomaterials, and nanocomposites. The course provides an understanding of modern fabrication techniques, characterization methods, and the role of advanced materials in electronics, energy, healthcare, catalysis, sensors, and sustainable technologies.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

CO1: Explain the synthesis, structure, properties, and characterization of advanced materials, including ceramics, silicates, molecular materials, nanomaterials, and nanocomposites, and correlate their structure with functional properties.

CO2: Evaluate the fabrication techniques and applications of functional and nanostructured materials in energy storage, electronics, catalysis, sensors, biomedical devices, and sustainable technologies.

Pedagogy

Interactive lectures supported by ICT-enabled presentations, molecular and crystal structure models, videos, and simulations to explain material synthesis, crystal defects, and nanostructures.

Application-oriented learning through case studies, seminars, and discussions on advanced materials used in energy, electronics, catalysis, environmental remediation, biomaterials, and nanotechnology.

Laboratory demonstrations and characterization-based learning involving exposure to synthesis methods and characterization techniques such as XRD, SEM, TEM, FTIR, UV–Visible spectroscopy, and thermal analysis.

Research-based learning through literature review, journal presentations, assignments, and mini-projects on recent developments in materials chemistry, nanoscience, sustainable materials, and emerging functional materials.

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3	3	3	2	2	3	3	3	3
CO2	3	3	2	3	3	3	3	2	2	3	3	3

UNIT-I

[16 HOURS]

Materials chemistry: Historical Perspectives. Design of new materials through a Critical Thinking Approach. Materials sustainability.

Synthesis of materials: The formation of bulk material by different methods.

Defects and ion transport: Extended defects. Atom andion diffusion.Solid electrolytes. Metal oxides, nitrides and fluorides: Monoxides of the 3d metals, higher oxides and complex oxides, oxide glasses, nitrides and fluorides.

Sulfides, intercalation compounds and metal rich phases: Layered MS2 compounds and intercalation, Chevrel phases.

Ceramic materials: Sol-gel process and applications of biomaterials of ceramics.

Inorganic pigments: Coloured pigments, white and black inorganic materials. Molecular materials and fullerides: Fullerides, Molecular material chemistry. Silicates: Structure, classification - silicates with discrete anions, silicates containing chain anion, silicates with layer structure, silicones with three dimensional net work and applications.

UNIT-II

[16 HOURS]

Nanomaterials- an Introduction. Fundamentals-Terminology and history.

Characterization and fabrication: Top-down and bottom-upfabrication. Solution based synthesis of nanoparticles. Vapour-phase synthesis of nanoparticles. Templated synthesis of nanomaterials using frameworks, supports and substrates. Sonochemical microwave methods for the synthesis of nanoparticles. Structural study of nanocomposites by different methods. Nanostructures and properties

One-dimensional control: carbon nanotubes and inorganic nanowires.

Two-dimensional control: grapheme, quantum wells and solid-state super lattices. Three-dimensional control: mesoporous materials and composites.

Some applications of inorganic/organic/polymeric materials: Optical, electrical, magnetic, and chemical and biosensors.

References

1. Inorganic Chemistry, 4th edition. P. Atkins, T. Overton, J. Rourke, M. Weller and F. Armstrong, Oxford University Press (2006).
2. Inorganic Chemistry Principles of Structure and Reactivity: James E. Huheey, Ellen A. Keiter, Richard L. Keiter, Okhil K. Medhi, Delhi University, New Delhi (2006).
3. Chemistry of the Elements – N.N. Greenwood and A. Earnshaw, Pergamon Press (1985).
4. Industrial Inorganic Chemistry – 2nd edition. K.H. Buchel, H.H. Moretto and P. Woditsh, Wiley - VCH (2000).
5. Basic Inorganic Chemistry – 3rd edition. F.A. Cotton, G. Wilkinson and P.L. Gaus, John Wiley and Sons (2002).
6. Inorganic Chemistry, 3rd edition. James E. Huheey, Harper and Row Publishers (1983).
7. Inorganic Chemistry, 3rd edition. G.L. Miessler and D.A. Tarr, Pearson Education (2004).
8. Inorganic Chemistry, 2nd edition. C.E. Housecroft and A.G. Sharpe, Pearson Education.

CHO SCT: 3.3. CHEMISTRY OF NATURAL PRODUCTS-II

Course Description

This course provides a comprehensive understanding of naturally occurring bioactive compounds, with emphasis on alkaloids and steroids. It covers their classification, isolation, structural elucidation, biosynthesis, chemical synthesis, and biological significance. The course enables students to understand the chemistry of natural products and their applications in medicinal chemistry, pharmaceutical sciences, and biotechnology, highlighting their importance in drug discovery and therapeutic development.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

CO1: Explain the classification, isolation, biosynthesis, structural elucidation, and biological significance of alkaloids and correlate their chemical structures with pharmacological properties.

CO2: Analyze the chemistry, synthesis, structural features, and biological functions of steroids, including hormones and sterols, and evaluate their pharmaceutical and biomedical applications.

Pedagogy

Interactive lectures supported by ICT-enabled presentations, molecular models, biosynthetic pathway illustrations, and reaction mechanism diagrams to explain the chemistry of alkaloids and steroids.

Case study and application-based learning through discussions on natural product-derived drugs, medicinal applications, pharmaceutical relevance, and recent advances in natural product chemistry.

Seminars and literature review involving research articles, journal presentations, and assignments on the isolation, biosynthesis, structural elucidation, and biological activities of natural products.

Student-centered learning through problem-solving exercises, structural analysis, group discussions, and presentations to strengthen analytical thinking and connect natural product chemistry with modern drug discovery and medicinal chemistry.

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	3	2	2	2	2	3	3
CO2	3	3	2	2	2	3	2	2	2	2	3	3

UNIT-I

[16 HOURS]

Alkaloids: Introduction, classification, isolation and general methods of structural elucidation of alkaloids. Classification of alkaloids. Biological importance of alkaloids. Structural elucidation of nicotin, papavarine, quinine, reserpine and morphine. Biosynthesis of alkaloids (nicotin, conine and cocaine).

UNIT-II

[16 HOURS]

Steroids: Introduction, Structural elucidation of cholesterol, 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.

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.

