K.M.G. COLLEGE OF ARTS AND SCIENCE

(AUTONOMOUS)

Approved by the Government of Tamil Nadu
Permanently Affiliated to Thiruvalluvar University, Vellore
Recognized under Section 2(f) and 12(B) of the UGC Act 1956
Accredited by NAAC (2nd Cycle) with (CGPA of 3.24/4) 'A' Grade

P.G. AND RESEARCH DEPARTMENT OF CHEMISTRY

M.Sc., CHEMISTRY

SYLLABUS

(CHOICE BASED CREDIT SYSTEM)

Under

LEARNING OUTCOMES-BASED CURRICULUM

FRAMEWORK (LOCF)

(Effective for the Batch of Students Admitted from 2024-2025)

PREFACE

"Life is simply a matter of Chemistry - James Watson"

The outcome-based curriculum for post graduate courses in chemistry is focused on the advanced level of learning fields such as inorganic, physical, organic and analytical chemistry. Chemistry is beyond the science of mere observation and understanding of nature. The curriculum is designed to include scientific research methodology and project as components of research along with the necessary provision for employability and entrepreneurship. The periodical restructuring of the syllabi is carried out to fulfill the requirements of graduate attributes, qualification descriptors, program learning outcomes and course-level learning outcomes. The purpose of the outcome-based education is meant to provide an exposure to the fundamental and advanced concepts in different branches of chemistry and its applications keeping in mind the growing needs for higher education, employability, entrepreneurship and social responsibility.

The outcome-based education enriches the curriculum to achieve self-learning module, minor projects and industrial internship to enable students to get equipped for higher studies and employment.

The program also includes training to students for seminar presentation preparation of internship reports, hands-on training in lab courses, skills to handle instruments, synthesis and analysis of compounds, developing leadership qualities, organization and participation in the inter-collegiate academic competitions. The papers studied under different categories such as subject elective, cross-disciplinary, value-added course, life skill training etc. provide additional strength to augment students' interest in related fields.

The outcome-based curriculum is intended to enrich the learning pedagogy to global standards. ICT enabled teaching learning methodology seminar invited lectures endowment lectures provide ample opportunities to students for interactions with industrialists, entrepreneurs, academics, researchers, alumni, etc. to update with recent trends in different fields of chemistry. The exposure to the academic/industrial internship and MOUs with industries can open an avenue for a start-up and its progress would be followed regularly. The OBE based evaluation methods will reflect the true cognitive levels of the students as the curriculum is designed with course outcomes and cognitive level correlations as per BLOOM's Taxonomy.

PREAMBLE

Taxonomy forms three learning domains: the cognitive (knowledge), affective (attitude), and psychomotor (skill). This classification enables to estimate the learning capabilities of students.

Briefly, it is aimed to restructure the curriculum as student-oriented, skill-based, and institution- industry-interaction curriculum with the various courses under

"Outcome Based Education with Problem Based Courses, Project Based Courses, and Industry Aligned Programmes" having revised Bloom's Taxonomy for evaluating students' skills.

1. Cognitive Domain
   (Lower levels: K1: Remembering; K2: Understanding; K3: Applying;Higher levels: K4: Analysing ; K5: Evaluating; K6: Creating)
2. Affective Domain
3. Psychomotor Domain

ABOUT THE COLLEGE

The College was founded in the new millennium 2000 by the vision of late Shri.K.M.Govindarajan fondly known as Iyah, with a mission to offer higher education in the fields of Arts and Science to the needy and the poor middle class students of this area and make them fully employable and economically self-reliant. With a humble beginning of launching an elementary school named Thiruvalluvar Elementary School in the year 1952, Iyah groomed it into a Higher Secondary School and later into a college. Education was his soul and breath. The college has grown into a full-fledged educational hub offering 12 under graduate programmes, 8 post graduate programmes, 5 M.Phil. research programmes and 4 Ph.D. programmes. The college has been accredited with 'A' grade by NAAC in 2nd cycle and recognized under section 2(f) & 12(B) of the UGC act 1956. The College is permanently affiliated to Thiruvalluvar University. The College is also acquired the status of Autonomous from the academic year 2024-2025. The College is an associate member of ICT Academy and registered member of NPTEL and Spoken Tutorials of IIT Bombay. The college is also a member of INFLIBNET and NDL.

VISION OF THE COLLEGE

Empower young men and women by educating them in the pursuit of excellence, character building and responsible citizen.

MISSION OF THE COLLEGE

Offer higher education in the fields of Arts, Science & Management to the needy and make them fully self-dependent.

QUALITY POLICY OF THE COLLEGE

KMG Students achieve the best learning results and personal growth with modern education that equip them for working life and a changing society to become deserving citizens.

ABOUT THE DEPARTMENT

The knowledge of basic science is essential for the sustainable development of the society. To get the basic knowledge in chemical science to young students the Department of Chemistry initiated in the academic year 2007-2008. The objective of our department is to motivate students to excel in chemistry at the global level, which is necessary for chemists getting placement as well as becoming an entrepreneur in future. The department was uplifted as the post graduate department in the year 2010-2011. The department has been recognized as a research department since 2014-15 to offer M.Phil., Followed that the Thiruvallur University accorded recognition to the Department as a centre for Doctoral research in Chemistry from 2019-2020. The focus of the department is the holistic development of the students and involves them in curricular and co-curricular activities. The Chemistry Department pledges itself to serve in the broadest, innovative and most liberal manner towards the advancement of chemistry in all of its branches through academics, research and service missions upholding the values and entrepreneurial skills. The job potential to the chemist is very high now and opportunities to provoke research in chemistry are ample. Needless to say that for a developing country likes ours, "CHEMISTRY IS OUR LIFE AND FUTURE".

VISION OF THE DEPARTMENT

The Department is determined to educate and graduate rural students. The department is committed to produce the quality chemist with highest caliber who would engage in research, technological design and development to lend-a-hand in the national economic development.

MISSION OF THE DEPARTMENT

- To develop a basic knowledge in Chemistry with practical experience.
- To kindle the interest of students towards the development of technical skills to start their own business through mini projects and in-plant training.
- To enhance the students with the capacity of application oriented skills, which is a gateway to professional chemists.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1 - Professional Skill Development: To provide professional training and skill development to students in physical sciences, related disciplines and nurture them to become responsible persons in the society.

PEO2 - Core Competency Development: To augment their core-competencies and knowledge levels in science, humanities and inter-disciplinary areas by imparting education of high standards and advanced technological tools with specialized research orientation.

PEO3 - Innovative Curriculum of Global Relevance: To upgrade the curriculum periodically based on scientific advancements, innovations and societal relevance, so as to cater to the shifting global demands as cited by University Grants Commission, CSIR, etc.

PEO4 - Environmental Sensitivity and Sustainability: To infuse environmental sensitivity in students through academic activities and hence equip them with technical skills and scientific knowledge required to protect and safeguard the environment for a sustainable future by respecting ecological balance of the globe.

PEO5 - Ethical Principles and Holistic Development: To promote ethical values and special focus on the holistic development of students to become proficient, skilled, competent and socially responsible people.

PEO6 - Accessibility and Academic Excellence: To provide an accessible learning environment of excellence and equal opportunity to students, enabling them to develop their creativity, critical thinking, leadership, employability skills and making them competent for job market.

PROGRAM OUTCOMES (POs)

On successful completion of the programme, the students will be able to:

POs	Graduate Attributes	Statements
PO1	**Disciplinary Knowledge**	Capable of demonstrating detailed knowledge and expertise in all the disciplines of the subject.
PO2	**Communication Skills**	Ability to develop communication, managerial and interpersonal skills.
PO3	**Decision Making Skill**	Foster analytical and critical thinking abilities for data-based decision-making.
PO4	**Analytical Reasoning**	Ability to evaluate the reliability and relevance of evidence, identify flaws, analyze and synthesize data from different sources.
PO5	**Problem Solving Skill**	Apply knowledge of Scientific and Management theories and Human Resource practices to solve business problems through research in Global context.
PO6	**Employability and Entrepreneurial Skill**	Equip the skills in current trends and future expectations for placements and be efficient entrepreneurs by accelerating qualities to facilitate startups in the competitive environment.
PO7	**Individual and Team Leadership Skill**	Capability to lead themselves and the team to achieve organizational goals and contribute significantly to society.
PO8	**Multicultural competence**	Possess knowledge of the values and beliefs of multiple cultures and a global perspective.
PO 9	**Moral and ethical awareness/reasoning**	Ability to embrace moral/ethical values in conducting one's life.
PO10	**Lifelong Learning**	Identify the need for skills necessary to be successful in future at personal development and demands of work place.

PROGRAM SPECIFIC OUTCOMES (PSOs)

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

PSOs	Statements
PSO1	To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations.
PSO2	Design and implement practices in research that comply with employment laws, leading the organization towards growth and development.
PSO3	To contribute to the development of the society by collaborating with stakeholders for mutual benefit.

Correlation Rubrics:

High	Moderate	Low	No Correlation
3	2	1	-

Mapping of PSOs with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
PSO1	3	3	3	3	3	3	2	1	-	2
PSO2	3	3	2	3	3	2	2	-	2	3
PSO3	3	3	1	2	-	2	2	2	3	-

K.M.G. COLLEGE OF ARTS AND SCIENCE

(AUTONOMOUS)

Subject and Credit System- M.Sc., Chemistry

(Effective for the Batch of Students Admitted from 2024-2025)

Semester–I	Credit	Hours	Semester-II	Credit	Hours	Semester-III	Credit	Hours	Semester–IV	Credit	Hours
1.1. Core-I	5	7	2.1. Core-IV	5	6	3.1. Core-VII	5	6	4.1. Core-XI	5	6
1.2 Core-II	5	7	2.2 Core-V	5	6	3.2 Core-VIII	5	6	4.2 Core-XII	5	6
1.3 Core – III	4	6	2.3 Core – VI	4	5	3.3 Core – IX	5	6	4.3 Project with viva voce	7	10
1.4 Discipline Centric Elective -I	3	5	2.4 Discipline Centric Elective – III	3	4	3.4 Core – X	4	6	4.4Elective - VI (Industry / Entrepreneurship) 20% Theory 80% Practical	3	4
1.5 Generic Elective-II:	3	5	2.5 Generic Elective -IV:	3	4	3.5 Discipline Centric Elective - V	3	3	4.5 Skill Enhancement course / Professional Competency Skill	2	4
			2.6 NME I	2	3	3.6 NME II	2	3	4.6 Extension Activity	1	
			2.7 Human Rights	2	2	3.7 Internship/ Industrial Activity	2	-			
			2.8 MOOC	2	-						
	20	**30**		**26**	**30**		**26**	**30**		**23**	**30**
Total Credit Points -95											

Semester	Part	Category	Course Code	Course Title	Ins.Hrs/ Week	Credit	Maximum Marks		
							Internal	External	Total
SEMESTER - I	Part - I	Core-I	APCCH11	Organic Reaction Mechanism-I	7	5	25	75	100
		Core-II	APCCH12	Structure and Bonding in Inorganic Compounds	7	5	25	75	100
		Core-III	APCPCH13	Organic Chemistry Practical	6	4	25	75	100
		Elective – I (Choose any One)	APECH14A	Pharmaceutical Chemistry	5	3	25	75	100
			APECH14B	Electrochemistry					
		Elective – II (Choose any One)	APECH15A	Nanomaterials and Nanotechnology	5	3	25	75	100
			APECH15B	Molecular Spectroscopy					
				Semester Total	**30**	**20**			
SEMESTER - II	Part - I	Core-IV	APCCH21	Organic Reaction Mechanism-II	6	5	25	75	100
		Core-V	APCCH22	Physical Chemistry – I	6	5	25	75	100
		Core-VI	APCPCH23	Inorganic Chemistry Practical	6	4	25	75	100
		Elective-III (Choose any One)	APECH24A	Medicinal Chemistry	4	3	25	75	100
			APECH24B	Green Chemistry					
		Elective-IV (Choose any One)	APECH25A	Bio-inorganic Chemistry	4	3	25	75	100
			APECH25B	Material Science					
		SEC - I	APSCH26	Skill Enhancement Course (One from Group G)	2	2	25	75	100
	Part - II	Compulsory	APHR20	Human Rights	2	2	25	75	100
		Compulsory	APMOOC20	MOOC course	-	2	-	100	100
				Semester Total	**30**	**26**			

Semester	Part	Category	Course Code	Course Title	Ins.Hrs/ Week	Credit	Maximum Marks		
							Internal	External	Total
SEMESTER - III	Part - I	Core-VII	APCCH31	Organic Synthesis and Photochemistry	6	5	25	75	100
		Core-VIII	APCCH32	Coordination Chemistry – I	6	5	25	75	100
		Core-IX	APCPCH33	Physical Chemistry Practical	6	5	25	75	100
		Core-X	APCPCH34	Analytical Instrumentation Technique Practical	6	4	25	75	100
		Elective-V (Choose any One)	APECH35A	Pharmacognosy and Phytochemistry	4	3	25	75	100
			APECH35B	Biomolecules and Heterocyclic compounds					
		SEC - II	APSCH36	Skill Enhancement Course - Professional Communication	2	2	25	75	100
		Compulsory	APICH37	Internship / Industrial Activity (Carried out in Summer Vacation at the end of I year – 30 hours)	-	2	100	-	100
				Semester Total	**30**	**26**			
SEMESTER - IV	Part - I	Core-XI	APCCH41	Coordination Chemistry –II	6	5	25	75	100
		Core-XII	APCCH42	Physical Chemistry – II	6	5	25	75	100
		Core-XIII	APPCH43	Core Project with viva voce	10	7	25	75	100
		Elective VI (Choose any One)	APECH44A	Chemistry of Natural Products	4	3	25	75	100
			APECH44B	Polymer Chemistry					
		SEC - III	APSCH45A	Professional Competency Skill Enhancement Course Training for Competitive Examinations • Chemistry for NET / UGC - CSIR/ SET / TRB Competitive Examinations (2 hours) • General Studies for UPSC / TNPSC / Other Competitive Examinations (2 hours)	4	2	25	75	100
			APSCH45B	Chemistry for Advanced Research Studies (4 hours)					
	Part - II	Compulsory	APEA40	Extension Activity	-	1	100	-	100
				Semester Total	**30**	**23**			

Consolidated Semester wise and Component wise Credit distribution

Parts	Semester-I	Semester-II	Semester-III	Semester-IV	Total Credits
Part-I	20	22	26	22	90
Part-II	-	04	-	01	05
Total	20	26	26	23	**95**

*****Part I and Part II components will be separately taken into account for CGPA calculation and classification for the post graduate programme and has to be completed during the duration of the programme as per the norms, to be eligible for obtaining the PG degree.

Elective Courses

Courses are grouped (Group A to Group F) so as to include topics from Pure Chemistry (PC), Applied Chemistry (AC) and Industrial Components (IC) like pharmaceutical industries, Polymer labs courses for flexibility of choice by the stakeholders / institutions.

Semester I: Elective I and Elective II

Elective I to be chosen from Group A and **Elective II** to be chosen from Group B

Group A: (PC/AC/IC)

1. Pharmaceutical Chemistry
2. Electrochemistry

Group B:(PC/AC/IC)

1. Nanomaterials and Nanotechnology
2. Molecular Spectroscopy

Semester II: Elective III & Elective IV

Elective III to be chosen from **Group C** and **Elective IV** to be chosen from **Group D**

Group C:**(PC/AC/IC)**

1. Medicinal Chemistry
2. Green Chemistry

Group D :(PC/AC/IC)

1. Bioinorganic Chemistry
2. Material Science

Semester III: Elective V

Elective V to be chosen from Group E.

Group E: (PC/AC/IC)

1. Pharmacognosy and Phytochemistry
2. Biomolecules and Heterocyclic compounds

Semester IV: Elective VI

Elective VI to be chosen from Group F.

Group F:(PC/AC/IC)

1. Chemistry of Natural products
2. Polymer Chemistry

Skill Enhancement Courses

Skill Enhancement Courses are chosen to keep in pace with the latest developments in the academic / industrial front and provides flexibility of choice by the stakeholders / institutions.

Group G (Skill Enhancement Courses) SEC:(Practical based paper)

- Computational Chemistry
- 3D printing in Chemistry
- Preparation of Consumer products
- Chemistry in everyday life
- Cosmetic Chemistry
- Origin lab
- Industrial Chemistry
- Research Tools and Techniques

Instructions for Course Transaction

Courses	**Lecture Hrs**	**Tutorial hrs**	**Lab Practice**	**Total hrs**
Core	75	15	--	90
Electives	75	15	--	90
ED	75	15	--	90
Lab Practice Courses	-	15	75	90
Project	20	--	70	90

Written Examination: Theory Paper (Bloom's Taxonomy based)

Question paper Model

Intended Learning Skills	**Maximum 75 Marks** **Passing Minimum: 50%Duration:** **Three Hours**
	Part –A (10x 2 = 20 Marks) Answer ALL questions **Each Question carries 2mark**
Memory Recall / Example/ Counter Example / Knowledge aboutthe Concepts/ Understanding	Two questions from each UNIT
	Question 1 to Question 10
	Part – B (5 x 5 = 25 Marks)Answer ALL questions **Each questions carries 5 Marks**
Descriptions/ Application(problems)	**Either-or Type** Both parts of each question from the same UNIT
	Question 11(a) or 11(b) To **Question 15(a) or 15(b)**
	Part-C (3x 10 = 30 Marks) Answer any THREE questions Each question carries 10 Marks
Analysis /Synthesis / Evaluation	There shall be FIVE questions covering all the five units
	Question 16 to Question 20

COURSE DESCRIPTORS

Title of the Course	ORGANIC REACTION MECHANISM - I	**Hours/Week**	07
Course Code	APCCH11	**Credits**	05
Category	Core-1	**Year & Semester**	I & I
Prerequisites	Basic concepts of organic Chemistry	**Regulation**	2024

Objectives of the course:

- To explain the concepts of advanced organic chemistry with mechanistic approach.
- To discuss about the methods of determining the reaction mechanism and stereochemistry.
- To explain the evidences in favour of the mechanism of organic reactions and rearrangements.
- Detaille discussed stereochemical aspects of organic reaction mechanisms.
- To describes the important aspects involved in the preparation of various functional organic compounds..

