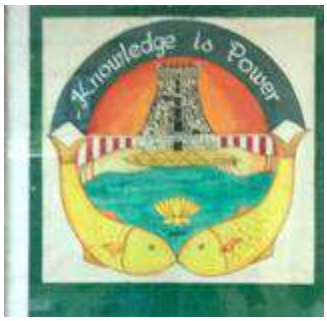
SRI MEENAKSHI GOVERNMENT ARTS COLLEGE FOR WOMEN (A)

MADURAI-02



DEPARTMENT OF CHEMISTRY

CBCS SYLLABUS FOR
M.Sc CHEMISTRY
FROM

2022 ONWARDS

DEPARTMENT OF CHEMISTRY

The department of chemistry was established in the year 1965 for the pre-university course. Bachelor's degree of Chemistry was started in the year 1968 with a few staff members. The department has been upgraded to post graduate department in 2017.

FACULTY

The Department comprises of a goal-oriented group of highly qualified, experienced and dynamic faculty members. The Department of Chemistry has 16 faculty members, of which 14 are Ph.D., holders. At present, two of our staff members are pursuing their Ph.D. degree. Their areas of expertise and research include organic, inorganic, physical, electrochemistry, phytochemistry, nanotechnology and supramolecular chemistry.

ACTIVITIES AND ACHIEVEMENTS

Most of the staff members are actively involved in research and various important decision-making committees at the College level and act as expertise in Boards of studies at college as well as University level. The staff members have been serving as NSS & NCC coordinators, Science Forums coordinator, Autonomy-in-charge, RUSA Coordinator, women-empowerment cell, remedial/ special coaching coordinators, Sports committee member, Thaatha-paattikuzhu coordinator, Admission committee member, admission coordinator, Career guidance cell coordinator, Controller of examinations, additional controller of examinations, Deputy warden in college hostel, Youth welfare association coordinator, Parent Teacher Association treasurer, Old student's association, Course coordinators, syllabus committee representatives, question paper setters and external examiners at undergraduate as well as postgraduate levels. Faculty members have contributed to academics by publishing books, contributing research articles in journals, presenting papers in conferences and delivering guest lectures. Faculty members have been recognized by national agencies and Universities with awards for their contribution to research.

Four staff members (retired from service) were elevated to the cadre of Principal, Regional Joint Director and have served as efficient administrators at various colleges and regional offices. Some of the staff members are carrying out UGC funded minor research projects, received research awards, awards from All India Radio serial programme and have also served as editors in peer journals like Elsevier.

COURSE

At present our department caters to the needs of 294 (UG -243 and PG - 51) major chemistry students and 230 Ancillary chemistry students. Our march towards the zeal will continue in the forthcoming years also.

DEPARTMENT HIGHLIGHTS

The Department organizes National Conferences, workshops, visiting faculty lectures and faculty Development Programmes for the benefit of students. The Department, with a focus on enhancing the knowledge and skills of the students, has been conducting inter-Departmental and inter-collegiate activities, through the Chemistry Association, Science Forum and Chemistry Club. It has also been actively involved in various outreach programmes for the upliftment of society. Equal opportunity centre program has been conducted by our department.

RESOURCES

The Department has five laboratories which are fully equipped with instruments for teaching and research activities. The instruments available in the laboratories include UV-visible spectrophotometer, Conductometer, Potentiometer, pH meter, Polarimeter, turbidity meter, LCD projector, colorimeter etc.

The Department has an excellent library for the benefit of students, faculty members and research scholars. Library has a large collection of books covering various branches of Chemistry like organic, inorganic, physical, electrochemistry, green chemistry and nano chemistry. Internet facility is available in the department.

ALUMNI ACTIVITIES

During 55 years of successful journey our department has produced flourishing alumni who have occupied various positions in different sectors like academic, administrative, research, innovative scientists, overseas employment, banking and recent blooming fields like information technology.

The alumni of the department had served as the Principal in Govt. Arts College, HOD and eminent professor in the School of chemistry at MKU, Madurai. It is a privilege to specify that, 22 alumni of chemistry department are serving as Associate Professors and Assistant Professors in various esteemed institutions. Alumni meet for the 1991 – 94 batch of B.Sc., Chemistry was organized on 8thJanuary 2017.

We have further goals to enrich our department as research department for the benefits of the students.

COURSES OFFERED:

UG COURSES: **B.Sc CHEMISTRY**

PG COURSES: **M.Sc CHEMISTRY**

VISION

To create an academically sound environment that nurtures, motivates and inspires excellence in teaching along with concern for society.

MISSION

To impart theoretical and practical training in different areas of chemistry, which encourages creativity, insight development and a passion for science.

SRI MEENAKSHI GOVT. ARTS COLLEGE FOR WOMEN (AUTONOMOUS)
MADURAI-2

Programme : M.Sc Chemistry

SEMESTER –I

Course Type	Code	Title of the Course	Hrs. /W	Credits	Exam Hrs.	Marks		
						Int	Ext	Total
CCI	P22CD1	Core Course I Inorganic Chemistry I	5	4	3	25	75	100
CC II	P22CD2	Core Course II Organic Chemistry I	6	4	3	25	75	100
CC III	P22CD3	Core Course III Physical Chemistry I	6	4	3	25	75	100
CCIV	P22CD4P	Core Course IV Inorganic Chemistry Practical	6	4	6	40	60	100
DSEC- I	P22DSD1	Discipline Specific Elective Course I Molecular Spectroscopy & Analytical Chemistry I	5	4	3	25	75	100
		Industrial Chemistry						
SEC -I	P22SED1	Skill Enhancement Course I (Practical) Analysis of Soil, Food and Cosmetics	2	2	3	40	60	100
	Total		**30**	**22**				**600**
SEMESTER –II								
CC V	P22CD5	Core Course V Inorganic Chemistry II	6	4	3	25	75	100
CCVI	P22CD6	Core Course VI Organic Chemistry II	5	4	3	25	75	100
CC VII	P22CD7	Core Course VII Physical Chemistry II	6	4	3	25	75	100
CCVIII	P22CD8P	Core Course VIII Organic Chemistry Practical	6	4	6	40	60	100
DSEC-II	P22DSD2	Discipline Specific Elective Course II Molecular Spectroscopy & Analytical Chemistry II	5	4	3	25	75	100
		Polymer Chemistry						
SEC- II	P22SED2P	Skill Enhancement Course II (Practical) Computational Software in Chemistry	2	2	3	40	60	100
	Total		**30**	**22**				**600**

SEMESTER –III								
CC– IX	P22CD9	Core Course IX Inorganic Chemistry III	6	5	3	25	75	100
CC – X	P22CD10	Core Course X Organic Chemistry III	5	5	3	25	75	100
CC – XI	P22CD11	Core Course XI Physical Chemistry III	5	5	3	25	75	100
CC–XII	P22CD12P	Core Course XII Physical Chemistry Practical	6	4	6	40	60	100
DSEC–III	P22DSD3	Discipline Specific Elective Course-III Nanochemistry	5	4	3	25	75	100
		Environmental Chemistry						
NMEC -I	P22NMEC1	Non Major Elective Course: Cosmetology (Offered to other programmes)	2	2	3	25	75	100
		Total	**30**	**25**				**600**
SEMESTER –IV								
CC–XIII	P22CD13	Core Course XIII Organic Chemistry IV	6	4	3	25	75	100
CC–XIV	P22CD14	Core Course XIV Selected Topics in Chemistry	5	4	3	25	75	100
CC-XV	P22CD15P	Core Course XV Inorganic & Organic quantitative Analysis Practical	6	4	6	40	60	100
CC– XVI	P22CDPW	Core Project	8	5	-	80	20	100
DSEC–IV	P22DSD4	Discipline Specific Elective Course IV Green Chemistry	5	4	3	25	75	100
		Medicinal and Pharmaceutical Chemistry						
		Total	**30**	**21**				**500**