CHP SCT: 3.4. MATERIALS CHEMISTRY

Course Description

This course provides an in-depth understanding of nanomaterials and advanced functional materials with emphasis on their synthesis, characterization, properties, and technological applications. It covers the chemistry of metal and semiconductor nanoparticles, carbon nanomaterials, quantum dots, graphene, superconductors, and semiconductor devices. The course familiarizes students with modern nanofabrication methods and characterization techniques, highlighting the role of nanomaterials in electronics, energy, catalysis, medicine, environmental science, and advanced materials research.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

CO1: Explain the synthesis, structure, properties, characterization, and theoretical concepts of nanomaterials, including metal nanoparticles, carbon nanostructures, quantum dots, graphene, and semiconductor nanomaterials.

CO2: Analyze the principles and applications of semiconductors, superconductors, and nanomaterials in modern technologies such as electronics, energy storage, catalysis, sensing, biomedical devices, and advanced functional materials.

Pedagogy

Interactive lectures supported by ICT-enabled presentations, molecular visualization tools, videos, and animations to explain nanostructures, semiconductor devices, and superconducting phenomena.

Application-oriented learning through case studies, seminars, and discussions on nanotechnology applications in electronics, renewable energy, healthcare, catalysis, environmental remediation, and smart materials.

Laboratory demonstrations and characterization-based learning involving exposure to synthesis methods and analytical techniques such as XRD, SEM, UV–Visible spectroscopy, FTIR, and electron microscopy for nanomaterial characterization.

Research-based learning through journal article discussions, literature review, assignments, and mini-projects focusing on recent advances in nanoscience, semiconductor technology, superconducting materials, and emerging functional materials.

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3	3	3	2	2	3	3	3	3
CO2	3	3	2	3	3	3	3	2	2	3	3	3

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).

FOURTH SEMESTER

CHI HCT: 4.1. BIOINORGANIC CHEMISTRY

Course Description

This course introduces students to the principles of Bioinorganic Chemistry and Medicinal Inorganic Chemistry, emphasizing the indispensable roles of metal ions in biological systems and their applications in medicine. It covers the structural and functional aspects of biomolecules, bioenergetics, ion transport, metalloproteins, metalloenzymes, oxygen transport mechanisms, and electron transfer processes. The course also explores the therapeutic applications of metal complexes, metal-based drugs, radiopharmaceuticals, and treatments for metal toxicity. Students gain an understanding of the relationship between inorganic chemistry, biological processes, and modern healthcare applications.

Course Outcomes (COs)

At the end of the course, students will be able to:

CO1: Explain the structure, function, and biological significance of metal ions, metalloproteins, metalloenzymes, and metal-mediated biochemical processes in living systems.

CO2: Analyze the mechanisms of oxygen transport, electron transfer, ion transport, bioenergetics, and the role of metal-containing enzymes in biological reactions.

CO3: Evaluate the applications of inorganic chemistry in medicine, including metal-based therapeutics, radiopharmaceuticals, anticancer drugs, and strategies for the treatment of metal toxicity.

Pedagogy

The course will be delivered through a learner-centered approach using:

Interactive classroom lectures supported by multimedia presentations.

Concept-based discussions on bioinorganic and medicinal inorganic chemistry.

Problem-solving sessions involving biological and medicinal applications of metal ions.

Case studies on metalloproteins, metalloenzymes, and metal-based pharmaceuticals.

Assignments, seminars, and student presentations on recent advances in bioinorganic chemistry.

Literature review of current research articles related to medicinal inorganic chemistry.

ICT-enabled teaching using animations, molecular visualization tools, and scientific databases.

Continuous assessment through quizzes, tutorials, assignments, and group discussions to strengthen conceptual understanding and critical thinking.

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	3	2	2	2	2	3	3
CO2	3	3	2	2	2	3	2	2	2	2	3	3
CO3	3	3	2	3	3	3	2	2	2	3	3	3

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.

Sodium and potassium-channels and pumps: Introduction, transport across membranes.

Potassium and sodium channels, The sodium-potassium ATPase, Macrocyclic crown ether compounds, cryptands and ionophores.

Biochemistry of calcium: Introduction - comparison of Ca^{2+} and Mg^{2+}. Biological roles of calcium, binding sites of calcium and proteins, storage of calcium, calcium in muscle contraction, calcium in blood clotting process.

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.

UNIT-II

[16 HOURS]

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.

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

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

UNIT-III

[16 HOURS]

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, Diabetes: Vanadium and diabetes,

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, mercury, iron and copper.

Antidote accelerated metabolic conversion of poison to non-toxic product: 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).

CHO HCT: 4.2. HETEROCYCLIC AND BIOORGANIC CHEMISTRY

Course Description

This course provides a comprehensive understanding of heterocyclic chemistry and biomolecules, emphasizing the structure, synthesis, reactivity, and applications of important heterocyclic compounds in pharmaceuticals, agrochemicals, and natural products. It covers the chemistry of carbohydrates, amino acids, peptides, proteins, and nucleic acids, including their structural elucidation, biosynthesis, and biological significance. The course also introduces modern synthetic methodologies, protecting group strategies, and the relationship between molecular structure and biological function, enabling students to appreciate the role of organic chemistry in biological and medicinal sciences.

Course Outcomes (COs)

At the end of the course, students will be able to:

CO1: Explain the nomenclature, structure, synthesis, reactivity, and synthetic applications of important heterocyclic compounds and relate their properties to pharmaceutical and biological applications.

CO2: Analyze the chemistry, stereochemistry, biosynthesis, structural elucidation, and biological significance of carbohydrates, amino acids, peptides, proteins, and nucleic acids.

CO3: Apply concepts of protecting group chemistry, peptide and oligonucleotide synthesis, and biomolecular structure–function relationships to solve problems in organic synthesis, medicinal chemistry, and chemical biology.

Pedagogy

The course will be delivered through a student-centered and outcome-based teaching approach comprising:

Interactive lectures supported by multimedia presentations and molecular models.

Concept-oriented discussions on heterocyclic compounds, natural products, and biomolecular chemistry.

Mechanism-based teaching of organic reactions and synthetic strategies.

Problem-solving sessions involving reaction mechanisms, stereochemistry, and biomolecular structure elucidation.

Tutorials and assignments focused on synthesis, retrosynthetic analysis, and structural determination.

Student seminars, group discussions, and presentations on recent developments in heterocyclic and bioorganic chemistry.