UNITS	Contents	COs	Cognitive Levels
UNIT-I	**UNIT - I** Methods of Determination of Reaction Mechanism: Reaction intermediates. The transition state, Reaction coordinate diagrams. Methods of determining mechanism: non-kinetic methods – product analysis, determination of intermediates-isolation, detection, and trapping. Cross-over experiments, isotopic labelling, isotope effects and stereo chemical evidences. Kinetic methods - relation of rate and mechanism. Effect of structure on reactivity: Hammett and Taft equations. Linear free energy relationship, partial rate factor, substituent and reaction constant	CO1 CO2	K1 K2
UNIT-II	**UNIT – II: Aromatic and Aliphatic Electrophilic Substitution:** Aromaticity: Aromaticity in benzenoid, non-benzenoid, heterocycliccompounds and annulenes. Aromatic electrophilic substitution: Orientation and reactivity of di- and polysubstituted phenol, nitrobenzene andhalobenzene. Reactions involving nitrogen electrophiles: nitration, nitrosation and diazonium coupling; Sulphur electrophiles: sulphonation; Halogen electrophiles: chlorination and bromination; Carbon electrophiles: Friedel-Crafts alkylation, acylation and arylation reactions. Aliphaticelectrophilic substitution Mechanisms: SE_2 and SE_i, SE_1- Mechanism and evidences.	CO1 CO2 CO3	K1 K2 K4

UNIT-III	**UNIT - III** Aromatic and Aliphatic Nucleophilic Substitution: Aromatic nucleophilic substitution: Mechanisms - SNAr, SN1 and Benzyne mechanisms - Evidences - Reactivity, Effect of structure, leaving group and attacking nucleophile. Reactions: Oxygen and Sulphur-nucleophiles, Bucherer and Rosenmund reactions, von Richter, Sommelet- Hauser and Smiles rearrangements. SN1, ion pair, SN2 mechanisms and evidences. Aliphatic nucleophilic substitutions at an allylic carbon, aliphatic trigonal carbon and vinyl carbon.SN1, SN2, SNi, and SE1 mechanism and evidences.	CO3 CO4	K1 K2 K3 K5
UNIT-IV	**UNIT – IV: Stereochemistry-I:** Introduction to molecular symmetry and chirality – axis, plane, centre, alternating axis of symmetry. Optical purity, prochirality, enantiotopic and diastereotopic atoms, groups, faces, axial and planar chirality, chirality due to helical shape, methods of determining the configuration. Racemic modifications: Racemization by thermal, anion, cation, reversible formation, epimerization, mutarotation. D, L system, Cram's and Prelog's rules: R, S notations, proR, proS, side phase and re phase Cahn-Ingold- Prelog rules, absolute and relative configurations. Configurations of allenes, spiranes, biphenyls.	CO4 CO5	K4 K5 K6
UNIT-V	**UNIT-V: Stereochemistry-II** Conformation and reactivity of acyclic systems, intramolecular rearrangements, neighbouring group participation, chemical consequence of conformational equilibrium. Stability of five and six-membered rings: mono-, di- and polysubstituted cyclohexanes, conformation and reactivity in cyclohexane systems. Fused and bridged rings: bicyclic, poly cyclic systems, decalins and Brett's rule. Optical rotation and optical rotatory dispersion, conformational asymmetry, ORD curves, octant rule, configuration and conformation.	CO5	K3 K4 K5 K6

Recommended Text Books

1. *J. March and M. Smith, Advanced Organic Chemistry, 5th edition, John-Wiley and Sons.2001.*
2. *E. S. Gould, Mechanism and Structure in Organic Chemistry, Holt, Rinehart and Winston Inc., 1959.*
3. *P.S.Kalsi, Stereochemistry of carbon compounds, 8th edition, New Age International Publishers, 2015.*
4. *P. Y. Bruice, Organic Chemistry, 7th edn, Prentice Hall, 2013.*
5. *J.Clayden, N. Greeves, S. Warren, Organic Compounds, 2nd edition, Oxford University Press, 2014.*

Reference Books

1. Maron, S. H. and Prutton C. P. Principles of Physical Chemistry,4thed.; The Macmillan Company: Newyork,1972.

2. Lee, J. D. Concise Inorganic Chemistry, 4th ed.; ELBS William Heinemann: London,1991.

3. Gurudeep Raj, Advanced Inorganic Chemistry, 26thed.; Goel Publishing House: Meerut, 2001.

4. Atkins, P.W. & Paula, J. Physical Chemistry, 10th ed.; Oxford University Press:New York, 2014.

5. Huheey, J. E. Inorganic Chemistry: Principles of Structure and Reactivity, 4th ed .; Addison, Wesley Publishing Company: India,1993.

Website and e-learning source

1) https://sites.google.com/site/chemistryebookscollection02/home/organic- chemistry/organic
2) https://www.organic-chemistry.org/

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	Comprehend the concepts of stereochemistry and write the configurational nomenclature	K1,K2
CO2	Examine the mechanisms of nucleophilic substitution reactions and describe nucleophilic substitution on aromatic rings.	K3
CO3	Compose multiple ways for addition-elimination reactions and predict the stereochemistry of elimination mechanisms.	K4
CO4	Assess the concept of aromaticity and classify the reactions on aromatic rings.	K5
CO5	Evaluate the orientation of aliphatic and aromatic substitution reactions	K6

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	-	2	-	-	-	-	-	2	2	1	2
CO2	3	2	2	3	2	-	-	-	-	1	2	1	1
CO3	3	2	-	2	2	-	-	-	-	-	1	2	1
CO4	3	2	-	-	-	-	-	-	-	-	2	2	2
CO5	3	2	-	2	2	-	-	-	-	-	3	2	1

COURSE DESCRIPTORS

Title of the Course	Structure and Bonding in Inorganic Compounds	**Hours/Week**	07
Course Code	APCCH12	**Credits**	05
Category	Core-2	**Year & Semester**	I & I
Prerequisites	Basic concepts of Inorganic Chemistry	**Regulation**	2024

Objectives of the course:

This course aims at providing knowledge on

- To determine the structural properties of main group compounds and clusters.
- To gain fundamental knowledge on the structural aspects of ionic crystals.
- To familiarize various diffraction and microscopic techniques.
- To study the effect of point defects and line defects in ionic crystals.
- To evaluate the structural aspects of solids.

UNITS	Contents	COs	Cognitive Levels
UNIT-I	Structure of main group compounds and clusters: VB theory – Effect of lone pair and electronegativity of atoms (Bent's rule) on the geometry of the molecules. Structural and bonding features of B-N, S-N and P-N compounds; Poly acids – types, examples and structures; Borane cluster: Structural features of closo, nido, arachano; carboranes, hetero and metalloboranes; Wade's rule to predict the structure of Borane cluster; main group clusters	CO1 CO2	K1 K2 K3
UNIT-II	**Solid state chemistry – I:** Ionic crystals: Packing of ions in simple, hexagonal and cubic close packing, voids in crystal lattice, Radius ratio, Crystal systems and Bravais lattices, Symmetry operations in crystals, glide planes and screw axis; point group and space group; Solid state energetics: Lattice energy – Born-Lande equation - Kapustinski equation, Madelung constant.	CO1 CO2	K1 K2 K3

UNIT-III	**Solid State Chemistry – II:** Structural features of the crystal systems: Rock salt, zinc blende & wurtzite, fluorite and anti-fluorite, rutile and anatase, cadmium iodide and nickel arsenide; Spinels -normal and inverse types and perovskite structures. Crystal Growth methods: From melt and solution (hydrothermal, sol-gel methods) – principles and examples.	CO1 CO2 CO3	K1 K4
UNIT-IV	**Techniques in Solid State Chemistry:** X-ray diffraction technique: Bragg's law, Powder diffraction method – Principle and Instrumentation; Interpretation of XRD data, Phase purity, lattice constants calculation; Systematic absence of reflections; Electron diffraction technique – principle, instrumentation and application. Electron microscopy – difference between optical and electron microscopy, theory, principle, instrumentation, sampling methods and applications of SEM and TEM.	CO2 CO3 CO4 CO5	K1 K2 K3 K4 K5
UNIT-V	**Band theory and defects in solids** Band theory – features and its application of conductors, insulators and semiconductors, Intrinsic and extrinsic semiconductors; Defects in crystals – point defects (Schottky, Frenkel, metal excess and metal deficient) and their effect on the electrical and optical property, laser and phosphors; Linear defects and its effects due to dislocations.	CO3 CO5	K1 K2 K4 K5

Recommended Text Books

1. *A R West, Solid state Chemistry and its applications, 2ndEdition (Students Edition), John Wiley & Sons Ltd., 2014.*
2. *A K Bhagi and G R Chatwal, A textbook of inorganic polymers, Himalaya Publishing House, 2001.*
3. *L Smart, E Moore, Solid State Chemistry – An Introduction, 4th Edition, CRC Press, 2012.*
4. *K. F. Purcell and J. C. Kotz, Inorganic Chemistry; W.B. Saunders company: Philadelphia, 1977.*
5. *J. E. Huheey, E. A. Keiter and R. L. Keiter, Inorganic Chemistry; 4th ed.; Harper and Row: NewYork, 1983.*

Reference Books

1. *D. E. Douglas, D.H. McDaniel and J. J. Alexander, Concepts and Models in Inorganic Chemistry, 3rd Ed, 1994.*
2. *R J D Tilley, Understanding Solids - The Science of Materials, 2nd edition, Wiley Publication, 2013.*
3. *C N R Rao and J Gopalakrishnan, New Directions in Solid State Chemistry, 2nd Edition, Cambridge University Press, 199.*
4. *T. Moeller, Inorganic Chemistry, A Modern Introduction; John Wiley: New York, 1982.*
5. *D. F. Shriver, P. W. Atkins and C.H. Langford; Inorganic Chemistry; 3rd ed.; Oxford University Press: London, 2001.*

Website and e-learning source

https://ocw.mit.edu/courses/3-091-introduction-to-solid-state-chemistry-fall-2018/video_galleries/lecture-videos/

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	Predict the geometry of main group compounds and clusters.	K1,K2,K3
CO2	Explain about the packing of ions in crystals and apply the radius ratio rule to predictthe coordination number of cations.	K1,K2,K3
CO3	Understand the various types of ionic crystal systems and analyze their structuralfeatures.	K1,K4
CO4	Elucidate the crystal growth methods and principles of diffraction and microscopic techniques	K3,K4,K5
CO5	To recognize the important of Defects in crystals	K1,K2,K3

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	-	3	2	-	-	-	-	-	2	2	2
CO2	3	3	-	-	-	-	-	-	-	-	2	1	2
CO3	3	3	-	2	1	-	-	-	-	-	1	1	1
CO4	3	3	2	3	2	1	-	-	-	2	3	2	1
CO5	3	3	-	2	-	-	-	-	-	1	1	2	1

COURSE DESCRIPTORS

Title of the Course	Organic Chemistry Practical	Hours/Week	06
Course Code	APCPCH13	Credits	04
Category	Core Practical	Year & Semester	I & I
Prerequisites	Basic concepts of Organic Chemistry	Regulation	2024

Objectives of the course:

The course aims at giving an overall view of the

- To understand the concept of separation, qualitative analysis and preparation of organic compounds.
- To develop analytical skill in the handling of chemical reagents for separation of binary and ternaryorganic mixtures.
- To analyze the separated organic components systematically and derivatize them suitably.
- To construct suitable experimental setup for the organic preparations involving two stages.
- To experiment different purification and drying techniques for the compound processing.

UNITS	Contents	COs	Cognitive Levels
UNIT-I	**Separation and analysis:** Two component mixtures. Ternary component (Demo)	CO1 CO2 CO3	K1,K2 K3,K4
UNIT-II	**Estimations:** **a)** Estimation of Phenol (bromination) **b)** Estimation of Aniline (bromination) **c)** Estimation of Ethyl methyl ketone (iodimetry) **d)** Estimation of Glucose (redox) **e)** Estimation of Ascorbic acid (iodimetry).	CO2	K1,K2 K3,K4 K5

UNIT-III	**Two stage preparations:** a) p-Bromoacetanilide from aniline b) p-Nitroaniline from acetanilide c) 1,3,5-Tribromobenzene from aniline d) Acetyl salicyclic acid from methyl salicylate e) Benzilic acid from benzoin f) m-Nitroaniline from nitrobenzene g) m-Nitrobenzoic acid from methyl benzoate	CO2 CO4 CO5	K1,K2 K3, K4

Recommended Text Books

1. *Ganapragasm, N. S., & Ramamurthy, C. (2015). Organic Chemistry Lab Manual, (2nd Ed.). Vishwanathan S Printers and Publishers (P) Ltd.*
2. *Furniss, B. S., Hannaford, A. J., Smith, P. W. G., & Tatchell, A. R. Vogel's Textbook of Practical Organic Chemistry, (5th Ed.). Pearson publication.*

Reference Books

1. *Venkateswaran, V., Veeraswamy, R., & Kulandaivelu, A. R. (1997). Basic principles of practical chemistry, (2nd ed.). Sultan Chand & Sons.*
2. *Organic Chemistry Lab Manual for Micro Qualitative Analysis. Department of Chemistry, KMG College of Arts And Science (AUTONOMOUS), Gudiyatham,635803 (Private circulation).*

Website and e-learning source

1. *https://youtu.be/EyWGc-vizic*
2. *https://youtu.be/mQ035ZrdD4Y*
3. *https://youtu.be/N96JaRnE7n0*

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	To recall the basic principles of organic separation, qualitative analysis and preparation.	K1,K2,K3,K4
CO2	To explain the method of separation and analysis of separated organic mixtures and convert them as derivatives by suitable preparation method.	K1,K2
CO3	To determine the characteristics of separation of organic compounds by various chemical reactions.	K1,K2,K3,K4,K5
CO4	To develop strategies to separate, analyze and prepare organic compounds.	K3,K4,K5
CO5	To formulate a method of separation, analysis of organic mixtures and design suitable procedure for organic preparations.	K3,K4,K5

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	-	3	-	-	-	-	-	2	3	3	1
CO2	3	3	-	3	-	-	-	-	-	1	3	2	-
CO3	3	2	2	3	-	-	-	-	-	-	3	3	-
CO4	3	3	3	3	3	-	2	-	2	2	3	3	2
CO5	3	3	2	3	2	-	-	-	-	2	3	3	-

COURSE DESCRIPTORS

Title of the Course	PHARMACEUTICAL CHEMISTRY	Hours/Week	05
Course Code	APECH14A	Credits	03
Category	ELECTIVE - I	Year & Semester	I & I
Prerequisites	Basic knowledge on drugs and doses	Regulation	2024

Objectives of the course:

This course aims at providing knowledge on

- To understand the advanced concepts of pharmaceutical chemistry.
- To recall the principle and biological functions of various drugs.
- To train the students to know the importance as well the consequences of various drugs.
- To have knowledge on the various analysis and techniques.
- To familiarize on the drug dosage and its structural activities.