COURSE STRUCTURE ABSTRACT FOR
M.Sc Chemistry Programme

PART	COURSES	TOTAL NO. OF COURSES	HOURS	CREDIT	MARK
III	Core Course	15	86	63	1500
III	Core Project	1	8	5	100
III	Discipline Specific Elective Course	4	20	16	400
III	Non-Major Elective Course	1	2	2	100
III	Skill Enhancement Course	2	4	4	200
Total		**23**	**120**	**90**	**2300**

PROGRAMME OBJECTIVES FOR ALL POSTGRADUATE PROGRAMMES

PO1: Getting enriched by the existing knowledge in their respective disciplines and apply appropriate methodology for research and implementation.

PO2: Develop technology compatible to new perceptions and evolve innovative pedagogy in their discipline.

PO3 Design creative projects and translate it to the present-day scenario.

PO4 Evaluate the issues and challenges pertaining to their disciplines and synergize them with the growing needs in their arena.

PO5 Explore the diverse value systems of our nation and contribute towards building an egalitarian society.

M.Sc., CHEMISTRY PROGRAMME SPECIFIC OUTCOMES (PSO)

Curriculum of M.Sc., Chemistry is designed to prepare postgraduates to attain the following program specific outcomes:

PSO 1: Ability to appreciate the potential of Inorganic, Organic, Physical, Analytical, Nano and Green chemistry.

PSO 2: Ability to update with the current Chemistry and search for further higher studies, employment and research.

PSO 3: Ability to apply the gained knowledge and other concepts to new systems, thereby, recognizing the need for life-long learning in the broadest view of changing advances in Chemistry.

PSO 4: Demonstrate the theory behind the experiment and able to handle the experiments independently, able to use modern instruments efficiently and sequentially recording the results of the experiment.

PSO 5: Communicating efficiently on the topic chosen for Discussion/Seminar by appropriate designing, making effective documentation & presentations and comprehending in an appropriate way.

LEVELS OF MAPPING AND QUESTION PATTERN

Mapping	1- 20%	21 - 40%	41 – 60 %	61 – 80%	81 – 100%
Scale	1	2	3	4	5
Relation	0.0 - 1.0	1.1 – 2.0	2.1 – 3.0	3.1 – 4.0	4.1 – 5.0
Quality	Very Poor	Poor	Moderate	High	Very High
Mean Score of COs = Total of value / Total No. of POs and PSOs			Mean Overall Score of COs = Total of Mean Score / Total No. of COs		

BLOOM'S TAXONOMY	INTERNAL	EXTERNAL
K1 (Remembering / Recalling)	20%	20%
K2 (Understanding / Comprehension)	20%	20%
K3 (Application and analysis)	30%	30%
K4 (Synthesis & evaluation)	30%	30%

Year	K1	K2	K3	K4
I & II	Part-A (1 question) 1 x 5 = 5	Part-A (1 question) 1 x 5 = 5	Part-A (1 question) 1 x 5 = 5	Part-A (2 questions) 2 x 5 = 10
	Part-B (1 question) 1 x 10 = 10	Part-B (1 question) 1 x 10 = 10	Part-B (1 question) 1 x 10 = 10	Part-B (2 questions) 2 x 10 = 20

Programme : M.Sc Chemistry **CORE 1**
Semester : I **Hours : 5 /W, 75 Hrs./S**
Sub. Code : P22CD1 **Credits : 4**

TITLE OF THE PAPER: INORGANIC CHEMISTRY I

Pedagogy	Hours	Lecture	Peer Teaching/Seminar//Discussion//Problem solving session/Quiz/videos/Library session.	ICT
	5	3	1	1

PREAMBLE: The objectives of the course is to understand the concepts and theories of acids and bases, Pearson and HSAB concepts and its applications, lattice energy, ionic bonds, symmetry in crystals, types of crystals, Molecular orbital theory, wave mechanical treatment of covalent bonds, characteristics of p-block elements, the principle of stability constant, chelate effects, atomic states and term symbols of coordination complexes, various theories, spectral and magnetic properties of coordination complexes.

COURSE OUTCOME: At the end of the Semester, the Students will be able to	Unit	Hrs P/S
CO1: discuss the theories of Bronsted, Lewis and Lux concepts of acids and bases, Pearson and HSAB concepts and its applications.	1	15
CO2: explain the fundamental knowledge of lattice energy, radius ratio of different geometries, calculation of lattice energy, miller indices, symmetry in crystals and various types of crystals.	2	15
CO3: discuss band theory of solids, electrical and optical properties of solids. Compare neutron diffraction and X-ray diffraction, discuss the application of XRD	3	15
CO4: demonstrate the principle of coordination compound, describe the stability of metal complexes by the use of different methods and parameters, and illustrate the stereoisomerism in inorganic complexes.	4	15
CO5: draw the splitting of d-orbitals under various geometries, discuss the factors affecting splitting, explain Jahn-Tellar distortion and chelation, identify the complexes using ORD and CD, draw the energy level diagrams of various complexes, compare CFT and MOT of bonding in octahedral complexes	5	15

UNIT I

ACIDS AND BASES (15 Hours)

Bronsted and Lewis acid bases, pH, pK_a, acid base concept in non-aqueous media, buffer solution, Protonic acids- Proton Affinities –leveling solvents – acidic behaviour of the binary hydrides – strength of oxyacids – hydrolysis – Amphoteric oxides – Non protonic concept of acid-base reactions- Lux concept- Solvent Ion theory of acids and bases ammonia, acetic acid– Hard and Soft acid base concept – Pearson concept- Applications of HSAB principle.

UNIT II

CHEMISTRY OF SOLID STATE : I (15 Hours)

Ionic bond – lattice energy – Radius ratio for tetrahedral, octahedral and cubic sites – applications of radius ratio – Calculations of lattice energies of ionic crystals – Born- Lande equation – Born Haber Cycle – symmetry in crystals- Miller indices – Close packing – Crystal types – AB, AB_2. Representative structures of AB, AB_2, types of compounds – rock salt, cesium chloride, wurtzite, zinc blende, rutile, fluorite, cadmium iodide. Structure of graphite and diamond.

UNIT III

CHEMISTRY OF SOLID STATE : II (15 Hours)

Band theory of solids – non-stoichiometry – point defects – linear defects- effects due to dislocations – electrical properties of solids – conductor, insulator, semi-conductor – intrinsic – impurity semiconductors – optical properties – lasers and phosphors – elementary study of liquid crystals.

X-ray diffraction by single crystal – rotating crystal – powder diffraction

Neutron diffraction: Elementary treatment- Comparison with X-ray diffraction. Electron diffraction – basic principle. Applications of XRD.

UNIT IV

PRINCIPLES OF COORDINATION CHEMISTRY (15 Hours)

Stability of complexes – Factors affecting stability of complexes, Thermodynamic aspects of complex formation, stepwise and overall formation constants, Statistical factors and chelate effect, Determination of stability constants and composition of the complexes; Formation curves and Bjerrum's half method Potentiometric and photometric methods, continuous variation method (Job's variation method) Stereochemical aspects – Stereoisomerism in inorganic complexes – Isomerism arising out of ligand distribution and ligand conformation.