Literature review of contemporary research articles related to medicinal chemistry, peptide synthesis, and nucleic acid chemistry.

ICT-enabled learning using molecular visualization software, reaction databases, and scientific resources.

Continuous assessment through quizzes, assignments, presentations, and case studies to strengthen analytical, critical thinking, and scientific communication skills.

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	3	2	2	3	2	3	3
CO2	3	3	2	2	2	3	2	2	2	2	3	3
CO3	3	3	3	3	2	3	2	2	3	2	3	3

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.

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.

Protecting groups: Protection of hydroxyl, carboxyl, carbonyl, thiol and amino groups. Illustration of protection and deprotection in synthesis.

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.

CHP HCT: 4.3. NUCLEAR, RADIATION AND PHOTOCHEMISTRY

Course Description

This course provides a comprehensive understanding of photochemistry, radiation chemistry, and nuclear chemistry, focusing on the interaction of light and ionizing radiation with matter and their applications in chemistry, environmental science, medicine, and industry. The course covers the principles of photochemical reactions, fluorescence, phosphorescence, photocatalysis, radiation detection, radiochemical techniques, isotope applications, nuclear reactions, radioactive decay, and nuclear power technology. It enables students to understand modern analytical techniques and the safe handling of radioactive materials while developing knowledge of emerging applications in environmental remediation, energy, and healthcare.

Course Outcomes (COs)

At the end of the course, students will be able to:

CO1: Explain the principles of photochemistry, radiation chemistry, and nuclear chemistry, including electronic excitation, photochemical reactions, radioactive decay, nuclear reactions, and radiation detection techniques.

CO2: Analyze photochemical and radiochemical processes by applying concepts such as quantum yield, fluorescence, phosphorescence, photocatalysis, isotope tracer techniques, radiation dosimetry, and radiochemical separation methods to solve chemical and environmental problems.

CO3: Evaluate the applications of photochemical, radiochemical, and nuclear techniques in environmental remediation, medical diagnostics, industrial processes, isotope analysis, and nuclear power generation while recognizing the importance of radiation safety and protection.

Pedagogy

The course will be delivered through an outcome-based and student-centered teaching approach that includes:

Interactive classroom lectures supported by multimedia presentations and animations.

Concept-based teaching of photochemical, radiochemical, and nuclear processes using molecular and energy-level diagrams.

Problem-solving sessions involving quantum yield calculations, radioactive decay kinetics, half-life calculations, radiation dosimetry, and nuclear reaction analysis.

Demonstrations and laboratory exposure (where feasible) on photochemical experiments, radiation detection instruments, and photocatalytic applications.

Case studies on nuclear energy, medical radioisotopes, environmental pollution control, and industrial applications of radiation chemistry.

Student seminars, group discussions, and presentations on recent advances in photochemistry, nuclear technology, and radiation-based analytical techniques.

ICT-enabled learning through scientific simulations, videos, virtual laboratories, and current research literature.

Continuous assessment through quizzes, assignments, tutorials, seminars, and problem-based learning activities to enhance analytical thinking, scientific communication, and practical understanding.

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	3	2	2	2	2	3	2	2
CO2	3	3	2	3	3	3	3	2	2	3	3	3
CO3	3	3	2	3	3	3	3	3	2	3	3	3

UNIT-I

[16 HOURS]

Photochemistry: Introduction to photochemistry, laws of photochemistry, laws of light absorption, quantum yield and its determination, factors affecting quantum yield,

Actinometry - Uranyloxalate and potassium ferrioxalate actinometers, acetone and diethylketone actinometers. Term symbols for atoms and its significance. Photochemical properties of electronically excited molecules, nature of changes on electronic excitation, shapes of absorption band and Frank Condon principle. Experimental techniques to determine the intermediates in photochemical reactions. Photosensitization: by mercury, dissociation of H_2. Photochemical kinetics of: Decomposition of CH_3CHO, formation of HI and HCl. Fluorescence and phosphorescence – theory and applications. Resonance fluorescence and quenching of fluorescence, Kinetics of colliosional quenching (Stern-Volmer equation).

Photocatalyst – Principle, application of ZnO/TiO_2 photocatalysts in the photo cleavage of dyes, environmentally hazardous waste and industrial effluents. Effect of photo degradation on COD value.

UNIT-II

[16 HOURS]

Radiation chemistry: Introduction, units, interaction of electromagnetic radiation with matter, G-value, LET of radiation. Chemical dosimetry - Fricke and ceric sulphate dosimeters. Radiolysis - cysteine, water and biphenyl. Radioisotopes as tracers, use of isotopic tracers in the elucidation of reaction mechanism, structure determination and solubility of sparingly soluble substances. ^{14}C dating, medical applications of isotopic tracers. Physico-chemical applications – isotope dilution method, activation analysis and radiometric titrations. Hazards in radiochemical work and radiation protection.

Radiation detection and measurement: Experimental techniques in the assay of radioisotopes. Radiation detectors – ionization chambers, proportional and Geiger- Muller counters – G.M. Plateau, dead time, coincidence loss, determination of dead time. Scintillation and semiconductor radiation detectors.

UNIT-III

[16 HOURS]

Nuclear chemistry: Nuclear stability – nuclear forces, packing fraction, binding energy, liquid drop, shell and collective models. Radioactive decay – General characteristics, decay kinetics, parent – daughter decay growth relationships, determination of half- lives. Brief survey of alpha, beta and gamma decays. Nuclear reactions – Bethe's notation, types of nuclear reactions – specific nuclear reactions, photonuclear reactions, Oppenheimer – Phillips process, spallation reactions, Szilard-Chalmers process. Definition of Curie and related calculations. Production of radioisotopes and labelled compounds by bombardment.

Radiochemical separation techniques: carriers, solvent extraction and ion ion- exchange methods. Nuclear power reactors: Types of nuclear power reactors, basic features and components of nuclear power reactors. An introduction to breeder reactors.