UNITS	Contents	COs	Cognitive Levels
UNIT-I	Physical properties in Pharmaceuticals: Physical properties of drug molecule: physical properties. Refractive index- Definition, explanation, formula, importance, determination, specific & molar refraction. Dielectric constant & Induced Polarization- Dielectric constant explanation & determination. Rheology of pharmaceutical systems: Introduction, Definition, Applications, concept of viscosity, Newton's law of flow, Kinematic, Relative, Specific, Reduced & Intrinsic viscosity.	CO1 CO2	K1 K2 K3
UNIT-II	**Isotopic Dilution analysis:** Principle and applications, Neutron activation analysis: Principle, advantages and limitations, Scintillation counters: Body scanning. Introduction to radiopharmaceuticals. Properties of various types of radiopharmaceuticals, Radio-pharmaceuticals As diagnostics, as therapeutics, for research and sterilization. Physico Chemical Properties and drug action. Physico chemical properties of drugs (a) Partition coefficient, (b) solubility (c) surface activity, (d) degree of ionization.	CO1 CO2	K1 K2

UNIT-III	**Drug dosage and product development:** Introduction to drug dosage Forms & Drug Delivery system – Definition of Common terms. Drug Regulation and control, pharmacopoeias formularies, sources of drug, drug nomenclature, routes of administration of drugs products, need for a dosage form, classification of dosage forms. Drug dosage and product development. Introduction to drug dosage Forms & Drug Delivery system – Definition of Common terms. Drug Regulation and control, pharmacopoeias formularies, sources of drug, drug nomenclature, routes of administration of drugs products, need for a dosage form, classification of dosage forms.	CO1 CO2 CO3 CO5	K1 K3 K4
UNIT-IV	**Development of new drugs:** Introduction, procedure followed in drug design, the research for lead compounds, molecular modification of lead compounds. Structure-Activity Relationship (SAR) Factors effecting bioactivity, resonance, inductive effect, isoterism, bioisosterism, spatial considerations, biological properties of simple functional groups, theories of drug activity, occupancy theory, rate theory, induced-fit theory.	CO2 CO3 CO5	K3 K4 K5
UNIT-V	**Computers in Pharmaceutical Chemistry:** Need of computers for chemistry. Computers for Analytical Chemists Introduction to computers: Organization of computers, CPU, Computer memory, I/O devices, information storage, software components. Application of computers in chemistry: Quantitative structure activity relationship (QSAR): Development of QSAR, drug receptor interactions, the additivity of group contributions, physico-chemical parameters, lipophilicity parameters, electronic parameter, ionization constants, steric parameters, chelation parameters, redox potential, indicator-variables	CO3 CO4 CO5	K1 K2 K4

Recommended Text Books

1. *Physical Chemistry- Bahl and Tuli.*
2. *Text Book of Physical Pharmaceutics, IInd edition, Vallabh Prakashan-.C.V.S. Subramanyam.*
3. *Medicinal Chemistry (Organic Pharmaceutical Chemistry), G.R Chatwal, Himalaya Publishing house.*
4. *Instrumental method of Analysis: Hubert H, Willard,7th edition.*
5. *Textbook of Pharmaceutical Chemistry by,Jayshree Ghosh, S. Chand & company Ltd.Pharmaceutical Chemistry by Dr. S. Lakshmi, Sultanchand & Sons.*

Reference Books

1. *Computers in chemistry, K.V. Raman, Tata Mc.Graw-Hill, 1993.*
2. *Computers for Chemists, S.K Pundir, Anshu bansal, A pragate prakashan., 2 nd edition, New age international (P) limited, New Delhi.*
3. *Physical Pharmacy and Pharmaceutical Sciences by Martins, Patrick J. Sinko, Lippincott. William and Wilkins.*
4. *Cooper and Gunn's Tutorial Pharmacy ,6th edition by S.J. Carter, CBS Publisher Ltd.*
5. *Ansels pharmaceutical Dosage forms and Drug Delivery System by Allen Popvich and Ansel, Indian edition-B.I. Publication Pvt. Ltd.*

Website and e-learning source

https://www.ncbi.nlm.nih.gov/books/NBK482447/

https://training.seer.cancer.gov/treatment/chemotherapy/types.html

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	To identify the suitable drugs for various diseases.	K1,K2
CO2	To apply the principles of various drug action and drug design.	K2,K3,K4
CO3	To acquire the knowledge on product development based on SAR.	K1,K2,K3
CO4	To apply the knowledge on applications of computers in Chemistry.	K3,K4,K5
CO5	To synthesize new drugs after understanding the concepts SAR.	K1,K5,K6

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	2	3	-	-	-	-	-	-	3	3	3
CO2	3	3	2	2	-	-	-	-	-	-	3	2	2
CO3	3	3	2	3	2	-	-	-	-	-	3	2	2
CO4	3	3	-	-	-	3	-	-	-	3	3	3	2
CO5	3	3	2	3	2	2	-	-	-	2	2	2	2

COURSE DESCRIPTORS

Title of the Course	ELECTROCHEMISTRY	Hours/Week	05
Course Code	APECH14B	Credits	03
Category	ELECTIVE - I	Year & Semester	I & I
Prerequisites	Basic knowledge of Electrochemistry	Regulation	2024

Objectives of the course:

This course aims at providing knowledge on

- To understand the behavior of electrolytes in terms of conductance, ionic atmosphere, interactions.
- To familiarize the structure of the electrical double layer of different models.
- To compare electrodes between current density and over potential.
- To discuss the mechanism of electrochemical reactions.
- To highlight the different types of over voltages and its applications in electroanalytical techniques.

UNITS	Contents	COs	Cognitive Levels
UNIT-I	**Ionics**: Arrhenius theory -limitations, van't Hoff factor and its relation to colligative properties. Deviation from ideal behavior. Ionic activity, mean ionic activity and mean ionic activity coefficient-concept of ionic strength, Debye Huckel theory of strong electrolytes, activity coefficient of strong electrolytes Determination of activity coefficient ion solvent and ion-ion interactions. Born equation. Debye-Huckel Bjerrum model. Derivation of Debye-Huckel limiting law at appreciable concentration of electrolytes modifications and applications. Electrolytic conduction -Debye- Huckel Onsager treatment of strong electrolyte-qualitative and quantitative verification and limitations.	CO1	K1 K2
UNIT-II	**Electrode-electrolyte interface:** Interfacial phenomena - Evidences for electrical double layer, polarizable and non-polarizable interfaces, Electrocapillary phenomena - Lippmann equation electro capillary curves. Electro-kinetic phenomena electro-osmosis, electrophoresis, streaming and sedimentation potentials. Structure of double layer: Helmholtz - Perrin, Guoy Chapman and Stern models of electrical double layer. Zeta potential and potential at zero charge. Applications and limitations.	CO1 CO4	K1 K2 K3

UNIT-III	**Electrodics of Elementary Electrode Reactions:** Behavior of electrodes: Standard electrodes and electrodes at equilibrium. Anodic and Cathodic currents, condition for the discharge of ions. Nernst equation, polarizable and non-polarizable electrodes. Model of three electrode system, over potential. Rate of electro chemical reactions: Rates of simple elementary reactions. Butler-Volmer equation-significance of exchange current density, net current density and symmetry factor. Low and high field approximations. Symmetry factor and transfer coefficient Tafel equations and Tafel plots.	CO1 CO2	K1 K2 K3 K4
UNIT-IV	**Electrodics of Multistep Multi Electron System:** Rates of multi-step electrode reactions, Butler - Volmer equation for a multi-step reaction. Rate determining step, electrode polarization and depolarization. Transfer coefficients, its significance and determination, Stoichiometric number. Electro-chemical reaction mechanisms-rate expressions, order, and surface coverage. Reduction of I^{3-}, Fe^{2+}, and dissolution of Fe to Fe^{2+}. Overvoltage - Chemical and electro chemical, Phase, activation and concentration over potentials. Evolution of oxygen and hydrogen at different pH. Pourbiax and Evan's diagrams.	CO2 CO3 CO4	K1 K2 K3 K4
UNIT-V	**Concentration Polarization, Batteries and Fuel cells:** Modes of Transport of electro active species - Diffusion, migration and hydrodynamic modes. Role of supporting electrolytes. Polarography principle and applications. Principle of square wave polarography. Cyclic voltammetry- anodic and cathodic stripping voltammetry and differential pulse voltammetry. Sodium and lithium-ion batteries and redox flow batteries. Mechanism of charge storage: conversion and alloying. Capacitors-mechanism of energy storage, charging at constant current and constant voltage. Energy production systems: Fuel Cells: classification, alkaline fuel cells, phosphoric acid fuel cells, high temperature fuel cells.	CO4 CO5	K1 K2 K3 K4

Recommended Text Books

1. *D. R. Crow, Principles and applications of electrochemistry, 4thedition, Chapman & Hall/CRC, 2014.*
2. *J. Rajaram and J.C. Kuriakose, Kinetics and Mechanism of chemical transformations Macmillan India Ltd., New Delhi, 2011.*
3. *S. Glasstone, Electro chemistry, Affiliated East-West Press, Pvt., Ltd., New Delhi, 2008.*
4. *B. Viswanathan, S. Sundaram, R. Venkataraman, K. Rengarajan and P.S. Raghavan, Electrochemistry-Principles and applications, S. Viswanathan Printers, Chennai,2007.*
5. *Joseph Wang, Analytical Electrochemistry, 2nd edition, Wiley, 2004.*

Reference Books

1. *J.O.M. Bockris and A.K.N. Reddy, Modern Electro chemistry, vol.1 and 2B, Springer, Plenum Press, New York, 2008.*
2. *J.O.M. Bockris, A.K.N. Reddy and M.G. Aldeco Morden Electro chemistry, vol. 2A, Springer, Plenum Press, New York, 2008.*
3. *Philip H. Rieger, Electrochemistry, 2nd edition, Springer, New York, 2010.*
4. *L.I. Antropov, Theoretical electrochemistry, Mir Publishers, 1977.*
5. *K.L. Kapoor, A Text book of Physical chemistry, volume-3, Macmillan, 2001.*

Website and e-learning source

. https://www.pdfdrive.com/modern-electrochemistry-e34333229.

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	Understand the behaviour of electrolytes in solution and compare the structures of electrical double layer of different models.	K2,K3
CO2	Predict the kinetics of electrode reactions by applying Butler-Volmer and Tafel equations.	K1,K3,K4
CO3	Analyze the mechanism of corrosion using Pourbiax and Evan's diagrams.	K2,K3,K4
CO4	Discuss the necessity electrical double layer and activity coefficient of electrolytes.	K1,K2
CO5	Describe electrochemical reaction mechanism in storage devices.	K3,K4

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	-	3	-	-	-	-	-	-	3	2	2
CO2	3	3	3	3	3	-	-	-	-	-	3	3	2
CO3	3	3	-	2	-	-	-	-	-	-	3	2	1
CO4	3	3	-	-	-	-	-	-	-	-	3	2	2
CO5	3	3	2	-	-	-	-	-	-	-	3	1	2

COURSE DESCRIPTORS

Title of the Course	**NANO MATERIALS AND NANO TECHNOLOGY**	**Hours/Week**	05
Course Code	APECH15A	**Credits**	03
Category	ELECTIVE - II	**Year & Semester**	I & I
Prerequisites	**Basic knowledge of crystallography and material science**	**Regulation**	2024

Objectives of the course:

This course aims at providing knowledge on

- To understand the concept of nano materials and nano technology.
- To understand the various types of nano materials and their properties.
- To understand the applications of synthetically important nano materials.
- To correlate the characteristics of various nano materials synthesized by new technologies.
- To design synthetic routes for synthetically used new nano materials.

UNITS	Contents	COs	Cognitive Levels
UNIT-I	Introduction of nanomaterials and nanotechnologies, Introduction-role of size, classification-0D, 1D, 2D, 3D. Synthesis Bottom – Up, Top–Down, consolidation of Nano powders. Features of nanostructures, Background of nanostructures. Techniques of synthesis of nanomaterials, Tools of the nanoscience. Applications of nanomaterials and technologies.	CO1 CO4 CO5	K1 K2
UNIT-II	Bonding and structure of the nanomaterials, Predicting the Type of Bonding in a Substance crystal structure. Metallic nanoparticles, Surfaces of Materials, Nanoparticle Size and Properties. Synthesis Physical and chemical methods - inert gas condensation, arc discharge, laser ablation, sol-gel, solvo-thermal and hydrothermal- CVD-types, metalloorganic, plasma enhanced, and low-pressure CVD. Microwave assisted and electrochemical synthesis.	CO1 CO2	K1 K2
UNIT-III	Mechanical properties of materials, theories relevant to mechanical properties. Techniques to study mechanical properties of nanomaterials, adhesion and friction, thermal properties of nanomaterials Nanoparticles: gold and silver, metal oxides: silica, iron oxide and alumina - synthesis and properties	CO1 CO3	K1 K2 K3

UNIT-IV	Classification of Materials based on Conductivity, magnetic properties, electronic properties. Semiconductor materials – classification-Ge, Si, GaAs, SiC, GaN, GaP, CdS, PbS. Identification of materials as p and n – type semiconductor-Hall effect - quantum and anomalous, Hall voltage - interpretation of charge carrier density. Applications of semiconductors: p-n junction as transistors and rectifiers, photovoltaic and photogalvanic cell**.**	CO1 CO2 CO5	K1 K2 K3 K4
UNIT-V	Nano thin films, nanocomposites. Application of nanoparticles in different fields. Core-shell nanoparticles - types, synthesis, and properties. Nanocomposites - metal-, ceramic- and polymer-matrix composites applications. Characterization – SEM, TEM and AFM - principle, instrumentation and applications.	CO4 CO5	K2 K3 K4

Recommended Text Books

1. *S.Mohan and V. Arjunan, Principles of Materials Science, MJP Publishers, 2016.*
2. *Arumugam, Materials Science, Anuradha Publications,2007.*
3. *Giacavazzo et. al., Fundamentals of Crystallography, International Union of Crystallography. Oxford Science Publications, 2010*
4. *Woolfson, An Introduction to Crystallography, Cambridge University Press, 2012.*
5. *James F. Shackelford and Madanapalli K. Muralidhara, Introduction to Materials Science for Engineers. 6th ed., PEARSON Press, 2007.*

Reference Books

1. *S.Mohan and V. Arjunan, Principles of Materials Science, MJP Publishers, 2016.*
2. *Arumugam, Materials Science, Anuradha Publications,2007.*
3. *Giacavazzo et. al., Fundamentals of Crystallography, International Union of Crystallography. Oxford Science Publications, 2010*
4. *Woolfson, An Introduction to Crystallography, Cambridge University Press, 2012.*
5. *James F. Shackelford and Madanapalli K. Muralidhara, Introduction to Materials Science for Engineers. 6th ed., PEARSON Press, 2007.*

Website and e-learning source

1. http://xrayweb.chem.ou.edu/notes/symmetry.html.
2. http://www.uptti.ac.in/classroom-content/data/unit%20cell.pdf.

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	Describe and consolidate the various types of nanomaterials.	K1,K2
CO2	Explain the fabricating methods of nanostructures	K1,K2
CO3	Narrate the unique properties of nanomaterials to reduce dimensionality of the material.	K2,K3
CO4	Discuss the tools to characterize the nanoparticles.	K2,K3
CO5	Analyze the advanced applications of nanomaterials.	K3,K4

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	-	-	-	-	-	3	1	2
CO2	3	3	-	2	-	-	-	-	-	-	3	1	1
CO3	3	3	-	-	-	-	-	-	-	-	3	2	1
CO4	3	3	-	2	-	-	-	-	-	-	3	2	2
CO5	3	3	-	3	-	-	-	-	-	-	3	3	2

COURSE DESCRIPTORS

Title of the Course	MOLECULAR SPECTROSCOPY	Hours/Week	05
Course Code	APECH15B	Credits	03
Category	ELECTIVE - II	Year & Semester	I & I
Prerequisites	Basic Knowledge of Spectroscopy	Regulation	2024

Objectives of the course:

This course aims at providing knowledge on

- To understand the influence of rotation and vibrations on the spectra of the polyatomic molecules.
- To study the principle of Raman spectroscopy, ESR spectroscopy, EPR spectroscopy and fragmentation patterns in Mass spectroscopy.
- To highlight the significance of Franck-Condon principle to interpret the selection rule, intensity and types of electronic transitions.
- To interpret the first and second order NMR spectra in terms of splitting and coupling patterns using correlation techniques such as COSY, HETCOR, NOESY.
- To carry out the structural elucidation of molecules using different spectral techniques.

UNITS	Contents	COs	Cognitive Levels
UNIT-I	**Rotational and Raman Spectroscopy:** Rotational spectra of diatomic and polyatomic molecules. Intensities of rotational spectral lines, effect of isotopic substitution. Non-rigid rotators. Classical theory of the Raman effect, polarizability as a tensor, polarizability ellipsoids, quantum theory of the Raman effect, Pure rotational Raman spectra of linear and asymmetric top molecules, Stokes and anti-Stokes lines. Vibrational Raman spectra, Raman activity of vibrations, rule of mutual exclusion, rotational fine structure-O and S branches, Polarization of Raman scattered photons.	CO1	K1 K2

UNIT-II	**Vibrational Spectroscopy:** Vibrations of molecules, harmonic and anharmonic oscillators-vibrational energy expression, energy level diagram, vibrational wave functions and their symmetry, selection rules, expression for the energies of spectral lines, computationof intensities, hot bands, effect of isotopic substitution. Diatomic vibrating rotor, vibrational-rotational spectra of diatomic molecules, P, R branches, breakdown of the Born-Oppenheimer approximation. Vibrations of polyatomic molecules – symmetry properties, overtone and combination frequencies. Influence of rotation on vibrational spectra of polyatomic molecule, P, Q, R branches, parallel and perpendicular vibrations of linear and symmetric top molecules.	CO2	K2 K3
UNIT-III	**Electronic spectroscopy:** Electronic Spectroscopy: Electronic spectroscopy of diatomic molecules, Frank-Condon principle, dissociation and pre dissociation spectra. $\pi \rightarrow \pi^*$, $n \rightarrow \pi^*$ transitions and their selection rules. Photoelectron Spectroscopy: Basic principles, photoelectron spectra of simple molecules, X-ray photoelectron spectroscopy (XPS). Lasers: Laser action, population inversion, properties of laser radiation, examples of simple laser systems.	CO3	K3 K4 K5
UNIT-IV	**NMR and ESR spectroscopy:** Chemical shift, Mechanism of shielding and de-shielding. Spin systems: Simplification of complex spectra. Spin-spin interactions: Homonuclear coupling interactions - AX, AX2, AB types. Vicinal, germinal and long-range coupling-spin decoupling. Nuclear Overhauser effect (NOE), Factors influencing coupling constants and Relative intensities. 13CNMR and structural correlations, Satellites. ESR spectroscopy Characteristic features of ESR spectra, line shapes and line widths; The g value and the hyperfine coupling parameter (A). Interpretation of ESR spectra and structure elucidation of organic radicals using ESR spectroscopy; Spin orbit coupling and significance of g tensors, zero/non-zero field splitting, Kramer's degeneracy.	CO4	K3 K4 K5

UNIT-V	**Mass Spectrometry, EPR and Mossbauer Spectroscopy:** Ionization techniques- Electron ionization (EI), chemical ionization (CI), isotope abundance, molecular ion, fragmentation processes of organic molecules, deduction of structure through mass spectral fragmentation, high resolution. Effect of isotopes on the appearance of mass spectrum. EPR spectra of anisotropic systems - anisotropy in g value, causes of anisotropy, anisotropy in hyperfine coupling, hyperfine splitting caused by quadrupole nuclei. Principle of Mossbauer spectroscopy: Doppler shift, Isomer shift, Applications: Mossbauer spectra of high and low-spin Fe and Sn compounds.	CO5	K3 K4