UNIT V

CHEMISTRY OF COORDINATION COMPOUNDS (15 Hours)

Crystal field theory – Splitting of d-orbital under various geometries – factors affecting splitting, CFSE, evidences for CFSE (Structural and thermodynamic effects) - Spectrochemical series – Jahn Teller distortion and chelation – Application of CFT – magnetic properties, spectral properties and kinetic properties. Limitations of CFT, evidences for M-L overlap. Application of ORD and CD in identification of complexes.

MOT- MO theory and energy level diagrams concept of weak and strong fields, sigma and pi bonding in octahedral, square planar and tetrahedral complexes. Nephlauxetic effect, comparison of CFT and MOT of bonding in octahedral complexes.

References

1. J.E. Huheey, Ellen A. Kaiter, Richard L. Kaiter & Okhil K. Medhi, Inorganic Chemistry, Principles of Structure & Reactivity, 4th Ed., Pearson, 2011.
2. F.A. Cotton, G.Wilkinson, G.A. Murillo& M. Bochmann, Advanced Inorganic Chemistry, 1st Ed., Wiley Student Edn, 2007.
3. R.S. Drago, Physical Methods in Inorganic Chemistry, 1st Ed., Affiliated East-West Press Pvt. Ltd., 1971.

4. M.C.Day and J.Selbin, Theoretical Inorganic Chemistry, Affiliated East West Press Pvt.Ltd. 2nd Ed., 1985.
5. H.J. Emeleus & A.G. Sharpe, Modern aspects of Inorganic Chemistry, 4th Ed., ISBN, 1974.
6. Selected Topics in Inorganic Chemistry, Dr. Wahid U. Malik, Dr.G.D.Tuli, Dr. R.D. Madan, 8th edition.
7. B.R. Puri, L.R. Sharma & K.C.Kalia, Principles of Inorganic Chemistry, Vishal Pub.33 ed., 2017.
8. R. Gopalan & V.Ramalingam, Concise Coordination Chemistry, 1st Ed., Vikas Pub. House Pvt. Ltd., 2001.
9. Manas Chanda, Atomic Structure & Chemical Bond, 1st Ed., Tata McGraw Hill Pub. Co., 1992.
10. H.J.Emeleus & A.G.Sharpe, Modern aspects of Inorganic Chemistry, 4th Ed., ISBN, 1974.
11. S.F.A. Kettle, Coordination compounds, ELBS, 1972
12. D. Bannerjea, Coordination chemistry, TATA Mcgraw Hill, 1993

UNITS	TOPIC	LECTURE HOURS	MODE OF TEACHING
UNIT 1: **ACIDS AND BASES**			
	Bronsted and Lewis theories of acids and bases, pH and pKa acid base concepts	4	Lecture
	acidic behavior of oxyacids, binary hydrides, amphoteric oxides	3	Lecture
	Buffer solution and leveling solvents	2	Problem solving session
	Non protonic concept of acid and base reactions, Lux concept, solvent ion theory,	4	ICT
	HSAB and Pearson concepts and applications of HSAB	2	Lecture and Group Discussion
UNIT II: **CHEMISTRY OF SOLID STATE – I**			
	Ionic bond, lattice energy and radius ratio for tetrahedral, octahedral and cubic sites	4	Lecture
	calculation of lattice energy of ionic crystals- Born equation	4	Problem solving session with the help of the teacher.
	Born Haber cycle and symmetry in crystals	4	ICT
	Miller indices, closed packing and crystal types	3	Seminar
UNIT III **CHEMISTRY OF SOLID STATE – II**			
	Band theory of solids – non-stoichiometry – point defects – linear defects- effects due to dislocations	2	Lecture
	electrical properties of solids – conductor, insulator, semi-conductor – intrinsic – impurity semiconductors – optical properties – lasers and phosphors – elementary study of liquid crystals.	4	Lecture
	Neutron diffraction: Elementary treatment- Comparison with X-ray diffraction. Electron diffraction – basic principle.	4	Lecture with Demo using charts

	X-ray diffraction by single crystal – rotating crystal – powder diffraction	3	ICT
	Applications of XRD	2	Discussion
UNIT IV	**PRINCIPLES OF COORDINATION CHEMISTRY**		
	Stability of complexes – Factors affecting stability of complexes	4	Lecture
	Determination of stability constants and composition of the complexes; Formation curves and Bjerrum's half method	5	Lecture
	Potentiometric and photometric methods, continuous variation method (Job's variation method) Stereochemical aspects – Stereoisomerism in inorganic complexes	2	seminar
	Isomerism arising out of ligand distribution and ligand conformation.	4	ICT
UNIT V	**CHEMISTRY OF COORDINATION COMPOUNDS**		
	Crystal field theory – Splitting of d-orbital under various geometries – factors affecting splitting, CFSE, evidences for CFSE (Structural and thermodynamic effects)	4	Lecture
	Spectrochemical series – Jahn Teller distortion and chelation – Application of CFT – magnetic properties, spectral properties and kinetic properties. Limitations of CFT, evidences for M-L overlap	4	Lecture
	Application of ORD and CD in identification of complexes.	1	Problem solving session
	MOT- MO theory and energy level diagrams concept of weak and strong fields, sigma and pi bonding in octahedral, square planar and tetrahedral complexes	4	ICT
	Nephlauxetic effect, comparison of CFT and MOT of bonding in octahedral complexes.	2	Seminar / peer teaching

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	4	4	4	4	1	4	4	4	3	4	3.6
CO2	4	4	3	4	1	4	4	4	3	4	3.5
CO3	4	4	3	3	1	4	4	4	3	3	3.3
CO4	4	4	4	3	1	4	4	4	3	4	3.5
CO5	4	4	4	3	1	4	4	4	3	4	3.5
Mean Overall Score											3.48

Result: The Score for this Course is 3.48 (High Relationship)

UNIT	Part A(5X5=25m)	Part B (5 X 10 = 50m) Either or Pattern
I	K1 / K4	K2 / K3
II	K3 / K4(2.5m), K3(2.5m)	K1/ K4
III	K3(2.5m) ,K4(2.5m) / K1	K4 / K2
IV	K2 / K3	K3 / K3(5m), k4(5m)
V	K4 / K2	K3(5m), k4(5m) / K1

Programme :M.Sc Chemistry **CORE 2**
Semester : I **Hours : 6 /W, 90 Hrs./S**
Sub. Code : P22CD2 **Credits : 4**

TITLE OF THE PAPER: ORGANIC CHEMISTRY I

Pedagogy	**Hours**	**Lecture**	**Peer Teaching/seminar/discussion/ /problem solving session/quiz/videos/demonstration class/library session.**	**ICT**
	6	4	1	1

PREAMBLE: The objective of the course is to make the student understand the concepts of electron displacement, resonance, H-bonding, Aromaticity and Stereochemistry, determination of reaction mechanisms by kinetic and non-kinetic methods and Aliphatic and aromatic substitution reactions.