References

1. Photochemistry, Calvert and Pitts, Wiley, New York (1996).
2. Fundamentals of Photochemistry, Gohatgi-Mukherjee, New Age International Ltd., 1986.
3. Principles and Applications of Photochemistry, R. P. Wayne, Elsevier, New York (1970).
4. Photochemistry, Paul Suppan, RSC, London (1994).
5. Introduction to Semiconductor Materials and devices, M. S. Tyagi, John Wiley & Sons, 1991.
6. Nuclear Chemistry by Friedlander and Kennedy, John Wiley and Sons (1987).
7. Essentials of Nuclear Chemistry by H.J. Arnikar, Eastern Wiley (1990).
8. Nuclear Chemistry by U.N. Dash, Sultan Chand and Sons (1991).
9. Fundamentals of Radiochemistry by D.D. Sood, A.V.R. Reddy and N. Ramamoorthy.
10. Nuclear Radiation Detectors by S.S. Kapoor and Ramamoorthy, Wiley Eastern (1986).

SOFT CORE

CHA SCT: 4.1 CHEMICAL METHODS OF ANALYSIS

Course Description

This course provides comprehensive knowledge of automated analytical techniques and clinical analytical chemistry, emphasizing modern instrumentation, sample preparation, and analysis of complex real-world samples. It introduces the principles and applications of automated analytical systems, including continuous flow analysis, flow injection analysis, discrete analyzers, and elemental analyzers. The course also covers systematic approaches to sample collection, decomposition, dissolution, and method validation, along with analytical procedures for the qualitative and quantitative determination of clinically important constituents in blood and urine. Students will develop an understanding of analytical automation, quality assurance, and the role of analytical chemistry in clinical diagnostics and industrial applications.

Course Outcomes (COs)

At the end of the course, students will be able to:

CO1: Explain the principles, instrumentation, operation, and applications of automated analytical techniques, flow analysis systems, and sample preparation methods used for the analysis of industrial, environmental, and clinical samples.

CO2: Apply appropriate analytical methods for the preparation, qualitative and quantitative analysis, and interpretation of real and clinical samples while evaluating method accuracy, reliability, and quality assurance in analytical measurements.

Pedagogy

The course will be delivered through an outcome-based and learner-centered approach using:

Interactive lectures supported by multimedia presentations and process flow diagrams.

Demonstration of automated analytical instruments and virtual laboratory simulations where applicable.

Case studies on industrial, environmental, and clinical analytical applications.

Problem-solving sessions involving method selection, sample preparation, analytical calculations, and interpretation of analytical data.

Laboratory demonstrations and hands-on exposure to automated analytical systems and clinical analytical techniques wherever feasible.

Student seminars, assignments, and literature reviews on recent developments in analytical automation and clinical chemistry.

ICT-enabled teaching using scientific databases, videos, analytical software, and instrumentation resources.

Continuous assessment through quizzes, assignments, tutorials, presentations, and practical discussions to enhance analytical reasoning, technical competence, and problem-solving skills.

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	3	2	2	2	2	3	2	3
CO2	2	3	3	3	3	3	3	3	2	3	3	3

UNIT-I

[16 HOURS]

Automated methods of analysis: An overview, definition, distinction between automatic and automated systems, advantages and disadvantages by automation, types of automated techniques. Nondiscrete techniques, segmented flow methods and basic equipment, special techniques and devices, theoretical considerations and problems, applications. Single channel and multi channel auto analysers, BUN analyzers, automatic glucose analyzers and ammonia in water analyzers, COD analyzers, CFA in industry. Non-segmented flow methods: Flow injection analysis. Principles, types of dispersion, factors affecting dispersion, applications of small, medium and large dispersions. Stopped flow methods, flow injection titrations. Discrete methods: Centrifugal fast scan analyzer, automatic multipurpose analyzers, Automatic elemental analyzer, automated analyzer based on multi layer film-principles, film structure, instrumentation applications. Comparison of discrete and non-discrete methods. Advantages of flow injection measurements over continuous flow measurements.

UNIT-II

[16 HOURS]

Analysis of real samples-real sample, choice of analytical method-defining the problem, investigating the literature, choosing or devising a method, testing the procedure, analysis of standard samples, using other methods, standard addition to the sample. Accuracy in the analysis of complex materials.

Decomposing and dissolving the sample- sources of error in decomposing and dissolution. Decomposing samples with inorganic acids. Microwave decomposition. Combustion methods for decomposing organic samples. Decomposition of inorganic materials with fluxes.

Clinical Analysis- Introduction, features of chinical analysis. Composition of blood, collection and preservation of samples. Common determinations - serum electrolytes, blood glucose and blood urea nitrogen, uric acid, albumin and globulins, acid and alkaline phosphates, barbiturates, chloride, sodium and potassium, bicarbonate, serum creatinine and cholesterol. Urine analysis-Principle components. Sample collection and preservation. Determination of creatinine, chloride, uric acid, ammonia, ascorbic acid, bilirubin and calcium.

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 ed., 2001 John Wiley & Sons, Inc, India.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition,1993 prenticeHall, 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 Inidan Reprint.2003 PearsonEducation Pvt. Ltd., New

Delhi.

5. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders College Publishing, California, 1990.
6. Principles and practice of analytical chemistry. Fifield and Kealey.
7. Instant Notes of Analytical Chemistry, Kealey and Haines, Viva Books Pvt. Ltd.,2002

CHI SCT: 4.2. BIOINORGANIC PHOTOCHEMISTRY

Course Description

This course provides an advanced understanding of the principles and applications of bioinorganic photochemistry, focusing on the interaction of light with inorganic and biological systems. The course introduces the fundamentals of light, electronic excitation, excited-state processes, photophysical and photochemical reactions, and the role of coordination compounds in photochemical transformations. It explores natural photochemical processes, photochemical pathways, and charge-transfer mechanisms in inorganic systems.

The course further emphasizes the applications of bioinorganic photochemistry in biochemical sensing, fluorescence labeling, photodynamic therapy, photomedicine, antimicrobial photoinactivation, photoprotection, and environmental photocatalysis. Students will gain insights into the role of metal complexes, nanoparticles, and photosensitizers in modern biomedical and environmental technologies.

Course Outcomes (COs)

CO1: Explain the fundamental concepts of light–matter interactions, electronic excited states, photophysical deactivation pathways, and photochemical reactions involving inorganic and coordination compounds.

CO2: Apply the principles of bioinorganic photochemistry to understand and analyze applications in biosensing, photodynamic therapy, antimicrobial treatments, nanomedicine, photoprotection, and photocatalytic environmental remediation.

Pedagogy

- Lectures and Interactive Discussions:
  Concept-based teaching of photochemical principles, excited-state chemistry, and applications of inorganic photochemistry through classroom discussions.
- PowerPoint Presentations and Visual Learning:

Use of diagrams, molecular structures, reaction mechanisms, and animation-based explanations to illustrate photochemical processes.