Recommended Text Books

1. *C. N. Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy, 4th Ed., Tata McGraw Hill, New Delhi, 2000.*
2. *R. M. Silverstein and F. X. Webster, Spectroscopic Identification of Organic Compounds, 6th Ed., John Wiley & Sons, New York, 2003.*
3. *W. Kemp, Applications of Spectroscopy, English Language Book Society, 1987.*
4. *D. H. Williams and I. Fleming, Spectroscopic Methods in Organic Chemistry, 4th Ed., Tata McGraw-Hill Publishing Company, New Delhi, 1988.*
5. *R. S. Drago, Physical Methods in Chemistry; Saunders: Philadelphia, 1992.*

Reference Books

1. *P.W. Atkins and J. de Paula, Physical Chemistry, 7th Ed., Oxford University Press, Oxford, 2002.*
2. *I. N. Levine, Molecular Spectroscopy, John Wiley & Sons, New York, 1974.*
3. *A. Rahman, Nuclear Magnetic Resonance-Basic Principles, Springer-Verlag, New York,1986.*
4. *K. Nakamoto, Infrared and Raman Spectra of Inorganic and coordination Compounds, PartB: 5th ed., John Wiley& Sons Inc., New York, 1997.*
5. *J. A. Weil, J. R. Bolton and J. E. Wertz, Electron Paramagnetic Resonance; Wiley Interscience, 1994.*

Website and e-learning source

https://onlinecourses.nptel.ac.in/noc20_cy08/preview

https://www.digimat.in/nptel/courses/video/104106122/L14.html

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	Explain the importance of rotational and Raman spectroscopy.	K1,K2
CO2	Apply the vibrational spectroscopic techniques to diatomic and polyatomic molecules.	K2,K3
CO3	Evaluate different electronic spectrum of simple molecules using electronicspectroscopy.	K3,K4,K5
CO4	Predict the spectrum of 2D NMR – COSY, NOESY and ESR spectroscopic techniques.	K3,K4,K5
CO5	Describe the Mass Spectrometry, EPR and Mossbauer Spectroscopy techniques.	K3,K4

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	-	-	-	-	-	3	3	2
CO2	3	3	-	2	-	-	-	-	-	-	3	3	1
CO3	3	3	2	3	2	-	-	-	-	-	3	3	2
CO4	3	3	2	3	1	-	-	-	-	-	3	3	2
CO5	3	3	3	2	-	-	-	-	-	-	3	3	2

COURSE DESCRIPTORS

Title of the Course	ORGANIC REACTION MECHANISM - II	**Hours/Week**	06
Course Code	APCCH21	**Credits**	05
Category	Core - IV	**Year & Semester**	I & II
Prerequisites	Basic Concepts of Organic Chemistry	**Regulation**	2024

Objectives of the course:

This course aims to providing knowledge on

- Understand the concept of aromaticity in benzenoid, non-benzenoid, heterocyclic and annulene compounds.
- Understand the mechanism involved in various types of organic reactions with evidences.
- Understand the applications of synthetically important reagents.
- Correlate the reactivity between aliphatic and aromatic compounds.
- Design synthetic routes for organic molecule synthesis.

UNITS	Contents	COs	Cognitive Levels
UNIT-I	**Elimination and Free Radical Reactions** Mechanisms: E2, E1, and E1cB mechanisms. Syn- and anti-eliminations. Orientation of the double bond: Hoffmann and Saytzeff rules. Reactivity: Effect of substrate, attacking bases, leaving group and medium. Stereochemistry of eliminations in acyclic and cyclic systems, pyrolytic elimination. Long lived and short-lived radicals – Production of radicals by thermal and photochemical reactions, Detection and stability of radicals, characteristics reactions of radicals; polymerization, addition, halogenations, aromatic substitutions, rearrangements. Reactivity: Reactivity on aliphatic, aromatic substrates, effect of solvent.	CO1	K1,K2, K3,K4
UNIT-II	**Oxidation and Reduction Reactions** Mechanisms: Direct electron transfer, hydride transfer, hydrogen transfer, displacement, addition-elimination, oxidative and reductive coupling reactions. Mechanism of oxidation reactions: Dehydrogenation by quinones, selenium dioxides, permanganate, manganese dioxide, osmium tetroxide, oxidation of saturated hydrocarbons, alkyl groups, alcohols, halides and amines. DMSO-Oxalyl chloride (Swern oxidation) and Corey-Kim oxidation, dimethyl sulphoxide- dicyclohexyl carbodiimide (DMSO-DCCD). Mechanism of reduction reactions: Wolff- Kishner, Clemmenson, Rosenmund - reduction with Trialkyl and triphenyl tin hydrides, McFadyen-Steven's reduction, Homogeneous hydrogenation, MPV and Bouveault-Blanc reduction.	CO1 CO2	K1,K2,K3

UNIT-III	**Rearrangements** Rearrangements to electron deficient carbon: Pinacol-pinacolone and semi-pinacolone rearrangements -applications and stereochemistry, Wagner-Meerwein, Demjanov, Dienone-phenol, Baker- Venkataraman, Benzilic acid and Wolff rearrangements. Rearrangements to electron deficient nitrogen: Hofmann, Curtius, Schmidt, Lossen, Beckmann. Rearrangements to electron deficient oxygen: Baeyer-Villiger oxidation &Dakin rearrangements. Rearrangements to electron rich atom: Favorskii, Stevens, [1,2]-Wittig and [2,3]-Wittig rearrangements. Fries and Photo Fries rearrangement.	CO3	K1,K2,K3
UNIT-IV	**Addition to Carbon Multiple Bonds** Mechanisms: (a) Addition to carbon-carbon multiple bonds- Addition reactions involving electrophiles, nucleophiles, free radicals, carbenes and cyclic mechanisms- Orientation and reactivity, hydrogenation of double and triple bonds, Michael reaction, addition of oxygen and Nitrogen; (b) Addition to carbon- hetero atom multiple bonds: Mannich reaction, acids, esters, nitrites, addition of Grignard reagents, Wittig reaction, Prinsreaction. Stereochemical aspects of addition reactions. Addition of Grignard reagents, organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compounds. Mechanism of condensation reactions involving enolates – Stobbe reactions.	CO1 CO2 CO4	K1,K2, K3,K4, K5
UNIT-V	**Reagents and Modern Synthetic Reactions** Lithium diisopropylamine (LDA), Azobisisobutyronitrile (AIBN), Sodium cyanoborohydride ($NaBH_3CN$), *meta*-Chloroperbenzoic acid (m-CPBA), Dimethyl aminiopyridine (DMAP), Triethylamine (TEA), Diazobicyclo[5.4.0]undec-7-ene (DBU), Diethylazodicarboxylate (DEAD), *N*-bromosuccinimide (NBS), Tetramethyl piperiridin-1-oxyl (TEMPO), Phenyltrimethylammonium tribromide (PTAB).Diazomethane and Zn-Cu, Suzuki coupling, Heck reaction, Negishi reaction, Baylis-Hillman reaction.	CO5	K1,K2,K3

Recommended Text Books

1. *J. March and M. Smith, Advanced Organic Chemistry, 5th ed., John-Wiley and Sons.2001.*
2. *E. S. Gould, Mechanism and Structure in Organic Chemistry, Holt, Rinehart and Winston Inc.,1959.*
3. *Peter Sykes, Guidebook to Mechanism in Organic Chemistry (6th Edition).*
4. *P. S. Kalsi, Stereochemistry of carbon compounds, 8th edn, New Age International Publishers,2015.*
5. *P. Y.Bruice, Organic Chemistry, 7th edn.,Prentice Hall, 2013.*
6. *R. T. Morrison, R. N. Boyd, S. K. BhattacharjeeOrganic Chemistry, 7th edn., Pearson Education,2010.*

Reference Books

1. *S. H. Pine, Organic Chemistry, 5th edn, McGraw Hill International Editionn,1987.*
2. *L. F. Fieser and M. Fieser, Organic Chemistry, Asia Publishing House, Bombay,2000.*
3. *E.S. Gould, Mechanism and Structure in Organic Chemistry, Holt, Rinehart and Winston Inc.,1959.*
4. *T. L. Gilchrist, Heterocyclic Chemistry, Longman Press, 1989.*
5. *J. A. Joule and K. Mills, Heterocyclic Chemistry, 4th edn., John- Wiley,2010.*
6. *V.K. Ahluwalia & Rakesh K. Parashar, Organic Reaction Mechanisms , 4th edn.*

Website and e-learning source

1) *https://sites.google.com/site/chemistryebookscollection02/home/organ ic-chemistry/organic*
2) *https://www.organic-chemistry.org/*

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	Predict the factors affecting elimination reactions and stability of free radicals	K1,K2,K3,K4
CO2	Explain the Mechanism of oxidation and reduction reactions.	K1,K2,K3
CO3	Discuss the Rearrangement reaction mechanism in electron deficient carbon, nitrogen atoms and electron rich atoms.	K1,K2,K3
CO4	Review the different types of Addition Mechanisms to multiple bonds	K1,K2,K3,K4, K5
CO5	Discuss the importance of Reagents in Modern Synthetic Reactions	K1,K2,K3

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	-	-	-	-	3	3	2	2
CO2	3	3	2	2	1	-	-	-	-	2	3	3	2
CO3	3	3	2	2	-	-	-	-	-	2	3	2	2
CO4	3	3	3	3	3	-	-	-	-	3	3	3	2
CO5	3	3	3	2	2	-	-	-	-	2	3	2	2

COURSE DESCRIPTORS

Title of the Course	PHYSICAL CHEMISTRY-I	**Hours/Week**	06
Course Code	APCCH22	**Credits**	05
Category	Core-V	**Year & Semester**	I & II
Prerequisites	Basic concepts in Physical Chemistry	**Regulation**	2024

Objectives of the course:

This course aims to providing knowledge on

- Remember the fundamentals of thermodynamics and the composition of partial molar quantities.
- Understand the classical and statistical approach of the functions.
- Compare the significance of Maxwell-Boltzman, Fermi-Dirac and Bose-Einstein
- Correlate the theories of reaction rates for the evaluation of thermodynamic parameters.
- Analyze the mechanism and kinetics of reactions.

UNITS	Contents	COs	Cognitive Levels
UNIT-I	**Classical Thermodynamics** Partial molar properties- Chemical potential, Gibb's-Duhem equation-binary and ternary systems. Determination of partial molar quantities. Thermodynamics of real gases - Fugacity- determination of fugacity by graphical and equation of state methods-dependence of temperature, pressure and composition. Thermodynamics of ideal and non-ideal binary mixtures, Duhem - Margulus equation applications of ideal and non-ideal mixtures. Activity and activity coefficients-standard states - Determination - vapour pressure, EMF and freezing point methods.	CO1	K1,K2,K3, K4,K5
UNIT-II	**Statistical Thermodynamics I** Introduction of statistical thermodynamics concepts of thermodynamic and mathematical probabilities distribution of distinguishable and non- distinguishable particles. Maxwell - Boltzmann, Fermi Dirac & Bose-Einstein Statistics- comparison and applications. Partition functions-evaluation of translational, vibrational and rotational partition functions for monoatomic, diatomic and polyatomic ideal gases.	CO2	K1,K2,K3,K4

UNIT-III	**Statistical thermodynamics II** Thermodynamic functions in terms of partition functions-calculation of equilibrium constants. Statistical approach to Thermodynamic properties: pressure, internal energy, entropy, enthalpy, Gibb's function, Helmholtz function residual entropy, equilibrium constants and equipartition principle. Heat capacity of mono and di atomic gases-ortho and para hydrogen. Heat capacity of solids-Einstein and Debye models.	CO2 CO3	K1,K2,K3
UNIT-IV	**Irreversible Thermodynamics:** Theories of conservation of mass and energy entropy production in open systems by heat, matter and current flow, force and flux concepts. Onsager theory-validity and verification- Onsager reciprocal relationships. Electro kinetic and thermo mechanical effects-Application of irreversible thermodynamics to biological systems.	CO4	K1,K2,K3
UNIT-V	**Kinetics of Reactions- Complex and fast reactions** Factors determine the reaction rates in solution - primary salt effect and secondary salt effect. Chain reactions-chain length, kinetics of $H_2 - Cl_2$ & $H_2 - Br_2$ reactions (Thermal and Photochemical reactions) - Rice Herzfeld mechanism. Study of fast reactions-relaxation methods-temperature and pressure jump methods electric and magnetic field jump methods -stopped flow flash photolysis methods and pulse radiolysis. Kinetics of polymerization-free radical, cationic, anionic polymerization.	CO5	K1,K2,K3,K4

Recommended Text Books

1. *J. Rajaram and J.C. Kuriacose, Thermodynamics for Students of Chemistry, 2nd edition, S.L.N. Chand and Co., Jalandhar, 1986.*
2. *I.M. Klotz and R.M. Rosenberg, Chemical thermodynamics, 6th edition, W.A.BenjaminPublishers, California, 1972.*
3. *M.C. Gupta, Statistical Thermodynamics, New Age International, Pvt. Ltd., New Delhi,1995.*
4. *K.J. Laidler, Chemical Kinetics, 3rd edition, Pearson, Reprint - 2013.*
5. *J. Rajaram and J.C. Kuriokose, Kinetics and Mechanisms of chemical transformation, Macmillan India Ltd, Reprint – 2011.*

Reference Books

1. *D.A. Mcqurrie and J.D. Simon, Physical Chemistry - A Molecular Approach, Viva Books Pvt. Ltd., New Delhi, 1999.*
2. *R.P. Rastogi and R.R. Misra, Classical Thermodynamics, Vikas Publishing, Pvt. Ltd., New Delhi, 1990.*
3. *S.H. Maron and J.B. Lando, Fundamentals of Physical Chemistry, Macmillan Publishers, New York, 1974*
4. *K.B. Ytsiimiriski, "Kinetic Methods of Analysis", Pergamom Press, 1996.*
5. *Gurdeep Raj, Phase rule, Goel Publishing House, 2011.*

Website and e-learning source

1. https://nptel.ac.in/courses/104/103/104103112/
2. https://bit.ly/3tL3GdN

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	Determine the Fugacity of real gases and partial molar quantities.	K1,K2,K3,K4,K5
CO2	Evaluate translational, vibrational and rotational partition functions.	K1,K2,K3,K4
CO3	Discuss the statistical approach to Thermodynamic properties.	K1,K2,K3
CO4	Explain the validity and verification of Onsager theory.	K1,K2,K3
CO5	Distinguish the Thermal and Photochemical reactions.	K1,K2,K3,K4

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	3	3	3	-	-	-	-	3	3	2	2
CO2	3	2	3	2	3	-	-	-	-	2	3	2	2
CO3	3	3	2	1	2	-	-	-	-	2	3	3	2
CO4	3	3	3	3	3	-	-	-	-	1	3	2	2
CO5	3	3	3	3	1	-	-	-	-	1	3	1	1

COURSE DESCRIPTORS

Title of the Course	Inorganic Chemistry Practical	Hours/Week	06
Course Code	APCPCH23	Credits	04
Category	Core Practical	Year & Semester	I & II
Prerequisites	Basic concepts of Inorganic Chemistry	Regulation	2024

Objectives of the course:

This course aims to providing knowledge on

- Understand and enhance the visual observation as an analytical tool for the quantitative estimation of ions.
- Analysis of group separation of metal ions in given inorganic mixture.
- Remember the principle and theory in preparing standard solutions.
- Estimate metal ions, present in the given solution accurately without using instruments.
- Determine the amount of ions, present in a binary mixture accurately.