COURSE OUTCOME: At the end of the Semester I, the students will be able to	**Unit**	**Hrs. /S**
CO1: discuss the concepts of electron displacement, resonance, H-bonding and aromaticity.	1	18
CO2: describe optical activity of organic compounds, projection formulae-Newman, Sawhorse and Fischer Configuration, nomenclature, Geometrical isomerism - types and determination by physical and chemical methods.	2	18
CO3: explain various organic reaction intermediates, types of reactions, collision theory and Transition state theory-Hammond postulate-microscopic reversibility, kinetic and non-kinetic methods of determining reaction mechanisms.	3	18
CO4: explain aliphatic nucleophilic and electrophilic substitution reactions-their mechanisms, stereo chemistry of these reactions.	4	18
CO5: explain aromatic electrophilic and nucleophilic substitution reactions and their mechanisms, effect of substrate structure, leaving group and attacking nucleophile.	5	18

UNIT I

CHEMICAL BONDING AND AROMATICITY (18 Hours)

Electron Displacement: Inductive and Field effects – Bond distances –Bond energies – Delocalized bonds – cross conjugation – Rules of Resonance – The resonance effect – Steric Inhibition of Resonance - Hyperconjugation – Hydrogen bonding – Bronsted and Lewis concepts – Factors affecting the strength of acids and bases.

Aromaticity: Aromaticity from NMR spectrum - Aromaticity in, six, five, and seven membered rings – Aromaticity in azulene, and heptalene – Alternant and Non alternant Hydrocarbons - Aromatic system with electron number other than six - Huckel's rule – Systems of 2 electron, 4 electron (antiaromaticity) 8 electron, 10 electron, more than 10 electron ($4n+2e^-$) and $4ne^-$ - Meso Ionic Compounds - Homo Aromatic Compounds.

UNIT II

INTRODUCTION TO STEREOCHEMISTRY (18 Hours)

Optical Isomerism: Optical Activity and Chirality- Classification of Optical active compounds - Newman, Sawhorse and Fischer Projection formulae – Configuration – Methods of determining configuration – Configurational Nomenclature – (Erythro and Threo – D & L, R & S Nomenclature)- Stereochemistry of allenes, spiranes, adamantoids and catenanes - Biphenyl derivatives and Atropisomerism - Stereochemistry of Ansa compounds and Cyclophanes - Concept of Prochirality, Topicity, Prostereo Isomerism, Equivalent, Enantiotopic and Diastereotopic Ligands - Stereospecific and Stereoselective Synthesis - Resolution, Racemisation and Asymmetric Synthesis - Cram's and Prelog rule.

Geometrical isomerism: Cis – Trans Isomerism E-Z nomenclature – determination of geometrical isomers using physical and chemical methods.

UNIT III

DETERMINATION OF REACTION MECHANISM (18 Hours)

Organic reactive Intermediates: Generation and stability and reactivity of carbocation, carbanion, free radical, carbenes and nitrenes.

Types of Mechanism – Types of Reaction - Energy profile (Collision and Transition State Theory) – Kinetic and Thermodynamic control– Hammond postulate - microscopic reversibility – Methods of Determining Reaction Mechanism.

UNIT IV

ALIPHATIC SUBSTITUTION REACTION (18 Hours)

Nucleophilic Substitution : S_N1 and S_N2 mixed S_N1 and S_N2 and SE^i mechanism – Stereochemistry of substitution reactions - Steric Orientation in S_N1 and $S_N2$mechanism - Neighbouring group mechanism - Neighbouring group participation Effect of substrate structure, attacking nucleophile, leaving group and reaction mechanism – Effect of the solvent - Nucleophilic substitution at an allylic, vinylic and aliphatic trigonal carbons - Ambident nucleophiles and ambident substrates - Mechanism of esterification and hydrolysis.

Electrophilic Substitution Reaction: Electrophilic Substitution reaction at aliphatic saturated carbon - S_E1, S_E2 and S_Ei mechanism - Reactivity.

UNIT V

AROMATIC SUBSTITUTION REACTION (18 Hours)

Electrophilic Substitution Reaction: π and Sigma complexes - S_E1 mechanism - Mechanism of Nitration, Halogenation, Sulphonation, Friedel Crafts Alkylation and Acylation reactions - Orientation and Reactivity in Monosubstituted rings.

Nucleophilic Substitution: SNAr, S_N1 and Benzyne Mechanism - Reactivity - Effect of substrate structure, leaving group, attacking nucleophile.

References

1. Peter Sykes, A Guidebook to Mechanisms in Organic Chemistry, 6th Ed., Longmans Scientific and Technical, Essex, 1986.
2. S.M. Mukerjee and S.P. Singh, Reaction Mechanism in Organic Chemistry, Mc Milan India Ltd., 1975.
3. E.L. Eliel, Stereochemistry of Carbon Compounds, McGraw Hill, 1962.
4. D. Nasipuri, Stereochemistry of Organic compounds, 2nd Ed, New Age International, New Delhi, 1972.
5. E.L. Eliel, N.C. Allinger, S.J. Angyal and G.A. Morrison, Conformational Analysis, Interscience, New York, 1965.
6. Jerry March, Advanced Organic Chemistry, 4th Ed., John Wiley, New York, 1992.
7. V.M. Potapov, Stereochemistry, MIR Publishers, Moscow 1979.

UNITS	TOPIC	LECTURE HOURS	MODE OF TEACHING
UNIT I: CHEMICAL BONDING AND AROMATICITY			
	Inductive effect, Field effect, hyperconjugation, hydrogen bonding, Definition- Huckel's rule-systems of 2 electrons, 4 electron, 8 electron, 10 electron, more than 10 electrons.	3	ICT
	Inductive and Field effects – Bond distances –Bond energies – Delocalized bonds – cross conjugation – Rules of Resonance – The resonance effect – Steric Inhibition of Resonance - Hyperconjugation – Hydrogen bonding – Bronsted and Lewis concepts – Factors affecting the strength of acids and bases. Aromaticity from NMR spectrum, Alternant and Non-alternant hydrocarbons, Meso Ionic Compounds and Homo Aromatic Compounds	13	Lecture
	Steric inhibition of resonance, Hydrogen bonding, Classifying compounds as aromatic, non-aromatic and anti-aromatic.	2	Seminar/ Assignment /Quiz
Unit II : INTRODUCTION TO STEREOCHEMISTRY			
	Definition of stereoisomerism, classification, explanation with suitable examples, Cram's and Prelog rule.	2	ICT
	Concepts of optical activity, methods of determining configuration, resolution, racemization, asymmetric synthesis, stereochemistry of allenes, spiranes, adamantoids, catenanes, cyclophanes, biphenyl derivatives and Atropisomerism, concepts of prochirality, topicity, prostereoisomerism, equivalent enantiotopic and diastereotopic ligands, stereospecific and stereoselective synthesis.	12	Lecture
	Assigning Erythro and Threo, R, S-configuration, E, Z configuration for alkenes, syn-anti configuration for oximes, classification of homotopic, enantiotopic and diastereotopic ligands.	2	seminar/assignment/ quiz