- Case Studies and Recent Research Articles:
  Discussion of recent advances in photodynamic therapy, metal-based drugs, nanoparticles, and photocatalytic technologies from scientific literature.
- Problem-Solving and Conceptual Exercises:
  Practice problems related to electronic transitions, excited states, photochemical mechanisms, and applications.
- Seminars and Student Presentations

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	3	3	2	2	2	3	3	2
CO2	3	3	2	3	3	3	3	2	2	3	3	3

UNIT-I

[16 HOURS]

Introduction, Philosophy of bioinorganic photochemistry Fundamentals: Light and matter. Nature of light, Accessible light sources and Interaction between light and matter.

Formation and properties of electronic excited states: Wave mechanics and quantum numbers and Electronic excitation.

Photophysical deactivation of electronic excited states: Spontaneous deactivation, Quenching and Coordination and organometallic compounds.

Photochemical reactions: Photochemical reaction channels, Intramolecular photoreactions, Photodissociation and photoionization, Photoisomerization, Intermolecular photoreactions, the coordination compound specificity. Ligand field photochemistry, Photochemistry from LC or LLCT states, Inner-sphere charge transfer photochemistry, Outer-sphere charge transfer photochemistry, Photosensitized reactions, Homogeneous photocatalysis.

Natural photo-processes involving inorganic compounds

From interstellar space to planetary atmospheres: Homogeneous systems: from interstellar space to planetary atmospheres and primitive soup models. Heterogeneous photochemistry in ice phases.

UNIT-II

[16 HOURS]

Applications: Fluorescent and chromogenic sensing and labeling: Cations as targets in biochemical sensing Cations common in biological systems, Fluorescent detection of toxic cations, Fluorescent and chromogenic sensing of anions, Common anions and Toxic anions. Optical detection of neutral molecules.Nanoparticles in biochemical sensing and labeling.

Therapeutic strategies; Photobio-stimulation, Photo-activation of drugs, Photodynamic therapy, Mechanisms of PDT and PTT. Photosensitizers, Inorganic photosensitizers, Supporting role of metal ions in photodynamic therapy, and Combination of polypyrrolic photosensitizers and metallo-pharmaceuticals, Recent PDT development and

Nanomedical methods.

Photodynamic inactivation of microorganisms: Bacteria, Viruses, Fungi and Parasites.

Phototoxicity and photoprotection: Chemical and physical photoprotection. Inorganic sunscreens.

Photocatalysis in environmental protection: Development of homo- and heterogeneous methods. Homogeneous photocatalysis and heterogeneous photocatalysis. Water and air detoxification. Other applications of photocatalysis.

References

1. Bioinorganic Photochemistry- Grazyna Stochel, Malgorzata Brindell, Wojciech Macyk, Zofia Stasicka, Konrad Szacilowski. Wiley Publishers (2009).
2. Photochemistry and Photophysics of Coordination Compounds I-Volume Editors: Balzani, V., Campagna, Springer Publications.Vol.280, 2007.
3. Photochemistry and Photophysics of Coordination Compounds II - Volume Editors: Balzani, V., Campagna, Springer Publications.Vol.281, 2007.

CHO SCT: 4.3. Natural Products and Medicinal Chemistry

Course Description

This course provides an advanced understanding of bioactive natural products and medicinal chemistry, focusing on the isolation, structural elucidation, synthesis, and biological significance of important natural compounds such as carotenoids and vitamins. The course introduces the chemistry, classification, and physiological roles of various vitamins, including fat-soluble and water-soluble vitamins.

The course also covers the fundamental principles of medicinal chemistry, including drug action, pharmacokinetics, pharmacodynamics, drug–receptor interactions, drug design approaches, and evaluation methods. It explores the chemistry, synthesis, mechanism of action, and therapeutic applications of various classes of drugs such as antipyretics, antimalarials, analgesics, sedatives, stimulants, antineoplastic agents, and cardiovascular drugs. The course emphasizes the relationship between chemical structure and biological activity in drug development.

Course Outcomes (COs)

CO1: Explain the isolation, structural elucidation, synthesis, and biological importance of carotenoids and vitamins, including their role in human health and biochemical processes.

CO2: Analyze the principles of medicinal chemistry, drug action mechanisms, structure–activity relationships, synthesis, and therapeutic applications of important pharmaceutical agents.

Pedagogy

- Interactive Lectures:
  Concept-based teaching of natural product chemistry, vitamin chemistry, medicinal chemistry principles, and drug mechanisms through classroom discussions.
- PowerPoint Presentations and Molecular Visualization:
  Use of structural diagrams, reaction pathways, molecular models, and animations to explain synthesis and structure–activity relationships.
- Mechanism-Based Learning:
  Detailed explanation of drug–receptor interactions, pharmacological actions, metabolic pathways, and mechanisms of therapeutic agents.

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	3	2	2	2	2	3	3
CO2	3	3	2	3	2	3	2	2	2	2	3	3

UNIT-I

[16 HOURS]

Carotenoids: Methods of isolation. Structure elucidation and synthesis of β-carotene. Structural relationship of α-, β- and γ-carotenes.

Vitamins: Introduction, constitution, synthesis and biological significance of thiamine, riboflavin, pyridoxine, biotin, ascorbic acid, vitamin A_1 & A_2, E_1 and E_2 , B_{12} and K groups.

UNIT-II

[16 HOURS]

Medicinal chemistry: Introduction, pharmacodynamics, pharmacokinetics, chemotherapy, metabolites antimetabolites, agonists and antiagonists. Classification drugs on the basis of therapeutic action. Concept of pro drug and soft drug. Theories of drug activity: Occupancy theory, rate theory, induced fit theory, concept of drug receptors. Evaluation methods: Free-wilson analysis, Hansch-anlysis, ID_{50} and IC_{50} (mathematical derivation of equation excluded).

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

Antimalarials: structure, synthesis and mechanism of action of quinine and chloroquine.

Hypnotics: Analgesics and sedatives: phenoborbitol, chlordiazepoxide, meprobamate.

Stimulants: structure, action and synthesis of caffeine.

Antineoplastics: Structure, pharmacological action and synthesis of 5-flurouracil, chlorambucil, cyclophosphaminde and podophyllotoxin.