UNITS	Contents	COs	Cognitive Levels
UNIT-I Compulsory	**Analysis of mixture of cations:** Analysis of a mixture of four cations containing two common cations and two rare cations. Cations to be tested. Group-I : W, Tl and Pb. Group-II : Se, Te, Mo, Cu, Bi and Cd. Group-III : Tl, Ce, Zr, V, Cr, Fe & Ti Group-IV : Zn, Ni, Co and Mn. Group-V : Ca, Ba and Sr. Group-VI : Li and Mg.	CO1 CO2 CO3	K1,K2,K3, K4,K5
UNIT-II	**Preparation of metal complexes** Preparation of inorganic complexes: 1. Preparation of tristhioureacopper(I)sulphate 2. Preparation of potassium trioxalate chromate(III) 3. Preparation of tetramminecopper(II) sulphate 4. Preparation of Reineck's salt 5. Preparation of hexathioureacopper(I) chloridedihydrate 6. Preparation of cis-Potassium tri oxalate diaquachromate(III) 7. Preparation of sodium trioxalatoferrate(III) 8. Preparation of hexathiourealead(II) nitrate	CO4	K1,K2,K3

UNIT-III (Unit II and III Choose any three)	**Complexometric Titration:** 1. Estimation of zinc, nickel, magnesium, and calcium. 2. Estimation of mixture of metal ions-pH control, masking and de- masking agents. 3. Determination of calcium and lead in a mixture (pH control). 4. Determination of manganese in the presence of iron. 5. Determination of nickel in the presence of iron.	CO5	K1,K2 K3, K4, K5

Recommended Text Books

1. *A. Jeya Rajendran, Micro analytical Techniques in Chemistry: Inorganic Qualitative Analysis, United global publishers, 2021.*
2. *V. V. Ramanujam, Inorganic Semimicro Qualitative Analysis; 3rded.,The National Publishing Company, Chennai, 1974.*
3. *Vogel's Text book of Inorganic Qualitative Analysis, 4thed., ELBS, London.*

Reference Books

1. *G. Pass, and H. Sutcliffe, Practical Inorganic Chemistry; Chapman Hall, 1965.*
2. *W. G. Palmer, Experimental Inorganic Chemistry; Cambridge University Press, 1954.*
3. *Inorganic Chemistry Lab Manual for Semi micro Qualitative Analysis, Quantitative Analysis and Preparation of Inorganic Complexes. Department of Chemistry, KMG College of Arts And Science (AUTONOMOUS), Gudiyatham, 635803 (Private circulation).*

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	Analyze the group separation and confirm the metal ions.	K1,K2,K3,K4,K5
CO2	Discuss the conformation reactions of different metal ions	K1,K2,K3,K4
CO3	Distinguish the common and rare cations	K1,K2,K3,K4,K5
CO4	Prepare the different inorganic complexes	K1,K2,K3
CO5	Estimate the metal ions present in given solution using titration process.	K1,K2,K3,K4,K5

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	3	2	3	-	-	-	-	2	3	2	2
CO2	3	3	1	2	2	-	-	-	-	2	3	2	1
CO3	3	3	3	3	1	-	-	-	-	-	3	-	-
CO4	3	3	-	-	-	-	-	-	-	-	3	2	2
CO5	3	3	3	3	3	-	-	-	-	3	3	2	2

SCHEME OF VALUATION

QUALITATIVE AND QUANTITATIVE

INORGANIC ANALYSIS

Internal assessment: 25 Marks

External assessment: 75 marks

Total: 100 marks

Max. Marks: 75

Record : 05 Marks

Viva : 10 Marks

Inorganic Analysis : 30 Marks

Group conformation : 10 Marks (4 * 2.5 = 10)

Report : 20 Marks (4 * 5 = 20)

Inorganic Preparation : 10 Marks (Quantity: 05 & Quality: 05)

Inorganic Estimation : 20 Marks

Error upto	2%	:	20 Marks.
	2 to 3 %	:	17 Marks.
	3 to 4 %	:	15 Marks.
	4 to 5 %	:	12 Marks.
	> 5 %	:	07 Marks.
	No calculation	:	05 Marks.
	Arithmetic error	:	Deduct 5 mark.
	Wrong calculation	:	Deduct 5 marks scored.

COURSE DESCRIPTORS

Title of the Course	MEDICINAL CHEMISTRY	Hours/Week	04
Course Code	APECH24A	Credits	03
Category	ELECTIVE - III	Year & Semester	I & II
Prerequisites	Basic Knowledge on Medicinal Chemistry	Regulation	2024

Objectives of the course:

This course aims at providing knowledge on

- To study the chemistry behind the development of pharmaceutical materials. To gain knowledge on mechanism and action of drugs.
- To understand the need of antibiotics and usage of drugs.
- To familiarize with the mode of action of diabetic agents and treatment of diabetes.
- To identify and apply the action of various antibiotics.

UNITS	Contents	COs	Cognitive Levels
UNIT-I	**Introduction to receptors** Introduction, targets, Agonist, antagonist, partial agonist. Receptors, Receptor types, Theories of Drug – receptor interaction, Drug synergism, Drug resistance, physicochemical factors influencing drug action.	CO1 CO2 CO3	K1,K2,K3, K4,K5
UNIT-II	**Antibiotics** Introduction, Targets of antibiotics action, classification of antibiotics, enzyme-based mechanism of action, SAR of penicllins and tetracyclins, clinical application of penicillins, cephalosporin. Current trends in antibiotic therapy.	CO1 CO2 CO3	K1,K2, K3,K4
UNIT-III	**Antihypertensive agents and diuretics** Classification of cardiovascular agents, introduction to hypertension, etiology, types, classification of antihypertensive agents, classification and mechanism of action of diuretics, Furosemide, Hydrochlorothiazide, Amiloride.	CO1 CO2 CO3	K1,K2,K3, K4,K5

UNIT-IV	**Analgesics, Antipyretics and Anti-inflammatory Drugs** Introduction, Mechanism of inflammation, classification and mechanism of action and paracetamol, Ibuprofen, Diclofenac, naproxen, indomethacin, phenylbutazone and meperidine. Medicinal Chemistry of Antidiabetic Agents Introduction, Types of diabetics, Drugs used for the treatment, chemical classification, Mechanism of action, Treatment of diabetic mellitus. Chemistry of insulin, sulfonyl urea.	CO3 CO4	K1,K2,K3, K4,K5
UNIT-V	**Traditional Indian Medicine system** Introduction to Ayurveda, Siddha, Unani, Homeopathy & Sowa- Rigpa Systems and Traditional Formulations - Important Medicinal Plants mentioned in ancient – Nochi, Adathoda, Tulasi, Vallarai, Sirukurunjan, Amla, Shatavari, Moringa, Punarnava - Agro-techniques of Few Aromatic Plants - AYUSH Products, food, nutraceuticals, cosmetics and agrochemicals, - Case Study: Value added products of Neem, Aloe, Licorice, Ashwagandha.	CO4 CO5	K1,K2,K3, K4,K5

Recommended Text Books

1. *Wilson and Gisvold's textbook of organic medicinal and pharmaceutical chemistry,*
2. *Wilson, Charles Owens: Beale, John Marlowe; Block, John H, Lipincott William, 12th edition, 2011.*
3. *Graham L. Patrick, An Introduction to Medicinal Chemistry, 5th edition, Oxford University Press, 2013. Jayashree Ghosh, A text book of Pharmaceutical Chemistry, S.Chandand Co.Lt d, 1999, edn.*
4. *O. LeRoy, Natural and synthetic organic medicinal compounds, Ealemi, 1976.*
5. *S. Ashutosh Kar, Medicinal Chemistry, Wiley Eastern Limited, NewDelhi, 1993, New edn.*
6. *H. Panda.The Complete Technology Book on Herbal Beauty Products with Formulations and Processes. NIIR Project Consultancy Services. 2005*
7. *Khadabadi SS, Deore SL, Baviskar BA. Experimental Phytopharmacognosy. Nirali Prakashan, Pune. 1st Edition, 2019.*
8. *Deore SL, Khadabadi SS, BaviskarBA. Pharmacognosy and Phytochemistry-A Comprehensive Approach. PharmMed Press, Hyderabad. 2nd Edition, 2018.*

Reference Books

1. *Foye's Princles of Medicinal Chemistry, Lipincott Williams, Seventh Edition, 2012*
2. *Burger's Medicinal Chemistry, Drug Discovery and Development, Donald J. Abraham, David P. Rotella, Alfred Burger, Academic press, 2010.*
3. *WilsonandGisvold'sTextbookofOrganicMedicinalandPharmaceuticalChe mistry,John M.BealeJrandJohnM. Block, Wolters Kluwer, 2011,12th edn.*
4. *P.Parimoo,ATextbookofMedicalChemistry,NewDelhi:CBSPublishers.199*
5. *S. Ramakrishnan, K.G. Prasannanand R.Rajan, Text book of Medical Biochemistry, Hyderaba d: OrientLongman.3rd edition, 2001.*

Website and e-learning source

1. https://www.ncbi.nlm.nih.gov/books/NBK482447/
2. https://training.seer.cancer.gov/treatment/chemotherapy/types.html
3. https://www.classcentral.com/course/swayam-medicinal-chemistry-12908

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	Predict a drugs properties based on its structure.	K1,K2,K3,K4,K5
CO2	Describe the factors that affects drug design.	K1,K2,K3,K4
CO3	Explain the relationship between drug's chemical structure and its therapeutic properties.	K1,K2,K3
CO4	Designed to give the knowledge of different theories in drug actions at molecular level	K1,K2,K3,K4,K5
CO5	Identify different targets for the development of new drugs for the treatment of infectious and GIT.	K1,K2,K3,K4,K5

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	-	-	-	-	3	3	2	1
CO2	3	3	2	2	2	-	-	-	-	2	3	2	2
CO3	3	3	2	2	2	-	-	-	-	2	3	2	1
CO4	3	3	2	2	2	-	-	-	-	1	3	2	2
CO5	3	3	2	2	2	-	-	-	-	2	3	2	1

COURSE DESCRIPTORS

Title of the Course	GREEN CHEMISTRY	Hours/Week	04
Course Code	APECH24B	Credits	03
Category	ELECTIVE - III	Year & Semester	I & II
Prerequisites	Basic Knowledge of Chemistry	Regulation	2024

Objectives of the course:

This course aims to providing knowledge on

- The Principles of green chemistry.
- Green solutions for chemical energy storage and conversion.
- Green solutions for industrial production of Petroleum and Petrochemicals.
- Solutions for pollution prevention in Industrial chemical and fuel production, automotive industry and Shipping industries.
- Green solutions for industrial production of Surfactants, Organic and Inorganic Chemicals.

UNITS	Contents	COs	Cognitive Levels
UNIT-I	Introduction - Need for Green Chemistry. Goals of Green Chemistry. Limitations/ of Green Chemistry. Chemical accidents, terminologies, International green chemistry organizations and Twelve principles of Green Chemistry with examples.	CO1	K1,K2,K3
UNIT-II	Choice of starting materials, reagents, catalysts and solvents in detail, Green chemistry in day today life. Designing green synthesis- green reagents: dimethyl carbonate. Green solvents: Water, Ionic liquids- criteria, general methods of preparation, effect on organic reaction. Supercritical carbon dioxide- properties, advantages, drawbacks and a few examples of organic reactions in Super Critical CO_2. Green synthesis - Adipic acid and catechol.	CO1 CO2	K1,K2, K3,K4
UNIT-III	Environmental pollution, Green Catalysis-Acid catalysts, Oxidation catalysts, Basic catalysts, Polymer supported catalysts - Poly styrene aluminum chloride, polymeric super acid catalysts, Poly supported photosensitizers.	CO1 CO3	K1,K2,K3
UNIT-IV	Phase transfer catalysis in green synthesis-oxidation using hydrogen peroxide, crown ethers-esterification, saponification, anhydride formation, Elimination reaction, Displacement reaction. Applications in organic synthesis.	CO1 CO3 CO4	K1,K2,K3

UNIT-V	Micro wave induced green synthesis-Introduction, Instrumentation, Principle and applications. Sonochemistry – Instrumentation, Cavitation theory - Ultra sound assisted green synthesis and Applications.	CO5	K1,K2, K3,K4

Recommended Text Books

1. *Ahluwalia, V.K. and Kidwai, M.R. New Trends in Green Chemistry, Anamalaya Publishers, 2005.*
2. *W. L. McCabe, J.C. Smith and P. Harriott, Unit Operations of Chemical Engineering, 7th edition, McGraw-Hill, New Delhi,2005.*
3. *J. M. Swan and D. St. C. Black, Organometallics in Organic Synthesis, Chapman Hall, 1974.*
4. *V. K. Ahluwalia and R. Aggarwal, Organic Synthesis: Special Techniques, Narosa Publishing House, New Delhi, 2001.*
5. *A. K. De, Environmental Chemistry, New Age Publications, 2017.*

Reference Books

1. *Anastas, P.T. and Warner, J.K. Oxford Green Chemistry -Theory and Practical, University Press, 1998*
2. *Matlack, A.S. Introduction to Green Chemistry, Marcel Dekker, 2001*
3. *Cann, M.C. and Connely, M.E. Real-World Cases in Green Chemistry, American Chemical Society, Washington, 2000*
4. *Ryan, M.A. and Tinnesand, M., Introduction to Green Chemistry, American Chemical Society Washington, 2002.*
5. *Chandrakanta Bandyopadhyay, An Insight into Green Chemistry, Books and Allied (P) Ltd, 2019.*

Website and e-learning source

1. https://www.organic-chemistry.org/
2. https://www.studyorgo.com/summary.php

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	Explain the Principles of Green Chemistry.	K1,K2,K3
CO2	Design Green Chemical reactions using Supercritical carbon dioxide.	K1,K2,K3,K4
CO3	Discuss the different types of catalyst in Green Chemical reactions.	K1,K2,K3
CO4	Utilize the Green Chemical reactions in organic Synthesis	K1,K2,K3
CO5	Explain the different synthetic methods in Green Chemistry	K1,K2,K3,K4

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	-	-	-	-	3	3	2	3
CO2	3	3	3	3	3	-	-	-	-	3	3	3	3
CO3	3	3	2	2	-	-	-	-	-	1	3	2	1
CO4	3	3	3	-	-	-	-	-	-	3	3	2	2
CO5	3	3	3	2	3	-	-	-	-	3	3	1	1

COURSE DESCRIPTORS

Title of the Course	**BIO-INORGANIC CHEMISTRY**	**Hours/Week**	04
Course Code	APECH25A	**Credits**	03
Category	ELECTIVE - IV	**Year & Semester**	I & II
Prerequisites	**Basic knowledge of Inorganic Chemistry**	**Regulation**	2024

Objectives of the course:

This course aims to providing knowledge on

- Understand the role of trace elements.
- Understand the biological significance of iron, sulpur.
- Study the toxicity of metals in medicines.
- Have knowledge on diagnostic agents.
- Discuss on various metalloenzymes and its properties.

UNITS	Contents	COs	Cognitive Levels
UNIT-I	**Essential trace elements** Selective transport and storage of metal ions: Ferritin, Transferrin and sidorphores; Sodium and potassium transport, Calcium signalling proteins. Metalloenzymes: Zinc enzymes– carboxypeptidase and carbonic anhydrase. Ironenzymes–catalase, peroxidase. Copperenzymes – superoxide dismutase, Plastocyanin, Ceruloplasmin, Tyrosinase. Coenzymes - Vitamin-B12 coenzymes.	CO1	K1,K2,K3
UNIT-II	**Transport Proteins** Oxygen carriers-Hemoglobin and myoglobin - Structure and oxygenation Bohr Effect. Binding of CO, NO, CN– to Myoglobin and Hemoglobin. Biological redox system: Cytochromes-Classification, cytochrome a, b and c. Cytochrome P-450. Non-heme oxygen carriers-Hemerythrin and hemocyanin. Iron-sulphur proteins- Rubredoxin and Ferredoxin- Structure and classification.	CO1 CO2	K1,K2,K3
UNIT-III	**Nitrogen fixation** Introduction, types of nitrogen fixing microorganisms. Nitrogenase enzyme - Metal clusters in nitrogenase- redox property - Dinitrogen complexes transition metal complexes of dinitrogen - nitrogen fixation via nitride formation and reduction of dinitrogen to ammonia. Photosynthesis:photosystem-I and photosystem-II-chlorophylls structure and function.	CO3	K1,K2

UNIT-IV	**Metals in medicine** Metal Toxicity of Hg, Pb, As. Therapeutic Compounds: Vanadium-Based Diabetes Drugs; Platinum-Containing Anticancer Agents. Chelation therapy; Cancer treatment. Diagnostic Agents: Technetium Imaging Agents; Gadolinium MRI Imaging Agents. Temperature and critical magnetic Field.	CO1 CO2 CO4	K1,K2 K3,K4
UNIT-V	**Enzymes** Introduction and properties -nomenclature and classification. Enzyme kinetics, free energy of activation and the effects of catalysis. Michelis - Menton equation - Effect of pH, temperature on enzyme reactions. Factors contributing to the efficiency of enzyme.	CO1 CO5	K1,K2 K3,K4

Recommended Text Books

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

Reference Books

1. *M. Satake and Y.Mido, Bioinorganic Chemistry - Discovery Publishing House, New Delhi (1996).*
2. *M.N. Hughes, 1982, The Inorganic Chemistry of Biological processes, II Edition, Wiley London.*
3. *R. W. Hay, Bio Inorganic Chemistry, Ellis Horwood, 1987.*
4. *R. M. Roat-Malone, Bio Inorganic Chemistry, John Wiley, 2002.*
5. *T. M. Loehr, Iron carriers and Iron proteins, VCH, 1989.*

Website and e-learning source

1. https://www.pdfdrive.com/instant-notes-in-inorganic-chemistry- the-instant-notes-chemistry-series-d162097454.html
2. https://www.pdfdrive.com/shriver-and-atkins-inorganic-chemistry- 5th-edition-d161563417.html

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	Discuss the importance of trace elements and Metalloenzymes.	K1,K2,K3
CO2	Explain the function of Transport Proteins	K1,K2,K3
CO3	Understand about the uses of nitrogen fixation and photosynthetic mechanism	K1,K2
CO4	Analyze the Therapeutic uses and toxicity of metals in medicine.	K1,K2,K3,K4
CO5	Describe the role of enzymes in biological systems.	K1,K2,K3,K4

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	2	-	-	-	-	-	-	-	3	3	3
CO2	3	3	-	2	-	-	-	-	-	3	3	2	2
CO3	3	3	-	-	-	-	-	-	-	-	3	2	2
CO4	3	3	3	3	2	-	-	-	-	3	3	3	3
CO5	3	3	-	-	-	-	-	-	-	-	3	3	2

COURSE DESCRIPTORS

Title of the Course	MATERIAL SCIENCE AND NUCLEAR CHEMISTRY	Hours/Week	04
Course Code	APECH25B	Credits	03
Category	ELECTIVE - IV	Year & Semester	I & II
Prerequisites	Basic Knowledge of Nuclear Chemistry	Regulation	2024

Objectives of the course:

This course aims to providing knowledge on

- Understand the crystal structure, growth methods and X-ray scattering.
- Explain the optical, dielectric and diffusion properties of crystals.
- Recognize the basis of semiconductors, superconductivity materials and magnets.
- Study the synthesis, classification and applications of nanomaterials.
- Learn about the importance of materials used for renewable energy conversion.
- Understand the nuclear chemistry and nuclear energy

UNITS	Contents	COs	Cognitive Levels
UNIT-I	**Crystallography** Symmetry - unit cell and Miller indices - crystal systems - Bravais lattices - point groups and space groups - X- ray diffraction-Laue equations-Bragg's law-reciprocal lattice and its application to geometrical crystallography. Crystal structure–powder and single crystal applications. Electron charge density maps, neutron diffraction-method and applications.	CO1	K1,K2
UNIT-II	**Crystal growth methods** Nucleation–equilibrium stability and metastable state. Single crystal –Low and high temperature, solution growth– Gel and sol-gel. Crystal growth methods – nucleation – equilibrium stability and metastable state. Single crystal – Low and high temperature, solution growth– Gel and sol-gel. Melt growth – Bridgeman - Stockbarger, Czochralski methods. Flux technique, physical and chemical vapour transport. Lorentz and polarization factor - primary and secondary extinctions.	CO2	K1,K2,K3

UNIT-III	**Materials for Renewable Energy Conversion** Solar Cells: Organic, bilayer, bulk heterojunction, polymer, perovskite based. Solar energy conversion: lamellar solids and thin films, dye-sensitized photo voltaic cells, coordination compounds anchored onto semiconductor surfaces - Ru(II) and Os(II) polypyridyl complexes. Photochemical activation and splitting of water, CO2 and N2. Manganese based photo systems for water-splitting. Complexes of Rh, Ru, Pd and Pt - photochemical generation of hydrogen from alcohol.	CO3	K1,K2,K3, K4,K5
UNIT-IV	**Nuclear Chemistry I:** Nuclear properties – Nuclear spin and Moments, origin of nuclear forces, Quark Theory for sub-atomic particles (basic). Salient features of the Shell and Liquid Drop Model of the nucleus. Modes of radioactive decay: Orbital electron capture; nuclear isomerism, internal conversion Isomeric Transition, detection and determination of activity by cloud chamber, Nuclear emulsion, Bubble chamber, Geiger Muller, Scintillation and Cherenkov counters. Compound Nucleus theory, high energy nuclear reactions, nuclear fission and fusion reactions as energy sources: direct reactions.	CO4	K1,K2,K3
UNIT-V	**Nuclear Chemistry II: Nuclear Reaction types, reaction,** Cross section, Q-value, threshold energy, Stellar energy: synthesis of elements, Hydrogen burning, Carbon burning. Photonuclear and Thermo nuclear reactions. Szilard Chalmers reaction. The e, s, r, p and x processes. Nuclear reactors- fast breeder reactors, particle accelerators, cyclotron and synchrotron. Radio analytical methods: Isotope dilution analysis, Radiometric titrations, Radio immuno assay, Neutron activation analysis.	CO4 CO5	K1,K2, K3,K4

Recommended Text Books

1. *S. Mohan and V. Arjunan, Principles of Materials Science, MJP Publishers, 2016.*
2. *Arumugam, Materials Science, Anuradha Publications, 2007.*
3. *Giacavazzo et. al., Fundamentals of Crystallography, International Union of Crystallography. Oxford Science Publications, 2010*
4. *James F. Shackelford and Madanapalli K. Muralidhara, Introduction to Materials Science for Engineers. 6th ed., PEARSON Press, 2007.*
5. *Essentials of nuclear chemistry by H.J. Arnikar, Eastern Wiley (1990)*
6. *Nuclear chemistry by Friedlander and Kennedy, John Wiley and Sons (1987)*

Reference Books

1. *Suggested Readings 1. M.G. Arora, Solid State Chemistry, Anmol Publications, New Delhi, 2001.*
2. *R.K. Puri and V.K. Babbar, Solid State Physics, S Chand and Company Ltd, 2001.*
3. *C. Kittel, Solid State Physics, John-Wiley and sons, NY, 1966.*
4. *H.P. Meyers, Introductory Solid State Physics, Viva Books Private Limited, 1998.*
5. *A.R. West, Solid State Chemistry and Applications, John-Wiley and sons, 1987.*
6. *Nuclear radiation detection by Price. Nuclear radiation detectors by*
7. *S.S. Kapoor and Ramamoorthy, Wiley Eastern (1986).*

Website and e-learning source

1. http://xrayweb.chem.ou.edu/notes/symmetry.html.
2. http://www.uptti.ac.in/classroom-content/data/unit%20cell.pdf.
3. https://bit.ly/3QyVg2R

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	Understand the importance of crystal structures in semiconductors, and renewable energy materials.	K1,K2
CO2	Explain the different types of crystal growth methods.	K1,K2,K3
CO3	Design and develop new materials with improved property for energy applications.	K1,K2,K3,K4,K5
CO4	Discuss the Salient features different nuclear models.	K1,K2,K3
CO5	Describe the fast breeder reactors and Radio analytical methods.	K1,K2,K3,K4

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	2	-	-	-	-	-	-	2	3	2	1
CO2	3	3	3	-	-	-	-	-	-	-	3	3	2
CO3	3	3	3	3	3	-	-	-	-	3	3	3	3
CO4	3	3	2	-	-	-	-	-	-	-	3	2	-
CO5	3	3	2	2	-	-	-	-	-	-	3	2	-

COURSE DESCRIPTORS

Title of the Course	INDUSTRIAL CHEMISTRY	Hours/Week	02
Course Code	APSCH26	Credits	02
Category	Skill Enhancement Course	Year & Semester	I & II
Prerequisites	Basic Knowledge of Industrial Chemistry	Regulation	2024

Objectives of the course:

This course aims to providing knowledge on

- Quality management concepts and principles in Control Techniques.
- Understanding the Distillation, Evaporation and Drying Process.
- Factors affecting the rate of filtration and choice of filter media.
- Metallurgical Extraction and refining of the metals.
- Necessity of Industrial Hygiene and Safety.

UNITS	Contents	COs	Cognitive Levels
UNIT-I	**Statistical Quality Control Techniques:** Quality Assurance: Elements of quality Assurance, Quality Management System Quality management concepts and principles: ISO 9001:2000 QMS Case studies on ISO 9001: 2000 in chemical industries. ISO 14000 Series of Standards. TQM in Chemical Industry. Six Sigma Approach to Quality: Applying Six Sigma to chemical Industries. Pharmaceutical Industries Accreditation of QC laboratories: Tools and Mechanisms ICH Guidelines on Drug substances and Products.	CO1	K1,K2
UNIT-II	**Distillation Unit Process:** Introduction, - types of distillation processes, concept of batch and continuous distillation, simple steam distillation, advantages and disadvantages of steam distillation, application of steam distillation in various chemical processes. Evaporation and Drying Introduction, factors affecting the rate of evaporation and choice of evaporators, application of evaporation in chemical process industries.	CO1 CO2	K1,K2, K3,K4
UNIT-III	**Purification and Filtration:** Introduction, filter media and filter aids, characteristics of ideal filter aids, factors affecting the rate of filtration and choice of filter media. Absorption Introduction, desorption or gas stripping, equipment-spray column for absorption. Material Balance Introduction, material balance equation without chemical reactions, flow/block diagrams for various industrially important chemical operations such as distillation, absorption and crystallization.	CO2 CO3	K1,K2,K3

UNIT-IV	**Metallurgical operations:** Definition, crushing and pulverization, concentration methods, gravity separation, magnetic concentration, froth flotation process, chemical methods- calcination and roasting, reduction using carbon and carbon monoxide, Alumino thermite reduction, auto reduction, reduction using precipitation method, refining methods polling, parting and electrolyte refining. Metallurgical Extraction and refining of the following metals from their important ores: Lead from galena, Aluminum from bauxite and Zinc from Zinc blende.	CO4	K1,K2,K3 K4,K5
UNIT-V	**Industrial hygiene & Safety:** Industrial hazards and Safety: Process hazards checklists, hazard surveys, safety program, Hazop safety reviews. Industrial pollution: Classification of hazards chemicals, storage, transportation, handling, risk assessments, challenges/solutions. Ecofriendly effluents disposal: Water pollutants, health hazards, sampling and analysis of water, water treatment, different industrial and domestic effluents and their treatment and disposal, advanced waste water treatment, effluent quality standards and laws, chemical industries, tannery, dairy, textile effluents, common treatment.	CO1 CO5	K1,K2, K3,K4

Recommended Text Books

1. *Physical chemistry by B.R Puri, I.R Sharma and M.S Pathania. Study Material in Vocational Subject to Industrial Chemistry (B.Sc. I, UGC) Sponsored (Text Book)*
2. *Principles of Extractive Metallurgy, Herbashi Vol. 1 and 2.*
3. *Introduction to Chemical Engineering W.L. Badger and J.T. Banchero, Mc Graw- Hill Book Co.,USA.*
4. *Unit Operations in Chemical Engineering W.L. McCabe and J.C Smith, Mc Graw- Hill Books co., New York.*
5. *Physical Chemistry, G.M. Barrow, Tata McGraw-Hill.*
6. *Riegel's Handbook of Industrial Chemistry, J.A. Kent, J.A.(ed), CBS Publishers, New Delhi.*
7. *Saxena Ruchi, Srivastava Alok Kumar, "Read & Do Practical Chemistry", Kitab Mahal, New Delhi, India (2016).*
8. *Skoog D. A., West. D.M and Holler .F.J., "Analytical Chemistry: An Introduction", 7 th edition, Saunders college publishing, Philadelphia (2010).*
9. *G. Larry Hargis, "Analytical Chemistry: Principles and Techniques" Pearson© (1988)*

Website and e-learning source

https://swayam.gov.in/

https://nptel.ac.in/courses/112/104/112104113/

https://onlinecourses.nptel.ac.in/noc19_ph14/preview

http://heecontent.upsdc.gov.in/Home.aspx

https://ncert.nic.in/textbook.php?kech1=0-7

https://www.labster.com/chemistry-virtual-labs/

http://chemcollective.org/vlab

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	Understand the quality management concepts and principles in Control Techniques	K1,K2
CO2	Separate the volatile samples using different types of distillation process	K1,K2,K3,K4
CO3	Discuss the industrially important chemical operations such as distillation, absorption and crystallization	K1,K2,K3
CO4	Extract and refine the metals from their important ores	K1,K2,K3,K4, K5
CO5	Design the Ecofriendly effluents disposal in industry	K1,K2,K3,K4

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	2	2	-	-	-	-	-	2	3	2	2
CO2	3	3	2	2	2	-	-	-	-	-	3	2	1
CO3	3	3	2	-	-	-	-	-	-	2	3	2	2
CO4	3	3	3	2	-	-	-	-	-	1	3	2	1
CO5	3	3	3	3	2	-	-	-	-	3	3	2	2

COURSE DESCRIPTORS

Title of the Course	COMPUTATIONAL CHEMISTRY	Hours/Week	02
Course Code	APSCH26	Credits	02
Category	Skill Enhancement Course	Year & Semester	I & II
Prerequisites	Basic Knowledge of Chemistry	Regulation	2024

Objectives of the course:

This course aims to provide

- Basics of Computers in Hardware and Software
- Understanding of basic programming
- Knowledge for the Applications of Computational Sciences in Chemistry
- Understanding in Input generation using coordinates and z matrix
- Skills in Cheminformatics and Molecular Modelling

UNITS	Contents	COs	Cognitive Levels
UNIT-I	**Basics of Computers:** Hardware and Software – Types of Languages: Higher level and lower languages, examples. BIOS and RAM: Significance. – Central Processing Unit and GPU Input Devices and Types of computing: Parallel and Sequential. Types: Personal Computers, Notebook, Workstation, Servers and Supercomputers- Definitions and examples. Storage Device: Magnetic tapes vs Solid State disks. Memory devices: OLED and OFET descriptions	CO1	K1,K2
UNIT-II	**Approach to computing:** Flowcharts: Significance of flowcharts and example to compute simple examples in chemistry like pH of a solution, Temperature conversion (F to C) and van der Waals' equation, First Order rate equation – all using BASIC programming. About useful programming languages for Chemistry: Examples C and C++ and Python (only introduction). Resources on the internet – Drawing of Chemical Structures and saving formats: ChemSketch and similar freeware. Online services for property prediction and internet basics (Example: Molinspiration)- Format conversions: OpenBabel.	CO1 CO2	K1,K2,K3

UNIT-III	**Applications of Computational Sciences in Chemistry:** Computational Quantum Chemistry and its applications, Prediction of Molecular Properties using Computational chemistry softwares, Overview of Quantum Chemistry Theories like HF, SCF and Approximation methods and their level of accuracy and hierarchy of computational requirements. Basis Sets used in computation. Overview of Computer aided Drug Design and prediction of Material properties. Analysis of optimized structure for geometry parameters like bond length, angle and torsional angle. Charge on the atoms – Mulliken, Lowdin and NBO charges and population.	CO1 CO2 CO3	K1,K2,K3, K4,K5
UNIT-IV	**Computational Methods and Software:** Molecular Dynamics, Semi-empirical methods, ab-initio and Density Functional Theory – Definitions and Significance. Introduction to Software available for all the above methods (Opensource like AMBER, MOPAC, GAMESS) including web based (online submission). Input generation using coordinates and z matrix. Generation of coordinates for Water, Hydrogen Peroxide, Formaldehyde, Methane, Ethane, Ethylene, Benzene and Aniline. Calculation of properties from these methods, including zero-point energy and reaction coordinates (description).	CO1 CO3 CO4	K1,K2,K3, K4,K5
UNIT-V	**Cheminformatics and Molecular Modelling:** Molecular descriptors to include HOMO, LUMO, Softness, Hardness, Dipole moment and log P. Fukui functions for predicting reactivity of molecules using FMO - Nucleophilicity and Electrophilicity - Band gap estimation in eV and their significance. QSAR and QSPR: Relating bio-reactivity with structure using simple IC 50 values. Use of Hammett-Taft equation and Lipinski Rule – Drug Designing basics to include action mechanism and using PDB structures for docking with software and Score prediction. Conformational Analysis – Ramachandran Plot. Protein Data Base and its significance.	CO2 CO3 CO4 CO5	K1,K2, K3,K4

Recommended Text Books

1. Molecular Modeling – Principles and Applications, A. R. Leach (Addison Wesley Longman)
2. Introduction to Computational Chemistry, F. Jensen (Wiley) Essentials of Computational Chemistry – Theories and Models, C. J. Cramer (Wiley)
3. Computational Chemistry – A Practical Guide for Applying Techniques to Real World Problems, David Young (Wiley)
4. Exploring Chemistry with Electronic Structure Methods, J. B. Foresman and A. Frisch (Gaussian Inc.)

Website and e-learning source

https://ocw.mit.edu/courses/5-04-principles-of-inorganic-chemistry-ii-fall-2008/pages/syllabus/

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	Understand the Basic Hardware and Software of Computer	K1,K2
CO2	Discuss the programming languages for Chemistry	K1,K2,K3
CO3	Predict the Molecular Properties using Computational Chemistry software	K1,K2,K3,K4,K5
CO4	Calculate the energy and reaction coordinates of molecules using Computational Software	K1,K2,K3,K4,K5
CO5	Utilize programming languages for Chemistry applications	K1,K2,K3,K4

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	-	-	-	-	2	3	2	1
CO2	3	3	2	-	-	-	-	-	-	3	3	3	2
CO3	3	3	3	3	2	-	-	-	-	-	3	2	2
CO4	3	3	3	3	3	-	-	-	-	3	3	2	2
CO5	3	3	2	2	-	-	-	-	-	-	2	2	1

COURSE DESCRIPTORS

Title of the Course	CHEMISTRY IN EVERYDAY LIFE	Hours/Week	02
Course Code	APSCH26	Credits	02
Category	Skill Enhancement Course	Year & Semester	I & II
Prerequisites	Basic Knowledge of Chemistry	Regulation	2024

Objectives of the course:

This course aims to

- Visualize the importance of Chemistry in daily life
- Know the agricultural chemistry
- Know about artificial sweetening agents and food preservatives
- Discuss the chemistry of cosmetics and perfumes.
- Understand the chemistry of polymers composites

UNITS	Contents	COs	Cognitive Levels
UNIT-I	**Principles of chemicals in daily life** Principles of chemistry cleanliness — soaps, detergents, household cleaning bleaches, tooth paste, shoe polish – composition and mechanism. Stains – Precautions in removal of stains, Removal of different Stains.	CO1	K1,K2
UNIT-II	**Daily use products** Preparations of Safety matches, Agarbathis, Napthalene balls, Wax candles, Fountain pen ink, Chalk crayons. Artificial sweetening agents and food preservatives.	CO1 CO2	K1,K2, K3,K4
UNIT-III	**Agricultural chemistry** Soil - Definition, Properties – pH, Texture, Acidity, Alkalinity, Soil water, Soil minerals, Soil fertility. Pesticides- Pest control methods – Mechanical, Biological, Environmental and Chemical. Pest control methods using chemicals – Sprays, Dust, Fumings, Aerosols and internal applications.	CO3	K1,K2,K3
UNIT-IV	**Perfumes and cosmetics** Perfumes – Production of natural perfumes, flower perfumes – Jasmine, Lily, Rose. Fruit flavours, Artificial flavours – Apple, Banana, Grape and Pine apple compounds. Facial make up kits, Lip stick and eye cosmetics.	CO4	K1,K2, K3,K4
UNIT-V	**Polymers composites** Necessity of composites , Role of matrix in composites – Matrix materials, reinforcements– Types of composites – Application of fibre composites – Smart composites – Functional sensor materials.	CO5	K1,K2,K3