	Ball and stick model for projection formula-Sawhorse for organic compounds, Cram's and prelog rule.	2	Animation videos
Unit III: DETERMINATION OF REACTION MECHANISMS			
	Energy profile diagram-collision and transition state theory	2	ICT
	Generation and stability of reactive intermediates, their reactivity, types of reactions- kinetic and thermodynamic controlled, Hammond postulate, microscopic reversibility, kinetic and non-kinetic methods of determining reaction mechanisms.	14	Lecture
	Identifying the kind of intermediates involved in the reactions, generation, stability and reactivity of carbocation, carbanion, free radicals, carbenes and nitrenes.	2	Quiz/Seminar/Assignment
Unit IV: ALIPHATIC SUBSTITUTION REACTION			
	S_N1 and S_N2 mixed S_N1 and S_N2 and S_Ei mechanism, Stereochemistry of substitution reactions - Steric Orientation in S_N1 and S_N2 mechanism. Neighbouring group mechanism - Neighbouring group participation	4	ICT
	Concepts, mechanism, stereochemistry and factors influencing nucleophilic Substitution and Electrophilic Substitution Reaction	12	Lecture
	Neighbouring group participation, Ambident nucleophiles and ambident substrates - Mechanism of esterification and hydrolysis.	2	Seminar
Unit V: AROMATIC SUBSTITUTION REACTION			
	S_E1 mechanism, S_NAr, S_N1 and Benzyne Mechanism	3	ICT
	Electrophilic Substitution Reaction: π and Sigma complexes - S_E1 mechanism - Mechanism of Nitration, Halogenation, Sulphonation, Friedal Crafts Alkylation and Acylation reactions, Orientation and Reactivity in Monosubstituted rings, Nucleophilic Substitution: S_NAr, S_N1 and Benzyne Mechanism - Reactivity - Effect of substrate structure, leaving group, attacking nucleophile.	13	Lecture
	Orientation and Reactivity in Monosubstituted rings, Effect of substrate structure, leaving group, attacking nucleophile.	2	Seminar

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	3	3	3.5	3.5	4	3	1.5	4	3.2
CO2	3	3	3	3	3.5	3	3	3	1	4	3.0
CO3	3	3	3	3	3.5	4	3	3.5	1	4	3.1
CO4	3	3	3	3	3.5	4	4	3	1	4	3.2
CO5	3	3	3	3	3.5	4	4	3.5	1	4	3.2
Mean Overall Score											3.14

Result: The Score for this Course is 3.6 (High Relationship)

UNIT	Part A(5X5=25m)	Part B (5 X 10 = 50m) Either or Pattern
I	K1 / K4	K2 / K3(5m), K4(5m)
II	K4 / K3	K1/ K2
III	K2 / K4	K3/ K1
IV	K4(2.5m), K3(2.5m)/K2	K4 / K3
V	K3/K1	K3(5m), K4(5m) / K4

Programme :M.Sc Chemistry **CORE 3**
Semester : I **Hours : 6 /W, 90 Hrs./S**
Sub. Code : P22CD3 **Credits : 4**

TITLE OF THE PAPER: PHYSICAL CHEMISTRY I

Pedagogy	Hours	Lecture	Peer Teaching/Seminar/Discussion/Problem solving session/Quiz/Lab session/videos/Demonstration class/Library session.	ICT
	6	4	1	1

PREAMBLE: The objective of the course is to emphasize the concepts of Quantum Chemistry, Group Theory, Thermodynamics and Electrochemistry.

COURSE OUTCOME: At the end of the Semester, the Students will be able to	Unit	Hrs. /S
CO1: discuss the basic aspects of quantum chemistry and derive Schrodinger wave equation	1	18
CO2: explain symmetry elements and symmetry operations and point grouos, and able to construct group multiplication table	2	18
CO3: discuss General laws of enthalpy, entropy, free energy concepts, Partial molar quantities, chemical potential, fugacity, activity coefficientsand Third law of thermodynamics.	3	18
CO4: describe the concepts of conductometric titrations and solubility products	4	18
CO5: explain Overvoltage, Corrosion and Prevention of Corrosion, Butler Volmer and Tafel equation & Different types of Storage batteries.	5	18

UNIT I : QUANTUM CHEMISTRY I (18 Hours)

Inadequacy of classical mechanics: Black body radiation - Planck′s quantum theory -Postulates - Derivation of Planck′s radiation law to explain cavity radiation – photoelectric effect, explanation by quantum theory - Compton effect - explanation by quantum theory and derivation of Compton shift in wavelength. Wave - particle dualism: De Broglie′s concept of matter waves - experimental verification - Davisson and Germer experiment - Heisenberg Uncertainty principle. Postulates of quantum mechanics. Wave nature of electron, Interpretation of the wave function, Normalized and orthogonal wave function, Eigen functions and Eigen values - Significance- Linear and Hermitian operators - Significance - Schrodinger time-independent wave equation- derivation.

UNIT II
GROUP THORY I (18 Hours)

Symmetry elements and symmetry operations– - Groups –Properties of groups - Types of groups - group multiplication table (C_2V, C_3V) - Subgroups, similarity transformation and classes – Mulliken symbols – Reducible and irreducible representations – Reduction formula – Great Orthogonality theorem; Character table- Construction of character tables - C_2V, C_3V and D_{2h}.

UNIT III

THERMODYNAMICS I (18 Hours)

General laws of enthalpy, entropy and free energy concepts - Systems of variable compositions - Partial molar quantities- definitions- physical significance - chemical potential- variation of chemical potential with temperature and pressure. Determination of partial molar properties - Gibbs Duhem equation - fugacity - Definition- determination of fugacity of real gases - variation of fugacity with temperature and pressure-activity coefficient- Determination of activity and activity coefficients of non-electrolytes. Third law of thermodynamics - Nernst heat theorem - Planck, Lewis and Randall statement- Determination of absolute entropy- Unattainability of absolute zero - Exceptions of third law.

UNIT IV

ELECTROCHEMISTRY I (18 Hours)

Debye - Huckel theory - Derivation of Debye Huckel Onsager equation- Experimental verification - Wein Effect, Debye Falkenhagen effect - Debye Huckel limiting law- Conductometry - Conductometric titrations and its applications. Determination of solubility product, Degree of dissociation of weak acid - Standard electrode potential and EMF - Concentration cells with and without transference- Determination of equilibrium constants, dissociation constants and solubility product.

UNIT V

ELECTROCHEMISTRY II (18 Hours)

Hydrogen oxygen overvoltage - Theories of overvoltage – Corrosion - Types of corrosion - Dry and Electrochemical - Factors influencing corrosion – Prevention of Corrosion : Sacrificial anodic method, impressed current cathodic protection, protective coatings, deaeration, dehumidification, inhibitors, passivation - Butler Volmer equation- Tafel equation- Storage battery- Lead acid storage battery - Nickel Cadmium cell- Fuel cells - Classification of fuel cells H_2-O_2 fuel cell – Hydrocarbon - O_2 cell - Solar Cell.

References

1. G.R.Chatwal & S.K.Anand, Quantum Mechanics, 2nd Ed., Himalaya Pub. House, 1989.
2. R.K. Prasad, Quantum Chemistry, 4th , New Age International Publishers, Reprint 2015.
3. Puri, Sharma and Pathania, Principles of Physical Chemistry, Vishal publishers, 2014
4. A.K.Chandra, Introductory Quantum Chemistry 3rd Ed., Tata McGraw Hill Pub. Reprint 1993.
5. K.V.Raman, Group Theory and its Applications to Chemistry, 1st Ed., Tata McGraw Hill Pub.
6. S.Swarnalakshmi, T. Saroja &R.M.Ezhilarasi, A Simple Approach to Group Theory in Chemistry, 1st Ed., Universities Press, Reprint 2012.
7. J.Rajaram&J.C.Kuriacose, Thermodynamics, 2nd Ed., Vishal Pub. 1993.
8. B. Viswanathan, R.Venkataraman, K.Rengarajan, D.Sundaram&P.S.Raghavan, Electrochemistry, 1st Ed., S.Viswanthan Pub. Pvt Ltd., 2007.
9. Ramakrishnan & Gopinathan, Group theory in chemistry, Vishal publication, 2005.
10. F. Albert Cotton, Chemical Applications of Group Theory, 3rd Ed., Wiley India Edition
11. S. Glasstone, Thermodynamics for chemists, East - West Press private Ltd.,
12. D.A. McQuarrie and J.D. Simon, Physical chemistry-A molecular Approach, Viva Books (p) Ltd.,
13. John O.M. Bockris & Amulya K.N. Reddy, Modern Electrochemistry Vol.2, 1st Ed., Plenum & Rosetta, Reprint 1977.