Cardiovascular drugs: Introduction, synthesis of dithiazem, verapamil, methyldopa, atenolol and oxprenolol.

References

1. Organic Chemistry, VI edition, Robert T. Morrison, Robert N. Boyd.
2. Organic Chemistry, Vol-II by I. L. Finar.
3. A text book of synthetic drugs, O. D. Tyagi and M. Yadav.
4. Synthetic drugs, Gurdeep R. Chatwal.
5. Medicinal chemistry by Graham Patrick.

CHP SCT: 4.4. QUANTUM CHEMISTRY AND BIOSENSORS

Course Description

This course provides an in-depth understanding of advanced concepts in quantum chemistry and biosensor technology. The first unit focuses on the applications of quantum mechanical principles in molecular systems, including variation theorem, molecular orbital theory, valence bond theory, self-consistent field methods, Slater orbitals, and Huckel molecular orbital theory. Students will learn about molecular bonding, electronic structures, energy levels, and π-electron systems through theoretical approaches.

The second unit introduces the principles, design, and applications of biosensors, including electrochemical, optical, piezoelectric, thermal, and mass-sensitive sensors. The course emphasizes bio-recognition elements, immobilization techniques, enzyme-based sensing mechanisms, and practical applications of biosensors in clinical diagnosis, environmental monitoring, and biochemical analysis.

Course Outcomes (COs)

CO1: Apply quantum mechanical principles and molecular orbital theories to explain molecular structure, bonding, electronic configurations, and properties of chemical systems.

CO2: Explain the working principles, components, and applications of various biosensors for the detection and analysis of biological, environmental, and pharmaceutical analytes.

Pedagogy

- Concept-Based Lectures:
  Detailed classroom teaching of quantum mechanical concepts, molecular orbital theories, and biosensor principles using logical explanations and mathematical approaches.
- PowerPoint Presentations and Visual Learning:
  Use of molecular orbital diagrams, energy level diagrams, potential energy curves, and biosensor schematics for better conceptual understanding.
- Problem-Solving Approach:
  Solving numerical problems related to variation theorem, Slater's rules, effective nuclear charge calculations, Huckel molecular orbital theory, and molecular parameters.
- Molecular Modeling and Computational Demonstrations:
  Use of molecular visualization tools to demonstrate molecular orbitals, bonding interactions, and electronic structures.

CO-PO/PSO Mapping Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	3	2	1	2	2	3	2	2
CO2	3	3	2	2	3	3	2	2	2	3	3	3

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 antibonding 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 atom. 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.

Huckel molecular orbital theory: Outline of method, assumptions. Application to ethylene, allyl radical, cyclopropenyl radical, butadiene, cyclobutadine, bicyclobutadine and benzene. Calculation of delocalization energy, charge density, π-mobile bond order and free valence.

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. Surface chemistry: Theory and applications, J. J. Bikertman, Academic press, New York (1972).
8. Chemical Kinetics, K. J. Laidler 3rd Edn., Harper International Edn., (1087).
9. Test Bok of Physical Chemistry, S. Glasston, McMillan India Ltd., 2nd Edn. (1986).
10. Physics at Surfaces, A. Zangwill, Combridge University Press (1988).
11. Surface Crystallography, L. J. Clarke, Wiley-Interscience (1985).
12. Biosensors: Fundamentals and Applications, Bansi Dhar Malhotra and Chandra Mouli Pandey, Smither Group Co., 2017, UK.
13. Biosensors: Techniques and Instrumentations in Analytical Chemistry, Frieder Scheller and Florian Schubert, Vol. 11, Elsevier Sci. Publishers, 1992.
14. Chemical Sensors and Biosensors, Brian R. Eggins, John Wiley & Sons Ltd, UK, 2004

JSS Mahavidyapeetha

JSS COLLEGE FOR WOMEN

SARASWATHIPURAM, MYSORE – 570 009

POSTGRADUATE DEPARTMENT OF CHEMISTRY

SYLLABUS

PROGRAMME: P. G. Diploma in Chemistry

Continuous Assessment Grading Pattern (CAGP)
Effective from 2026-2027

1. **Eligibility For Addmission:** The Eligibility of the Post Graduation Diploma in Chemistry (PGDC) Course is that the candidates must have B. Sc,/ B.Sc.(Honors) Chemistry, Physics or Maths or any other equivalent degree (with 50% marks) in which student had studied Chemistry as one of the subject in at least four semesters.
2. **Duration of the Program:** The program will be conducted for 2 semesters (1 year)
3. **Evaluation :** Single Evaluation.
4. **Question paper pattern:**

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

Note: *Answer all the questions*. *Each question carries two marks.*

***Q. No*. 1**: Twelve Medium/ Short Answer Type Questions and any ten should be answered.

($10 \times 2 = 20$)

***Q. No*. 2 to 8:** Any five questions have to be answered . Each question carries TEN marks. An examiner may set the questions like (4+6) or (5+5) or as his/her wish. (*Two marks questions shall be avoided for 2 to 8*). **($5 \times 10 = 50$)**

SCHEME OF EXAMINATION FOR C_1, C_2 AND C_3 COMPONENTS

Preamble

The following is the scheme which will be followed for the assessment of marks for PGDC courses 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.

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

POST GRADUATE DIPLOMA IN CHEMISTRY

SL. NO	COURSE NAME	SEMESTER	PAPER TITLE
1.	**Natural Products and Medicinal Chemistry**	**I**	Natural products
		I	Medicinal Chemistry Lab-I
		II	Advanced Medicinal chemistry
		II	Medicinal Chemistry Lab-II
2.	**Pharmaceutical Analysis and Instrumentation**	**I**	Pharmaceutical Analysis
		I	Analytical Chemistry Lab-I
		II	Instrumental Methods of analysis
		II	Analytical Chemistry Lab-II

POST GRADUATE DIPLOMA IN NATURAL PRODUCTS AND MEDICINAL CHEMISTRY

Program Name: POST GRADUATE DIPLOMA IN NATURAL PRODUCTS AND MEDICINAL CHEMISTRY	Semester I
Course Title: Natural Products	
Hours per week: 03	Total contact hourse:48
Continuous internal Evaluation Marks:30	Semester end Examinatin:70

NATURAL PRODUCTS

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 B12.

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.