Recommended Text Books

1. Industrial chemistry, B. K. Sharma
2. A Textbook of Chemical Technology, Shukla S. D and Pandey G. N
3. Chemistry of Pesticides, N.K. Rao
4. Industrial Chemsitry, Loutfy H. Madkour
5. Engineering chemistry, Jain and Jain

Reference Books

1. Industrial chemistry, B. K. Sharma
2. Introduction to Materials Management, by Steve Chapman, Ann K. Gatewood, Tony K. Arnold
3. Ullmann's Encyclopaedia of Industrial Chemistry, W. Gerhartz
4. Engineering chemistry, B.Sivashankar
5. Advanced Polymer Composites: Principles and Applications (Pdl Handbook Series), BorZ. Jang

Website and e-learning source

1.https://onlinelibrary.wiley.com/journal/15480569

2.https://www.sciencedirect.com/topics/materials-science/polymer-composite

3.https://en.wikipedia.org › wiki › Pesticide

4.npic.orst.edu › ingred › ptype

5.https://www.toppr.com/guides/science/soil/soil-and-soil-profile/

6.https://www.rsc.org › organic-chemistry-case-studies

7.https://en.wikipedia.org › wiki › Perfume

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	Understand the Principles of chemistry in daily usage chemicals.	K1,K2
CO2	Prepare the daily usage materials like Artificial sweetener and food preservatives.	K1,K2,K3,K4
CO3	Discuss the importance of chemistry in Agricultural process	K1,K2,K3
CO4	Prepare the Perfumes and cosmetics materials	K1,K2,K3,K4
CO5	Explain the Necessity of Polymers composites	K1,K2,K3

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	-	-	-	-	2	3	2	2
CO2	3	3	2	-	-	-	-	-	-	-	3	2	2
CO3	3	3	-	-	-	-	-	-	-	-	3	2	1
CO4	3	2	2	2	-	-	-	-	-	3	3	2	2
CO5	3	3	-	-	-	-	-	-	-	-	3	1	1

COURSE DESCRIPTORS

Title of the Course	RESEARCH TOOLS AND TECHNIQUES	Hours/Week	02
Course Code	APSCH26	Credits	02
Category	Skill Enhancement Course	Year & Semester	I & II
Prerequisites	Basic Knowledge of Chemistry	Regulation	2024

Objectives of the course:

This course aims to

- Understand the role of e-resources
- Understand the concepts of research – fundamental and industrial
- Learn the art of literature search
- Collect and understand references
- Discuss interpretation of data

UNITS	Contents	COs	Cognitive Levels
UNIT-I	**Introduction:** Objectives and motivations in research, Fundamental, experimental, industrial and Interdisciplinary research.	CO1	K1,K2,K3
UNIT-II	**Research:** Steps involved in selecting a research problem, criteria for ranking research topics, components, types, ethics, institutional ethical committee, plagiarism, patenting and intellectual property rights.	CO1 CO2	K1,K2
UNIT-III	**Techniques employed in literature search:** Google scholar, Web of science, SCOPUS, PUBMED, Science Direct, Research Gate. Research article segregation: Indexing and citation databases, Impact factor of journals as per citation report, h-index, g index and i10 index.	CO1 CO3	K1,K2,K3
UNIT-IV	**Referencing styles and techniques:** MLA, Harvard, Chicago, APA styles, Tools employed in referencing and citing Grammarly and Endnote. Softwares Mendeley, reference manager, Zotero etc.	CO4	K1,K2,K3
UNIT-V	**Data Interpretation and analysis:** Analysis of Variance (ANOVA)- mean, median, mode, range, standard deviation, curve fitting, general polynomial fitting, exponential fitting, types of errors, significant tests F & T test.	CO1 CO5	K1,K2, K3,K4

Recommended Text Books

1. Kothari, C. K., Research Methodology-Methods and Techniques, 2nd Ed., New Age International, New Delhi.
2. Power Analysis for Experimental research A Practical Guide for the Biological, Medical and social Sciences by R. Barker Bausell, Yi-Fang Li Cambridge University Press.
3. Panneerselvam R., Research Methodology, Prentice Hall of India, New Delhi,2004
4. Kumar, R., Research Methodology - A Step-By-Step Guide for Beginners, Pearson Education, Delhi (2006).

Reference Books

1. Montgomery, D. C., Design & Analysis of Experiments, 5th Ed., Wiley India (2007).

Website and e-learning source

1. https://onlinecourses.nptel.ac.in/noc24_ge21/preview
2. https://library.tiffin.edu/researchmethodologies/whatareresearch methodologies
3. https://research.com/research/how-to-write-research-methodology

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	Explain the Objectives and motivations in research.	K1,K2,K3
CO2	Understand the research problem, patenting and intellectual property rights	K1,K2
CO3	Discuss the different Techniques to employed for literature search	K1,K2,K3
CO4	Describe the Tools employed in referencing, citing Grammarly and Endnote.	K1,K2,K3
CO5	Analyze research Data and Interpretation	K1,K2,K3,K4

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	-	-	-	-	2	2	2	1
CO2	3	3	-	-	-	-	-	-	-	2	2	2	2
CO3	3	3	2	-	-	-	-	-	-	2	3	2	1
CO4	3	3	3	2	-	-	-	-	-	1	2	2	2
CO5	3	3	3	3	3	-	-	-	-	2	3	3	2

COURSE DESCRIPTORS

Title of the Course	**Organic Synthesis And Photochemistry**	**Hours/Week**	**06**
Course Code	**APCCH31**	**Credits**	**05**
Category	**Core Paper - VII**	**Year & Semester**	**II & III**
Prerequisites	**Basic knowledge of Organic Synthesis and Photochemistry**	**Regulation**	**2024**

Objectives of the course:

- Understand the principles of organic synthesis planning and retro synthetic strategies.
- Study Umpolung concepts, region specific control, and protective groups in synthesis.
- Understand photochemical principles, including electronic transitions and energy transfer.
- Explore Woodward-Hoffmann rules and molecular orbital approaches in pericyclic reactions.
- Examine cis-trans isomerization, photo-cycloadditions, and photochemical rearrangements.

UNITS	Contents	COs	Cognitive Levels
UNIT-I	**Planning an Organic Synthesis and Control elements:** Linear vs convergent synthesis. Synthesis based on Umpolung concepts of Seeback, regiospecific control elements. Use of protective groups, activating groups and bridging elements. Examples on retrosynthetic approach, calculation of yield, advantages of convergent synthesis, synthesis of stereochemistry-controlled products.	CO1	K1, K2 K3, K4
UNIT-II	**Organic Synthetic Methodology:** Retrosynthetic analysis; Alternate synthetic routes. Synthesis of organic mono and bifunctional compounds via disconnection approach. Protection of hydroxyl, carboxyl, carbonyl, thiol and amino groups. Illustration of protection and deprotection in synthesis. Stereospecific control elements. Functional group alterations and transposition.	CO2	K3, K4 K5
UNIT-III	**Pericyclic Reactions:** Woodward Hoffmann rules; The FMO, PMO method and correlation diagrams. Cycloaddition and retrocycloaddition reactions; [2+2], [2+4], [4+4], Cationic, anionic, and 1,3-dipolar cycloadditions. Cheletropic reactions. ; Electrocyclization and ring opening reactions of conjugated dienes and trienes. Sigmatropic rearrangements: (1,3), (1,5), (3,3) and (5,5)-carbon migrations, degenerate rearrangements. Ionic sigmatropic rearrangements. Group transfer reactions. Regioselectivity, stereoselectivity in pericyclic reactions.	CO3	K3, K4, K5

UNIT-IV	**Organic Photochemistry-I:** Photochemical excitation: Experimental techniques; electronic transitions; Jablonskii diagrams; intersystem crossings; energy transfer processes; Stern Volmer equation. Reactions of electronically excited ketones; $\pi \rightarrow \pi^*$ triplets; Norrish type-I and type-II cleavage reactions; photo reductions; Paterno-Buchi reactions.	CO4	K3, K4 K5
UNIT-V	**Organic Photochemistry-II:** Photochemistry of α-β -unsaturated ketones; cis-trans isomerisation. Photon energy transfer reactions, Photo cycloadditions, Photochemistry of aromatic compounds; photochemical rearrangements; photo-stationery state; di-π-methane rearrangement; Reaction of conjugated cyclohexadienone to3,4-diphenyl phenols; Barton's reactions.	CO4 CO5	K2 K3 K4

Recommended Text Books

1. K K Rohatgi – Mukherjee, Fundamentals of Photo Chemistry 3rd ed., New Age International publishers,2014**.**
2. M G Arora Organic Photo Chemistry and Pericyclic reactions, 1st ed., Anmol Publications PVT .Lt, 1994.
3. F. A. Carey and Sundberg, Advanced Organic Chemistry, 5th ed, Tata McGraw-Hill, New York, 2003.
4. J. March and M. Smith, Advanced Organic Chemistry, 5th ed., John-Wiley and sons, 2007.
5. R. E. Ireland, Organic synthesis, Prentice Hall India, Goel publishing house, 1990.
6. Clayden, Greeves, Warren, Organic Chemistry, Oxford University Press, Second Edition, 2016.
7. M. B. Smith, Organic Synthesis 3rd edn, McGraw Hill International Edition, 2011.

Reference Books

1. Jagdamba singh and Jaya Singh, Photo Chemistry and Pericyclic reactions, 4th ed., New Age International publishers,2019**.**
2. J.A. Joule, G.F. Smith, Heterocyclic Chemistry, Garden City Press, Great Britain, 2004.
3. W. Caruthers, Some Modern Methods of Organic Synthesis 4thedn, Cambridge University Press, Cambridge, 2007.
4. H. O. House. Modern Synthetic reactions, W.A. Benjamin Inc, 1972.
5. Gill and Wills, Pericyclic Reactions, Chapman Hall, London, 1974.

Website and e-learning source

1. **https://archive.nptel.ac.in/courses/104/106/104106077/**
2. **https://archive.nptel.ac.in/courses/104/105/104105038/**
3. **https://tech.chemistrydocs.com/Books/Organic/Photochemistry-and-Pericyclic-Reactions-By-Jagdamba-Singh-3rd-Edition.pdf**

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	Differentiate the linear and convergent organic synthesis.	K1,K2,K3, K4
CO2	Designing synthetic pathways of mono and bifunctional organic compounds using disconnection approach.	K3,K4,K5
CO3	Predict the pericyclic reaction outcomes using Woodward-Hoffmann rules.	K3, K4,K5
CO4	Understand the principles of photochemical excitation and its role in organic transformations.	K1,K2,K3
CO5	Describe the photochemistry of α,β-unsaturated ketones and their role in organic synthesis.	K2, K3,K4

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	3	3	1	-	-	-	2	2	3	2	2
CO2	3	3	3	3	3	-	-	-	1	3	3	3	2
CO3	3	3	2	3	3	-	-	-	3	3	3	3	2
CO4	3	3	1	2	1	-	-	-	2	1	3	2	2
CO5	3	3	3	2	2	-	-	-	3	2	3	2	2

COURSE DESCRIPTORS

Title of the Course	**COORDINATION CHEMISTRY – I**	**Hours/Week**	**06**
Course Code	**APCCH32**	**Credits**	**05**
Category	**Core Paper - VIII**	**Year & Semester**	**II & III**
Prerequisites	**Basic knowledge of Inorganic Chemistry**	**Regulation**	**2024**

Objectives of the course:

- To gain insights into the modern theories of bonding in coordination compounds.
- To learn various methods to determine the stability constants of complexes.
- To understand and construct correlation diagrams and predict the electronic transitions that are taking place in the complexes.
- To describe various substitution and electron transfer mechanistic pathways of reactions in complexes, electronic transitions that are taking place in the complexes.
- To evaluate the spectral characteristics of selected complexes.

UNITS	Contents	COs	Cognitive Levels
UNIT-I	**Modern theories of coordination compounds:** Crystal field theory - splitting of d orbitals in octahedral, tetrahedral and square planar symmetries - measurement of 10Dq - factors affecting 10Dq spectrochemical series - crystal field stabilisation energy for high spinand low spin complexes- evidences for crystal field splitting – site selections in spinels and antispinels - Jahn Teller distortions and its consequences. Molecular Orbital Theory and energy level diagrams concept of Weak and strong fields, Sigma and pi bonding in octahedral, square planar and tetrahedral complexes.	CO1	K1, K2
UNIT-II	**Spectral characteristics of complexes:** Term states for d ions - characteristics of d-d transitions - charge transfer spectra - selection rules for electronic spectra - Orgel correlation diagrams - Sugano-Tanabe energy level diagrams - nephelauxetic series – Racha parameter and calculation of inter-electronic repulsion parameter.	CO1 CO2	K1, K2 K3

UNIT-III	**Stability and Magnetic property of the complexes:** Stability of complexes: Factors affecting stability of complexes, Thermodynamic aspects of complex formation, Stepwise and overall formation constants, Stability correlations, statistical factors and chelate effect, Determination of stability constant and composition of the complexes: Formation curves and Bjerrum's half method, Potentiometric method, Spectrophotometric method, Ion exchange method, Polorographic method and Continuous variation method (Job's method) Magnetic property of complexes: Spin-orbit coupling, effect of spin-orbit coupling on magnetic moments, quenching of orbital magnetic moments.	CO3	K3, K4 K5
UNIT-IV	**Kinetics and mechanisms of substitution reactions of octahedral and square planar complexes:** Inert and Labile complexes; Associative, Dissociative and SNCB mechanistic pathway for substitution reactions; acid and base hydrolysis of octahedral complexes; Classification of metal ions based on the rate of water. replacement reaction and their correlation to Crystal Field Activation Energy; Substitution reactions in square planar complexes: Trans effect, theories of trans effect and applications of trans effect in synthesis of square planar compounds; Kurnakov test.	CO1 CO5	K3,K4,K5
UNIT-V	**Electron Transfer reactions in octahedral complexes:** Outer sphere electron transfer reactions and Marcus-Hush theory; inner sphere electron transfer reactions; nature of the bridging ligand in inner sphere electron transfer reactions. Photo-redox, photo-substitution and photo-isomerisation reactions in complexes and their applications	CO3 CO4	K3,K4,K5

Recommended Text Books

1. J E Huheey, EA Keiter, RL Keiter and OK Medhi, Inorganic Chemistry – Principles of structure and reactivity, 4th Edition, Pearson Education Inc., 2006
2. G L Meissler and D ATarr, Inorganic Chemistry, 3rd Edition, Pearson Education Inc., 2008
3. D. Bannerjea, Co-ordination Chemistry, TATA Mcgraw Hill, 1993.
4. B. N. Figgis, Introduction to Ligand Fields, Wiley Eastern Ltd, 1976.
5. F. A. Cotton, G. Wilkinson.; C. A. Murillo; M. Bochmann, Advanced Inorganic Chemistry, 6th ed.; Wiley Inter-science: New York, 1988.

Reference Books

1. Keith F. Purcell and John C. Kotz, Inorganic Chemistry, Saunders Publications, USA, 1977.
2. Peter Atkins and Tina Overton, Shriver and Atkins' Inorganic Chemistry, 5th Edition, Oxford University Press, 2010.
3. Basic Inorganic Chemistry, F. A. Cotton, G. Wilkinson, P. L. Guas, John Wiley, 2002, 3rd edn.
4. Concepts and Models of Inorganic Chemistry, B. Douglas, D.McDaniel, J. Alexander, John Wiley, 1994, 3rd edn.
5. Inorganic Chemistry, D. F. Shriver, P. W. Atkins, W. H. Freeman and Co, London, 2010.

Website and e-learning source

https://ocw.mit.edu/courses/5-04-principles-of-inorganic-chemistry-iifall-2008/pages/syllabus/

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	Comprehend various theories of coordination compounds.	K1,K2
CO2	Explain the spectroscopic and magnetic properties of coordination complexes	K1,K2,K3
CO3	Determine the stability of complexes using various experimental methods.	K3,K4,K5
CO4	Predict the electronic transitions in a complex based on correlation diagrams and UVvisible spectral details	K3,K4,K5
CO5	Comprehend the kinetics and mechanism of substitution reactions in octahedral and square planar complexes	K3,K4,K5

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	-	-	1	2	3	3	2	1
CO2	3	3	3	1	-	-	-	1	2	3	3	3	2
CO3	3	2	3	3	2	-	-	1	1	2	2	3	3
CO4	3	3	3	1	2	-	-	2	2	2	1	3	3
CO5	3	3	3	3	2	-	-	2	2	2	2	3	3

COURSE DESCRIPTORS

Title of the Course	**PHYSICAL CHEMISTRY PRACTICAL**	**Hours/Week**	**06**
Course Code	**APCPCH33**	**Credits**	**05**
Category	**Core Paper - IX**	**Year & Semester**	**II & III**
Prerequisites	**Basic knowledge of Physical Chemistry**	**Regulation**	**2024**

Objectives of the course:

- To Understand and apply the principles of conductivity experiments
- To Develop proficiency in phase diagram construction
- To Analyze solubility and precipitation phenomena
- To Explore adsorption phenomena and surface area determination

UNITS	Contents	COs	Cognitive Levels
UNIT-I	**Conductivity Experiments** 1.Determination of equivalent conductance of a strong electrolyte & the verification of DHO equation. 2. Verification of Ostwald's Dilution Law & Determination of pKa of a weak acid. 3. Determination of solubility of a sparingly soluble salt. 4. Acid-base titration (strong acid and weak acid vs NaOH). 5. Precipitation titrations (mixture of halides only).	CO1 CO2	K1, K2 K3, K4 K5
UNIT-II	**Kinetics** 1. Study the kinetics of acid hydrolysis of an ester, determine the temperature coefficient and also the activation energy of the reaction. 2. Study the kinetics of the reaction between acetone and iodine in acidic medium by half-life method and determine the order with respect to iodine and acetone.	CO3	K3, K4, K5

UNIT-III	**Phase diagram** Construction of phase diagram for a simple binary system 1. Naphthalene-biphenyl 2. Benzophenone- diphenyl amine **Adsorption** Adsorption of oxalic acid on charcoal & determination of surface area (Freundlich isotherm only).	CO4 CO5	K3, K4 K5, K6

Recommended Text Books

1. B. Viswanathan and P.S.Raghavan, Practical Physical Chemistry, Viva Books, New Delhi, 2009.
2. Sundaram, Krishnan, Raghavan, Practical Chemistry (Part II), S. Viswanathan Co. Pvt., 1996.
3. V.D. Athawale and Parul Mathur, Experimental Physical Chemistry, New Age International (P) Ltd., New Delhi, 2008.
4. E.G. Lewers, Computational Chemistry: Introduction to the Theory and Applications of Molecular and Quantum Mechanics, 2nd Ed., Springer, New York, 2011

Reference Books (Latest editions, and the style as given below must be strictly adhered to)

1. J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publishing House, 2001.
2. G.W. Garland, J.W. Nibler, D.P. Shoemaker, Experiments in Physical Chemistry, 8th edition, McGraw Hill, 2009.
3. J. N. Gurthu and R. Kapoor, Advanced Experimental Chemistry, S. Chand and Co., 1987.
4. Shailendra K Sinha, Physical Chemistry: A laboratory Manual, Narosa Publishing House Pvt, Ltd., New Delhi, 2014.