UNITS	TOPIC	LECTURE HOURS	MODE OF TEACHING
UNIT 1: **QUANTUM CHEMISTRY I**			
	Black body radiation, Planck′s quantum theory, photoelectric effect, Davisson and Germer experiment.	3	ICT
	Compton effect, Planck′s radiation law, Schrodinger time-independent wave equation, Heisenberg Uncertainty principle Eigen functions and Eigen values, Significance of operators.	12	Lecture
	Eigen functions and Eigen values, Significance of operators.	3	Problem solving
UNIT II**: GROUP THEORY I**			
	Group multiplication table (C_2V, C_3V)	3	ICT
	Symmetry elements, symmetry operators and Types of groups.	9	Lecture
	Mulliken symbols – Reducible and irreducible representations – reduction formula – Great Orthogonality theorem; Character table- Construction of character tables - C_2V, C_3V and D_{2h}.	6	Lecture
UNIT III **THERMODYNAMICS –I**			
	Laws of enthalpy, entropy and free energy concepts, Partial molar quantities chemical potential.	11	Lecture
	Gibbs Duhem equation, fugacity, activity coefficients and absolute entropy.	3	ICT
	Third law of thermodynamics, Nernst heat theorem, Planck, Lewis and Randall statement.	4	Seminar
UNIT 1V	**ELECTROCHEMISTRY I** Debye - Huckel theory - Derivation of DebyeHuckel Onsager equation- Experimental verification - Wein Effect, Debye Falkenhagen effect - Debye Huckel limiting law	15	Lecture
	Conductometry - Conductometric titrations and its applications. Determination of equilibrium constants, dissociation constants and solubility product. Measurement of EMF	2	Demo in Lab
	Determination of solubility product, Degree of dissociation of weak acid - Standard electrode potential and EMF - Concentration cells with and without transference.	1	Seminar/ Assignment

UNIT V	**ELECTROCHEMISTRY II** Hydrogen oxygen overvoltage - Theories of overvoltage – Butler Volmer equation- Tafel equation- Corrosion - Types of corrosion - Dry and Electrochemical - Factors influencing corrosion – Prevention of Corrosion: Sacrificial anodic method, impressed current cathodic protection, protective coatings, deaeration, dehumidification, inhibitors, passivation. - Storage battery- Lead acid storage battery - Nickel Cadmium cell- Fuel cells - Classification of fuel cells H_2-O_2 fuel cell – Hydrocarbon - O_2 cell - Solar Cell.	13 3 2	Lecture Videos Seminar/ Assignment

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	5	4	4	4	1	5	4	4	3	3	3.7
CO2	5	3	3	5	1	5	4	4	3	3	3.6
CO3	5	4	4	4	1	5	4	4	3	3	3.7
CO4	5	3	3	5	1	5	4	4	3	3	3.6
CO5	5	3	3	5	1	5	4	4	3	3	3.6
Mean Overall Score											3.64

The Score for this Course is 3.64 (High Relationship)

UNIT	Part A(5X5=25m)	Part B (5 X 10 = 50m) Either or Pattern
I	K1 (5m)	K2 (10 m)
II	K2 (5m)	K1 (10 m)
III	K3 (5m)	K4 (10 m)
IV	K3 (5m)	K4 (10 m)
V	K3(2.5m)/K1(2.5m)	K3 (10 m)

Programme : M.Sc Chemistry **CORE 4**
Semester : I & II **Hours : 6 /W, 90 Hrs./S**
Sub. Code : P22CD4P **Credits : 4**

TITLE OF THE PAPER: INORGANIC CHEMISTRY PRACTICAL

Pedagogy	Hours	Lab session//Demonstration class/Viva voce	
	6	6	
PREAMBLE: The objective of the course is to make the student understand the importance of semi micro Qualitative analysis of given inorganic mixture of basic radicals containing two common radicals and two rare radicals and prepare few inorganic complexes.			
COURSE OUTCOME: At the end of the Semester, the Students will be able to		Unit	Hrs.
CO1: demonstrate the method of analyzing a mixture of basic radicals		1	70
CO2: prepare crude and recrystallized samples of few inorganic complexes.		2	20

INORGANIC CHEMISTRY PRACTICAL

I : INORGANIC PREPARATION

1. Preparation of potassium tris(oxalato)chromate (III) trihydrate
2. Hexathiourea lead (II) nitrate
3. Tris thioureacopper(I) sulphate complex
4. Tetramminecopper(II) sulphate
5. Preparation of microcosmic salt

II. SEMIMICRO QUALITATIVE ANALYSIS

Semimicro qualitative analysis of mixtures containing two common and two rare cations. The following are the rare cations to be included: W, Mo, Ti, Te, Se, Ce, Th, V and Li.

References

1. J. Bassett *et al,* Text Book of Quantitative Chemical Analysis", 5th Edition, ELBS, Longmann, U.K., 1989.
2. V.V. Ramanujam, "Inorganic Semimicro Qualitative Analysis", The National Publishing Co,Ed.3, 2007
3. V.Venkatesan, R. Veerasamy, A.R.Kulandaivelu, Basic Principles of Practical Chemistry, S.Chand and Sons, 2004.
4. S.Sundaram, P.Krishnan and P.S.Ragavan, Practical Chemistry, Viswanathan Printers and Publishers.,1993.
5. Subash-Satish, Advanced Inorganic Analysis.

UNITS	TOPIC	LECTURE HOURS	MODE OF TEACHING
Unit 1 : Analysis of a mixture of inorganic radicals			
	Two Common Cations and two rare cations from Group I to Group VI and Zeroth group	75	Lab Session
	Two Common Cations and two rare cations	10	Demonstration
	Two Common Cations and two rare cations	5	Viva
Unit 1 : Synthesis of inorganic complex of certain transition metals			
	Chromium, Lead, Copper(I), Copper (II), and microcosmic salt	35	Lab Session
	Crude and recrystallised sample	10	Demonstration
	Chromium, Lead, Copper(I), Copper (II), and microcosmic salt	5	Viva

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	4	3	3	4	4	4	4	4	4	4	3.8
CO2	4	3	3	4	4	4	4	4	4	4	3.8
Mean Overall Score											3.5

The Score for this Course is 3.8 (High Relationship)

Programme : M.Sc Chemistry **ELECTIVE: 1**
Semester : I **Hours : 5 /W, 75 Hrs./S**
Sub. Code : P22DSD1 **Credits :4**

TITLE OF THE PAPER: MOLECULAR SPECTROSCOPY & ANALYTICAL CHEMISTRY I

Pedagogy	Hours	Lecture	Peer Teaching/Seminar//Discussion//Problem solving session/Quiz/videos/Library session	ICT
	5	3	1	1

PREAMBLE: The objective of the course is to make the student to comprehend the principle, instrumentation and applications of various spectra such as UV, IR, Raman, Mass and Chromatographic techniques.