Program Name: POST GRADUATE DIPLOMA IN NATURAL PRODUCTS AND MEDICINAL CHEMISTRY	Semester I
Course Title: Medicinal Chemistry Lab-I	
Hours per week: 04	Total contact hourse:64
Continuous internal Evaluation Marks:30	Semester end Examinatin:70

PART-A

Solid-Liquid Extractions & Isolations

1: Soxhlet Extraction of Plant Pigments
2: Isolation of Caffeine from Tea Leaves
3: Isolation of Nitrogenous Liquid Alkaloids (Nicotine from Tobacco)
4: Extraction of Volatile Essential Oils via Steam Distillation
5: Isolation of Piperine from Black Pepper

Part B: Chromatographic Separation Methods

6: Column Chromatography Fractionation of Crude Leaf Extracts
7: Paper Chromatography Analysis of Amino Acid Mixture

References

1. Natural Products Chemistry Practical Manual: For Science & Pharmacy Courses by Anees Ahmad Siddiqui (CBS Publishers).
2. **Vogel's Textbook of Practical Organic Chemistry (5th Edition)** by B.S. Furniss, A.J. Hannaford, P.W.G. Smith, and A.R. Tatchell (Pearson Education 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.

Program Name: POST GRADUATE DIPLOMA NATURAL PRODUCTS AND MEDICINAL CHEMISTRY	Semester II
Course Title: Advanced Medicinal Chemistry	
Hours per week: 03	Total contact hourse:48
Continuous internal Evaluation Marks:30	Semester end Examinatin:70

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.

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 Free Wilson analysis and Hansch-analysis – LD50, ED50, ID50, IC50 (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, -H2 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.

Program Name: POST GRADUATE DIPLOMA NATURAL PRODUCTS AND MEDICINAL CHEMISTRY	Semester II
Course Title: Medicinal Chemistry Lab-II	
Hours per week: 04	Total contact hourse:64
Continuous internal Evaluation Marks:30	Semester end Examinatin:70

PART-A
MULTISTEP SYNTHESIS

1. Prepartion of benzanilide from benzophenone oxime via Beckmann rearrangement.
2. Synthesis of m-chloroiodobenzene from m-dinitrobenzene.
3. Synthesis if 2,4-dinitro phenyl hydrazine
4. Preparation of phenacetin from *p*-nitro phenol (*via* reduction, acetylation and ethylation)
5. Synthesis of Luminol
6. Grignard reaction: Synthesis of triphenyl carbinol from benzophenone/ethylbenzoate
7. 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.

POST GRADUATE DIPLOMA IN PHARMACEUTICAL ANALYSIS AND INSTRUMENTATION

Program Name: POST GRADUATE DIPLOMA PHARMACEUTICAL ANALYSIS AND INSTRUMENTATION	Semester I
Course Title: Pharmaceutical Analysis	
Hours per week: 03	Total contact hourse:48
Continuous internal Evaluation Marks:30	Semester end Examinatin:70

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]

Medicinal Chemistry & Drug Design

Principles of Drug Discovery: Lead discovery, lead optimization, and identification of pharmacophores

Structure-Activity Relationships (SAR): Quantitative Structure-Activity Relationships (QSAR), Hansch analysis, and Free-Wilson parameters.

Physicochemical Properties in Drug Action: Role of partition coefficient, ionization, hydrogen bonding, and stereochemistry in drug-receptor interactions.

Computer-Aided Drug Design (CADD): Introduction to molecular docking, virtual screening, and pharmacophore modeling.

Unit 2

[16 HOURS]

Synthesis & Manufacturing of Active Pharmaceutical Ingredients (APIs)

Organic Synthesis: Retrosynthetic analysis, disconnection approach, synthons, and synthetic equivalents.

Green Chemistry in Pharma: Atom economy, safe solvent alternatives, microwave-assisted synthesis, and biocatalysis.

Industrial Scale-up Techniques: Principles of pilot plant scale-up, unit operations, process safety, and reaction yields optimization.

Synthesis of Selected Drug Classes: Synthetic pathways for critical drugs like Paracetamol, Ibuprofen, Ciprofloxacin, Diazepam, and Sulfamethoxazole.

Unit 3:

[16 HOURS]

Pharmacology & Pharmacokinetics

Pharmacodynamics: Mechanisms of drug action, drug-receptor interactions, agonists, antagonists, and signal transduction.

Pharmacokinetics (ADME): Mechanisms of drug Absorption, Distribution, Metabolism, and Excretion.

Drug Metabolism Pathways: Phase I reactions (oxidation, reduction, hydrolysis) and Phase II conjugation pathways (glucuronidation, sulfation).

References
1. Foye's Principles of Medicinal Chemistry by Thomas L. Lemke and David A. Williams (Lippincott Williams & Wilkins).
2. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry by John M. Beale and John H. Block (Lippincott Williams & Wilkins).
3 Synthetic Organic Chemistry, G. R. Chatwal, Himalaya Publishing House.
4. Synthesis and Chemistry of Agrochemicals, Vol I & II, ACS, Wahington.
5. Chemistry of Pesticides, K H Buchel.
6. Advances in Pesticide Formulation Technology, ACS.

Program Name: POST GRADUATE DIPLOMA PHARMACEUTICAL ANALYSIS AND INSTRUMENTATIONS	Semester I
Course Title: Analytical Chemistry Lab-I	
Hours per week: 04	Total contact hourse:64
Continuous internal Evaluation Marks:30	Semester end Examinatin:70

PART-A

Pharmacopoeial Volumetric Assays (Titrimetry)

1: Assay of Ibuprofen or Aspirin tablets using acid-base neutralization titration.
2: Assay of Ferrous Sulfate tablets via redox cerimetric or permanganometric titration.
3: Assay of Calcium Gluconate injections or tablets using complexometric EDTA titration.
4: Assay of Sodium Chloride infusions via Argentometric (Volhard's or Mohr's) precipitation titration
5: Determination of moisture content in pharmaceutical raw materials using Karl Fischer titration.

Part B:

Instrumental Analysis & Spectroscopy

6: Determination of the absorption maximum and construction of a calibration curve for Paracetamol using UV-Visible Spectroscopy.
7: Quantitative estimation of Riboflavin (Vitamin B2) or Thiamine (Vitamin B1) using Fluorimetry.