Website and e-learning source

https://web.iitd.ac.in/~nkurur/2015-16/Isem/cmp511/lab_handout_new.pdf

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	Quantify concentration of sample using the principles of conductivity and ionic equilibria.	K1, K2, K3, K4, K5
CO2	Estimate the pKa of a weak acid.	K3, K4, K5
CO3	Find the rate and order of a reaction using kinetic.	K3, K4, K5
CO4	Construct a phase diagrams and interpret for binary systems.	K3, K4, K5, K6
CO5	Determination the adsorption processes and surface area.	K3, K4, K5

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	2	-	1	-	2	3	3	1
CO2	3	3	3	3	3	-	-	-	-	2	3	2	-
CO3	3	3	3	3	3	-	-	-	-	2	3	3	-
CO4	3	3	3	3	1	2	-	1	-	2	3	3	2
CO5	3	3	3	3	1	-	-	1	-	2	3	3	-

SCHEME OF VALUATION PHYSICAL CHEMISTRY PRACTICAL

Internal assessment: 25 Marks

External assessment: 75 marks

Total: 100 marks

Max. Marks: 75

Short Procedure ***: 10 Marks***
Manipulation ***: 15 Marks***
Result ***: 30 Marks***
Record ***: 10 Marks***
Viva voce ***: 10 Marks***
Total ***: 75 Marks***

Error up to 2 % ***: 30 Marks***
2 to 3 % ***: 25 Marks***
3 to 4 % ***: 20 Marks***
4 to 5 % ***: 15 Marks***
> 5 % ***: 10 Marks***
Arithmetic error ***: Deduct 3 Mark***
Wrong calculation ***: Deduct 5Mmarks***
No calculation ***: Deduct 10 Marks***

COURSE DESCRIPTORS

Title of the Course	**Analytical Instrumentation techniques Practical**	**Hours/Week**	**06**
Course Code	**APCPCH34**	**Credits**	**04**
Category	**Core Paper - X**	**Year & Semester**	**II & III**
Prerequisites	**Basic knowledge of Instrumentation techniques**	**Regulation**	**2024**

Objectives of the course:

- To design chromatographic methods for identification of species.
- To analyze different constituents through instrumental methods of analysis.
- To evaluate different contaminants in materials using turbidimetry and conductivity measurements.
- To design experiments for analysis of inorganic and organic materials.
- To analyze constituents in materials using emission and absorption techniques.

UNITS	Contents	COs	Cognitive Levels
UNIT-I	1. Potentiometric titration of a mixture of HCl and CH_3COOH Vs NaOH 2. Determination of pKa of weak acid by EMF method. 3. Potentiometric titration of FAS Vs $K_2Cr_2O_7$ 4. Potentiometric titration of KI Vs $KMnO_4$. 5. Potentiometric titration of a mixture of Chloride and Iodide Vs $AgNO_3$. 6. Determination of the pH of buffer solution by EMF method using Quinhydrone and Calomel electrode. **7.** Study of the inversion of cane sugar in the presence of acid by Polarimetric method.	CO1 CO2	K1, K2, K3, K4, K5
UNIT-II	1. Estimation of Fe, Cu and Ni by colorimetric method. 2. Estimation of Na and K by flame photometric method. 3. Determination of the amount (mol/L) of ferricyanide present in the given solution using cyclic voltammetry. 4. Determination of the diffusion coefficient of ferricyanide using cyclic voltammetry. 5. Estimation of the amount of nitrate present in the given solution using spectrophotometric method. 6. Analysis of water quality through COD, DO, BOD measurements. 7. Assay of Riboflavin and Iron in tablet formulations by spectrophotometry 8. Separation of (a) mixture of Azo dyes by TLC (b) mixture of metal ions by Paper chromatography	CO3 CO4	K2, K3, K4, K5

UNIT-III	Interpretation and identification of the given spectra of various organic compounds arrived at from the following instruments 1.UV-Visible 2.IR 3.Raman 4.NMR 5.ESR 6.Mass etc.,	CO5	K2, K3, K4, K5

Recommended Text Books

1. Handbook of Instrumental Techniques for Analytical Chemistry— 4 June 1997 by Frank A. Settle
2. Vogel's Text book of Practical Organic Chemistry, 5th Ed, ELBS/Longman, England, 2003.
3. G. H. Jeffery, J. Bassett, J. Mendham and R. C. Denney, Vogel's Textbook of Quantitative Chemical Analysis; 6th ed., ELBS, 1989.
4. J. D. Woollins, Inorganic Experiments; VCH: Weinheim, 1995

1. "Fundamentals of Analytical Chemistry" by Skoog

2. J. N. Gurtu and R. Kapoor, Advanced Experimental Chemistry, S. Chand and Co., 2011.

3. G.W. Garland, J.W. Nibler, D.P. Shoemaker, Experiments in Physical Chemistry, 8th edition, McGraw Hill, 2009.

4. J. N. Gurthu and R. Kapoor, Advanced Experimental Chemistry, S. Chand and Co., 1987.

Website and e-learning source

1. https://bit.ly/3QESF7t
2. https://bit.ly/3QANOnX

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	Determine the concentration, pKa and pH of unknown sample using Potentiometric method	K1,K2,K3,K4,K5
CO2	Analyze the inversion of cane sugar by Polarimetric method.	K2,K3,K4
CO3	Estimate the metal ions by colorimetric method.	K2,K3,K4,K5
CO4	Determination of diffusion coefficient using cyclic voltammetry.	K2,K3,K4,K5
CO5	Identify various organic compounds using different spectral Data	K2,K3,K4,K5

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	3	3	3	2	-	-	-	1	3	2	1
CO2	3	2	3	3	2	-	-	-	-	2	3	1	1
CO3	3	2	3	3	3	2	-	-	-	2	3	3	2
CO4	3	2	3	3	2	2	-	-	-	1	3	1	1
CO5	3	3	3	3	2	3	-	2	-	3	3	3	2

SCHEME OF VALUATION ANALYTICAL INSTRUMENTATION

TECHNIQUES PRACTICAL

Internal assessment: 25 Marks

External assessment: 75 marks

Total: 100 marks

Max. Marks: 75

Manipulation ***: 15 Marks***
Result ***: 30 Marks***
Record ***: 05 Marks***
Viva voce ***: 10 Marks***
Spectra ***: 15 Marks***
Total ***: 75 Marks***

Error up to 2 % ***: 30 Marks***
2 to 3 % ***: 25 Marks***
3 to 4 % ***: 20 Marks***
4 to 5 % ***: 15 Marks***
> 5 % ***: 10 Marks***
Arithmetic error ***: Deduct 3 Mark***
Wrong calculation ***: Deduct 5Mmarks***
No calculation ***: Deduct 10 Marks***

COURSE DESCRIPTORS

Title of the Course	**Pharmacognosy and Phytochemistry**	**Hours/Week**	**04**
Course Code	**APECH35A**	**Credits**	**03**
Category	**Elective-V**	**Year & Semester**	**II & III**
Prerequisites	**Basic Chemistry**	**Regulation**	**2024**

Objectives of the course:

- To develop the knowledge of natural products, biological functions and pharmacological uses.
- To develop knowledge on primary and secondary metabolites and their sources.
- To understand the concepts of isolation methods and separation of bioactive compounds.
- To provide the knowledge on selected glycosides and marine drugs.
- To familiarize the guidelines of WHO and different sampling techniques.

UNITS	Contents	COs	
UNIT-I	**Pharmacognosy and Standardization of Herbal drugs:** Introduction, definition, development classification and Source of Drugs: Biological, mineral, marine, and plant tissue cultures. Study of pharmacognosticof a crude drug. Biosynthesis: Shikimic acid pathway and acetate pathway. Systematic analysis of Crude drugs. Standardization of Herbal drugs. WHO guidelines, Sampling of crude drug, Methods of drug evaluation. Determination of foreign matter, moisture Ash value. Phytochemical investigations-General chemical tests.	CO1	K1, K2
UNIT-II	**Extraction Techniques:** General methods of extraction, types – maceration, Decoction percolation, Immersion and soxhlet extraction. Advanced techniques-counter current, steam distillation, supercritical gases, sonication, Microwaves assisted extraction. Factors affecting the choice of extraction process.	CO2	K1, K2, K3
UNIT-III	**Drugs containing Terpenoids and volatile oils:** Terpenoids: Classification, Isoprene rule, Isolation and separation techniques, General properties Camphor, Menthol, Eucalyptol. Volatile Oils or Essential Oils: Method of Preparations, Classifications of Volatile oils, Camphor oil, Geranium oil, Citral-Structure uses. Pentacyclic triterpenoids: amyrines; taraxasterol: Structure and pharmacological applications.		
UNIT-IV	**Drugs containing alkaloids:** Occurrence, function of alkaloids in plants, pharmaceutical applications. Isolation, Preliminary Qualitative tests and general properties. General methods of structural elucidation. Morphine, Reserpine, papaverine - chemical properties, structure and uses. Papaverine - structure, chemical properties and uses.		

UNIT-V	**Plant Glycosides and Marine drugs**: Glycosides: Basic ring system, classification, isolation, properties, qualitative analysis. Pharmacological activity of Senna glycosides, Cardiacglycosides - Digoxin, digitoxin, Steroidal saponins glycosides - Diosgenin, hecogenin. Plant pigments: Occurrence and general methods of structure determination, isolation andsynthesis of quercetin and cyanidin chloride. Marine drugs - Selected Drug Molecules: Cardiovascular active substances, Cytotoxic compounds, antimicrobial compounds, antibiotic compounds, Anti-inflammatory agents. Marine toxins.		

Recommended Text Books:

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

Reference Books :

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

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	Realize the general chemical tests for standardization of Crude and Herbal drugs.	K1, K2
CO2	Utilize the Advanced techniques for extraction of Herbal drugs.	K1, K2, K3
CO3	Recognize the Terpenoids containing Drugs and its pharmacological applications.	K1, K2
CO4	Understand the alkaloids Drugs structure, chemical properties and uses.	K1, K2
CO5	Explain the isolation, classification and qualitative analysis of Plant Glycosides	

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	2	-	-	-	-	-	-	1	2	2	1
CO2	3	3	2	2	-	2	-	-	-	-	3	2	2
CO3	3	2	2	-	-	-	-	-	-	-	2	1	1
CO4	3	2	2	-	-	-	-	-	-	-	2	2	2
CO5	3	3	3	3	2	2	-	-	-	2	3	1	1

COURSE DESCRIPTORS

Title of the Course	BIOMOLECULES AND HETEROCYCLIC COMPOUNDS	Hours/Week	04
Course Code	APECH35B	Credits	03
Category	Elective-V	Year & Semester	II & III
Prerequisites	Basic knowledge of Chemistry	Regulation	2024

Objectives of the course:

- To learn the basic concepts and biological importance of biomolecules and natural products.
- To explain various of functions of carbohydrates, proteins, nucleic acids, steroids and hormones.
- To understand the functions of alkaloids and terpenoids.
- To elucidate the structure determination of biomolecules and natural products.
- To extract and construct the structure of new alkaloids and terpenoids from different methods.

UNITS	Contents
UNIT-I	**Chemistry and metabolism of carbohydrates** Definition, classification and biological role of carbohydrates. monosaccharides: Linear and ring structures (Haworth formula) of ribose, glucose, fructose and mannose (structure determination not required), physical and chemical properties of glucose and fructose. Disaccharides: Ring structures (Haworth formula) –occurrence, physical and chemical properties of maltose, lactose and sucrose. Polysaccharides: Starch, glycogen and cellulose – structure and properties, glycolysis of carbohydrates.
UNIT-II	**Steroids and Hormones** Steroids-Introduction, occurrence, nomenclature, configuration of substituents. Diels' hydrocarbon, stereochemistry, classification, biological importance, colour reactions of sterols, cholesterol-occurrence, tests, physiological activity, biosynthesis of cholesterol from squalene. Hormones Introduction, classification, functions of sex hormones- androgens and estrogens, adrenocortical hormones-cortisone and cortisol structure and functions of non-steroidal hormones-adrenaline and thyroxin.
UNIT-III	**Proteins and nucleic acids** Separation and purification of proteins – dialysis, gel filtration and electrophoresis. Catabolism of amino acids - transamination, oxidative deamination and decarboxylation. Biosynthesis of proteins: Role of nucleic acids. Amino acid metabolism and urea cycle.

UNIT-IV	**Proteins and nucleic acids** Structure, methods for the synthesis of nucleosides - direct combination, formation of heterocyclic base and nucleoside modification, conversion of nucleoside to nucleotides. Primary and secondary structure of RNA and DNA, Watson Crick model, solid phase synthesis of oligonucleotides.
UNIT-V	**Fused Ring Heterocyclic Compounds** Benzofused five membered rings: Indole, isoindole, benzofuran and benzothiophene, Preparation and properties. Benzofused six membered rings: Quinoline and isoquinoline: Preparation by ring closure reactions, Reactions: Mechanism of electrophilic and nucleophilic substitutions, oxidation and reduction reactions.

Recommended Text Book

1. T. K Lindhorst, Essentials of Carbohydrate Chemistry and Biochemistry, Wiley VCH, North America, 2007.
2. I.L. Finar, Organic Chemistry Vol-2, 5 th edition, Pearson Education Asia, 1975.
3. V. K. Ahluwalia and M. Goyal, Textbook of Heterocyclic compounds, Narosa Publishing, New Delhi,2000.
4. M. K. Jain and S. C. Sharma, Modern Organic Chemistry, Vishal Publishing Co., Jalandhar, Delhi, 2014.
5. V. K. Ahluwalia, Steroids and Hormones, Ane books pub., New Delhi,2009.

Reference Books

1. Pelletier, Chemistry of Alkaloids, Van Nostrand Reinhold Co,2000.
2. I.L. Finar, Organic Chemistry Vol-1, 6thedition, Pearson Education Asia,2004.
3. Shoppe, Chemistry of the steroids, Butterworthes,1994.
4. I. A. Khan, and A. Khanum. Role of Biotechnology in medicinal & aromatic plants, Vol 1 and Vol 10, Ukkaz Publications, Hyderabad,2004.
5. M. P. Singh. and H. Panda, Medicinal Herbs with their formulations, Daya Publishing House, Delhi,2005.

Website and e-learning source

1. *https://www.organic-chemistry.org/*
2. *https://www.studyorgo.com/summary.php*
3. *https://www.clutchprep.com/organic-chemistry*

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	Analyze various structure and functions of carbohydrates	K1, K2, K3, K4
CO2	Integrate the different methods of preparation of Steroids and Hormones	K1, K2, K3
CO3	Describe the synthesis, transformations of proteins and amino acids	K1, K2, K3
CO4	Rationalize the structure and synthesis of heterocyclic compounds.	K1, K2, K3
CO5	Develop the structure of biologically important heterocyclic compounds by different methods.	K5

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	-	-	-	-	-	3	-	-
CO2	3	2	2	3	3	-	-	-	-	-	3	3	-
CO3	3	3	2	3	3	-	-	-	2	-	3	3	2
CO4	3	2	3	3	3	-	-	-	2	2	3	3	2
CO5	3	2	3	3	3	2	2	-	2	2	3	3	3

COURSE DESCRIPTORS

Title of the Course	**Professional Communication Skill** : **TERM PAPER & SEMINAR PRESENTATION**	**Hours/Week**	02
Course Code	**APSCH36**	**Credits**	02
Category	Skill Enhancement Course – II	**Year & Semester**	II & III
Prerequisites	Basic Chemistry and Presentation Skill	**Regulation**	2024

Course Outline

Professional Communication Skill : Term Paper & Seminar Presentation

Assignment of Problem by faculty Lecture

- I (by the student) 25% Lecture
- II (by the student) 25% Lecture
- III (by the student) 25%

Submission of a write-up (10 to 15 pages using LaTex) 25% Marks / Grade Points / Lecture Grade as per the Regulation)