COURSE OUTCOME: At the end of the Semester, the Students will be able to	Unit	Hrs. /S
CO1: demonstrate the fundamentals of molecular spectroscopy and UV spectroscopy.	1	15
CO2: demonstrate the fundamentals of vibrational spectroscopy, the selection rules, Instrumentation and the interpretation of IR spectra.	2	15
CO3: explain the underlying principle of Rayleigh and Raman scattering, differentiate stokes and antistokes lines, Raman and IR spectra and its applications in the structural determination of compounds.	3	15
CO4: demonstrate the fundamentals of mass spectrometry and mass spectra of important functional groups.	4	15
CO5: explain the principle, instrumentation and applications of Gas liquid chromatography, HPLC and Electrophoresis.	5	15

UNIT I

FUNDAMENTALS OF SPECTROSCOPY& UV SPECTROSCOPY (15 Hours)

Interaction of molecules with electromagnetic radiation – types of regions and representation of spectra. Resolution and intensity of spectral transition signal to noise ratio, width of spectral lines- collision broadening, Doppler broadening, and Heisenberg uncertainty principle - Intensity of spectral lines brief idea of selection rules and transition probability, Boltzmann distribution. Enhancing sensitivity of spectral lines: Fourier transform (FT) and computer averaging techniques (CAT).

Electronic spectra of molecules: Frank–Condon Principle, selection rules (brief idea), types of electronic transitions – Chromophore, auxochrome, bathochromic and hypsochromic shift- hyperchromic and hypochromic shift- Factors affecting absorbance, Woodward Fieser rules (only for conjugated dienes)- steric inhibition of resonance- Applications. A few examples of natural conjugated systems absorbing in visible region – instrumentation of double beam UV spectrophotometer.

UNIT II

VIBRATIONAL SPECTROSCOPY (15 Hours)

IR spectroscopy – Bonds as anharmonic oscillator - Morse curve - Oscillation frequency (only equation) – explaining fundamental absorptions, first and second overtones with respect to Boltzmann distribution - selection rules – fundamental vibrations of polyatomic molecules, combination and difference bands- Instrumentation and sampling techniques in IR spectroscopy. Fermi resonance, fingerprint region, characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, esters, amides,

ethers, phenols, amines, carbonyl compounds, acids. Effect of solvent and hydrogen bonding on vibrational frequencies, uses of group frequencies in the structural elucidation of metal complexes containing cyanide, nitro, ammine, thiocyanate and halogens as ligands – metal carbonyls.

UNIT III

RAMAN SPECTROSCOPY & ROTATIONAL SPECTROSCOPY (15 Hours)

Raman effect- Rayleigh and Raman scattering, Stokes and anti-Stokes radiation, molecular polarizability, Raman selection rules, rule of mutual exclusion, Depolarization ratio, instrumentation. Combined uses of IR and Raman spectroscopy in the structural elucidation of simple molecules like H_2O, ClF_3, SO_2, CO_2, N_2O. Advantages of Raman spectroscopy over IR spectroscopy. Differences between Raman and IR spectroscopy.

Microwave Spectroscopy: Rotational spectra of diatomic molecules, frequency separation – determination of moment of inertia and bond length.

UNIT IV (15 Hours)

MASS SPECTROMETRY

Mass spectrometry, ion production – electron impact and chemical ionization, field desorption, electrospray ionization, MALDI ion analysis- quadrupole mass spectrometry, time of flight. Determination of molecular formula: molecular ion peak, base peak, metastable peaks and isotope peaks, nitrogen rule, ring rule, fragmentation, retro Diels-Alder fragmentation- McLafferty rearrangement – Mass spectra of various functional groups containing compounds to be studied: aromatic, aliphatic hydrocarbons, ketones, acids, esters, amides, ethers, alcohols, amine and nitriles. Fragmentation patterns of heterocyclic compounds (furan, pyrrole and pyridine only)

UNIT V

CHROMATOGRAPHY (15 Hours)

Chromatography: Gas- Liquid chromatography, Principles, retention volume, retention time, instrumentation- Column, Stationary phase, carrier gas, Detectors- Thermal conductivity, Flame Ionization, electron capture, Applications of GLC. High performance liquid chromatography - Ion exchange chromatography – applications.

Electrophoresis - principles and applications.

References

1. Jag Mohan, Organic Analytical Chemistry, Theory and Practice, 1st Ed., Narosa Publishing House, Reprint 2012.
2. P.S. Kalsi, Spectroscopy of organic Compounds, 1st Ed., Wiley Eastern Limited, 1993.
3. Y.R. Sharma, Elementary Organic Spectroscopy, 1st Ed., S. Chand and Company Ltd, 2011.
4. C.N. Banwell, Fundamentals of Molecular spectroscopy, 3rdEd., Tata McGraw-Hill Publishing company limited, 1992.
5. B.K. Sharma, Instrumental methods of chemical Analysis, 29th Ed., Goel Publishing house, 2013.
6. A.K. Srivastava and P.C. Jain, Chemical Analysis: An Instrumental Approach, 4th Ed., 2009.
7. R. Gopalan, Elements of Analytical chemistry, Sultan Chand & Sons, 2002.
8. G.R. Chatwal, Analytical Spectroscopy, 1st Ed., Himalaya Publishing House, 1996.

9. William Kemp, Organic Spectroscopy, 2nd Ed., English Language Book Society, Macmillan, 1987.
10. John R. Dyer, Applications of Absorption Spectroscopy of organic compounds, 1st Ed., Prentice Hall of India Private Ltd, Reprint 1987.
11. Skoog and West, Fundamentals of Analytical chemistry, 9th Ed., Saunders College Pub. 2004.
12. Robert M. Silverstein, G. Clayton Bassier & Terence C.Morrill, Spectrometric Identification of organic compounds, 1st Ed., Prentice Hall of India Pvt Ltd, Reprint 1987.
13. C.N.Banwell, Fundamentals of Molecular spectroscopy, 3rdEd., Tata McGraw-Hill Publishing company limited, 1992.
14. Willard, Merrit, Dean & Settle, Instrumental Methods of Analysis, 7th Ed., CBS Pub. 1986.

UNITS	TOPIC	LECTURE HOURS	MODE OF TEACHING
UNIT 1: **FUNDAMENTALS OF SPECTROSCOPY & UV SPECTROSCOPY**			
	Instrumentation of UV, Steric inhibition of resonance	3	ICT
	Fundamentals of molecular spectroscopy, Resolution, intensity, and width, selection rules, transition probability of spectral transitions, Fourier transform and CAT techniques Fundamentals of UV spectroscopy, Steric inhibition of resonance, Frank Condon principle, Factors affecting absorbance.	10	Lecture
	Natural conjugated systems, Bathochromic shift and hypsochromic shifts with examples	2	Seminar
UNIT II **VIBRATIONAL SPECTROSCOPY**			
	Anharmonic oscillator, Overtones, Selection rules, Fermi resonance, and Group frequencies	9	Lecture
	Calculation of fundamental vibration, Fingerprint region, Effect of solvent and hydrogen bonding.	3	Problem solving, Quiz, Seminar
	Instrumentation and sampling techniques, and Examples of IR spectral interpretation.	3	ICT
UNIT III **RAMAN SPECTROSCOPY AND ROTATIONAL SPECTROSCOPY**			
	Rayleigh and Raman Scattering, Stokes and Anti stokes lines, Rule of mutual exclusion, Combined uses of IR and Raman spectroscopy in the structural elucidation. Microwave spectroscopy, Rotational spectra of diatomic molecules, Determination of moment of Inertia	9	Lecture
	Difference between Raman and IR, Advantages uses of Raman spectroscopy	3	Peer teaching, seminar
	Instrumentation and Structural elucidation of simple molecules	3	ICT
UNIT IV **MASS SPECTROMETRY**			
	Instrumentation of Mass spectrometry, MALDI ion Analysis, Quadrupole mass spectrometry, Time of flight	3	ICT