Program Name: POST GRADUATE DIPLOMA PHARMACEUTICAL ANALYSIS AND INSTRUMENTATIONS	Semester II
Course Title: Instrumental methods of analysis	
Hours per week: 03	Total contact hourse:48
Continuous internal Evaluation Marks:30	Semester end Examinatin:70

INSTRUMENTAL METHODS OF ANALYSIS

Objectives

- To understand the theory, instrumentation and applications of atomic emission spectroscopy.
- To get excel the knowledge on electro analytical techniques
- To learn the principles, instrumentation and applications of thermal methods of analysis.

Course Outcomes

After studying this course, the student to:

- Gain the knowledge on the differences between classical and instrumental methods of chemical analysis.
- Explain different types of instrumental methods employed in chemical analysis.
- Develop an understanding of the range and theories of instrumental methods available in analytical chemistry.
- Make clear distinctions among spectrometric, electro-analytical, thermal and microscopic methods.
- Gain knowledge pertaining to the appropriate instrumental techniques.
- Obtain the practical experience in selected instrumental methods of analysis.
- Develop the skills on instrumental methods for planning, developing, conducting, reviewing, conducting experiments and reporting results.

Pedagogy

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

UNIT – I

[16 HOURS]

Flame photometry and Atomic absorption spectrometry: Energy level diagrams - atomic absorption spectra. Flame characteristics. Flame atomizers and electrothermal atomization. Comparison of spectral interferences, chemical and physical interferences in FP and AAS. Use of organic solvents. Quantitative techniques - calibration curve procedure and the standard addition technique. Typical commercial instruments for FP and AAS, applications. Qualitative analysis and quantitative evaluations. Relative detectabilities of atomic absorption and flame emission spectrometry.

Molecular luminescence spectrometry: Theoretical basis for fluorescence and phosphorescence. Singlet and triplet excited states. Variables affecting luminescence - quantum efficiency, transition types, structure and structural rigidity, temperature and solvent effects, effect of pH, dissolved oxygen and concentration effect. Excitation spectra vs emission spectra. Fluorescence instrumentation - fluorometers and spectrofluorometers. Sensitivity and selectivity. Modification necessary to measure phosphorescence. General scope of applications of luminescence.

Nephelometry and turbidometry: Principles, instrumentation and applications.

UNIT – II

[16 HOURS]

Potentiometric methods of analysis. Potentiometric electrochemical cells. The Nernst equation. Liquid junction potentials. Reference electrodes - SHE, calomel electrode and silver/ silver chloride electrode. Metallic indicator electrodes - electrodes of first kind and second kind. Redox electrodes. Membrane electodes – membrane potential, selectivity of membranes. Glass ion selective electrodes. Crystalline solid state ion selective electrodes. Liquid-based ion selective electrodes. Gas sensing electrodes. Potentiometric biosensors. Quantitative applications. Activity vs concentration. Quantitative analysis using external standards and the method of standard additions. Measurement of pH. Clinical and environmental applications.

Electrogravimetric analysis: Theory, apparatus, cell processes, deposition and separation, electrolytic separation of metals, applications.

Coulometric methods of analysis: General discussion, coulometry at controlled potential, apparatus and general technique, applications, coulometric titrations (amperometric coulometric) - principles, apparatus, comparison of coulometric titrations with conventional titrations, automatic coulometric titrations, applications.

Voltammetry: Fundamentals of voltammetry. Cyclic voltammetry: Principles and applications. Stripping analysis: Stripping voltammetry - basic principles, electrodes used for stripping analysis, apparatus for stripping analysis, applications, determination of lead in water voltammetry with micro electrodes.

UNIT – III

[16 HOURS]

Thermal method of analysis: Introduction,

Thermogravimetric analysis (TGA): types of thermogravimetric analysis, principles. Factors affecting the results - heating rate, furnace, instrument control/ data handling. Applications - purity and thermal stability, evaluation of correct drying temperature, analysis of complex mixture and determination of kinetic parameters of thermal degradation.

Differential thermal analysis (DTA): Theory - variables affecting the DTA curves. Differences between TGA and DTA. General principles. Instrumentation. Applications - analysis of the physical mixtures and thermal behaviour study. Determination of melting point, boiling point and decomposition point.

Differential scanning calorimetry (DSC): Basic principle. Differences between DTA and DSC. Instrumentation - power compensated DSC, Heat flux DSC. Applications - studies of thermal transitions and isothermal crystallization. Pharmaceutical industry for testing the purity of the samples.

Microcalorimetry: Micro-DSC instrumentation, Applications of Micro-DSC, Isothermal titration calorimetry, Microliter-flow calorimetry.

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. Instrumental Methods of Analysis by H.H. Willard, L.L. Merritt and J.A. Dean, 7th Edition, CBS Publishers, New Delhi, 1988.
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

Program Name: POST GRADUATE DIPLOMA PHARMACEUTICAL ANALYSIS AND INSTRUMENTATIONS	Semester II
Course Title: Analytical Chemistry Lab-II	
Hours per week: 04	Total contact hourse:64
Continuous internal Evaluation Marks:30	Semester end Examinatin:70

PART-A

1. Determination of sulpha drugs by potentiometry using $NaNO_2$ and iodometric assay of penicillin.
2. Polarographic determination of copper and zinc in brass.
3. Determination of manganese in steel by extraction-free spectrophotometry and molybdenum in steel by extractive spectrophotometry.
4. Determination of iron in mustard seeds and phosphorous in peas by spectrophotometry.

PART-B

1. Analysis of waste waters for DO and COD by titrimetry.
2. Analysis of a ground water sample for sulphate by titrimetry (EDTA) and turbidimetry.
3. Potentiometric determination of formula and stability constant of a silver- ammonia complex ion.
4. Photometric and potentiometric titration of iron(III)/copper with EDTA.
5. Analysis of brackish water for chloride content by a**)** spectrophotometry (mercuric thiocyanate method), b) conductometry (silver nitrate) and c**)** potentiometry (silver nitrate).
6. Ascorbic acid determination in natural orange juice by coulometry.
7. Analysis of urine for:
   a) Urea and uric acid by titrimetry snd spectrophotometry.
   b) Sulphate by precipitation titration after ion-exchange separation.
   c) Sugar by Benedict's reagent.
8. Analysis of blood for:
   a) Cholesterol by spectrophotometry
   b) Bicarbonate by acid-base titration