	Identifying the compounds using mass spectra	2	Problem solving
	Fundamentals of mass spectrometry, Different ionization techniques, Determination of molecular formula using natural abundance, discussing different peaks involved, McLafferty rearrangement, Mass spectra of various functional groups	10	Lecture
UNIT V	**CHROMATOGRAPHY**		
	Principles of Chromatography, GC, HPLC, Ion exchange chromatography and Electrophoresis	9	Lecture
	Applications of GC, HPLC and Electrophoresis	3	Group discussion, Seminar.
	Instrumentation and working of GC, HPLC and Electrophoresis	3	ICT

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	4	3	4	3	1	4	4	4	3	4	3.4
CO2	4	3	3	3	1	4	4	4	3	4	3.3
CO3	4	3	4	3	1	4	4	4	3	4	3.4
CO4	4	3	3	3	1	4	4	4	3	4	3.3
CO5	4	3	3	3	1	4	4	3	3	4	3.2
Mean Overall Score											3.32

The Score for this Course is 3.32 (High Relationship)

UNIT	Part A(5X5=25m)	Part B (5 X 10 = 50m) Either or Pattern
I	K1 / K4	K2 / K3(5m), K4(5m)
II	K4 / K3	K3(5m), K4(5m) / K4
III	K2 / K4	K3/ K1
IV	K4(2.5m), K3(2.5m)/K2	K4 / K3
V	K3/K1	K1/ K2

Programme : M.Sc Chemistry **ELECTIVE: 1**
Semester : I **Hours : 5 P/W, 75 Hrs./S**
Sub. Code : P22DSD1 **Credits : 4**

TITLE OF THE PAPER: INDUSTRIAL CHEMISTRY

Pedagogy	Hours	Lecture	Peer Teaching/Seminar//Discussion//Problem solving session/Quiz/videos/Library session.	ICT
	5	3	1	1

PREAMBLE: The objective of the course is to make the student understand principles of chemical technology and to know about raw materials and energy for chemical industry, cement, ceramics, glass and fertilizers, small scale chemical industries & sugar and agro chemicals.

COURSE OUTCOME: At the end of the Semester, the Students will be able to	Unit	Hrs P/S
CO1: gain knowledge on basics of Commercial manufacturing process technology of various chemicals.	1	15
CO2: identify and analyze the raw materials and source of energy for chemical industries.	2	15
CO3: appreciate the chemistry of selected industrial processes including cement, ceramics glass and fertilizers.	3	15
CO4: recognize employment opportunities in areas of small chemical enterprisers which manufacture goods of personal or household services with the help of relatively smaller machines and a few workers and employees.	4	15
CO5: identify and discuss the basics of sugar and agrochemicals like insecticides, fungicides, herbicides and various pesticides.	5	15

UNIT I
PRINCIPLES OF CHEMICAL TECHNOLOGY (15 Hours)

Introduction: Basic principles – importance – classification – designing and modeling of chemical plants – unit process and unit operations.

Basic requirements of industrial reactors – choice and selectivity of reactor – basic principles of homogeneous and heterogeneous processes and reactors with examples.

UNIT II
RAW MATERIALS AND ENERGY FOR CHEMICAL INDUSTRY (15 Hours)

Raw materials – Characteristics of raw materials and their resources – methods of raw material concentrations – integral utilization of raw materials.

Energy for chemical industry – Fuels – classification of fuels – coal – fuel gases and liquid fuels – petroleum – cracking – Octane number – cetane number – composition and uses of coal gas, water gas, producer gas, oil gas and gobar gas.

UNIT III
CEMENT, CERAMICS, GLASS AND FERTILIZERS (15 Hours)

Cement: Manufacture – Wet Process and Dry process. Types, Analysis of major constituents, setting of cement, reinforced concrete. Cement industries in India.

Ceramics: Important clays and feldspar, glazing and verification.

Glass: Types, Composition, manufacture of Optical glass, colored glasses, lead glass and neutron absorbing glass.
Fertilizers: Fertilizer industries in India, Manufacture of ammonia, ammonium salts, urea, superphosphate, triple superphosphate and nitrate salts.

UNIT IV
SMALL SCALE CHEMICAL INDUSTRIES (15 Hours)

Electrothermal and electrochemical industries: electroplating – surface coating industries – oils, fats and waxes – soaps and detergents – cosmetics. Match industries and fireworks: manufacture of some industrially important chemicals like potassium chlorate, and red phosphorus – metal powders.

UNIT V
SUGAR AND AGRO CHEMICALS (15 Hours)

Sugar: Cane sugar manufacture, recovery of sugar from molasses, sugar estimation, sugar industries in India.
Agrochemical industries: Important categories of insecticides, fungicides, herbicides. Mode of action and synthesis of common pesticides like Gammexane, DDT, alathrin, Parathion, Malathion, Baygon, DDVP, Warfarin.

References

1. I.Mukhlyonov, Chemical Technology, Vol.1, Mir publication, Moscow, III edn., 1979.
2. A.K. De., Environmental Chemistry, Wiley Eastern Ltd.,11 edn., Meerut 1989.Chs 5-7
3. B.K Sharma – Industrial chemistry – Goel publishing house.
4. R. Norris Shreve and J.A. Brink, Jr. Chemical Process Industries. IV edn., McGraw Hill.
5. B.N. Chakrabarty, Industrial Chemistry, Oxford & IBH Publishing Co.
6. P.P. Singh, T.M. Joseph, R.G. Dhavale, College Industrial Chemistry, Himalaya Publishing House.

UNITS	TOPIC	LECTURE HOURS	MODE OF TEACHING
UNIT I: **PRINCIPLES OF CHEMICAL TECHNOLOGY**			
	Basic principles, importance classification of chemical industries	5	Seminar/ peer teaching
	Designing and modeling of chemical plants – unit process and unit operations.	5	Lecture
	Basic requirements of industrial reactors – choice and selectivity of reactor – basic principles of homogeneous and heterogeneous processes and reactors with examples.	5	ICT
UNIT II: **RAW MATERIALS AND ENERGY FOR CHEMICAL INDUSTRY**			
	Characteristics of raw materials and their resources – methods of raw material concentrations – integral utilization of raw materials.	5	Lecture
	Fuels – classification of fuels – coal – fuel gases and liquid fuels – petroleum – cracking – Octane number – cetane number	5	ICT

	Composition and uses of coal gas, water gas, producer gas, oil gas and gobar gas.	5	Seminar / assignment
UNIT III: **CEMENT, CERAMICS, GLASS AND FERTILIZERS**			
	Manufacture of cement by Wet Process and Dry process, Types and Analysis of major constituents, setting of cement, reinforced concrete	5	Lecture
	Cement and fertilizer industries in India. Ceramics: Important clays and feldspar, glazing and verification	2	Assignment/ discussion/ Library session
	Glass: Types, Composition, manufacture of Optical glass, colored glasses, lead glass and neutron absorbing glass.	3	ICT
	Fertilizers- Manufacture of ammonia, ammonium salts, urea, superphosphate, triple superphosphate and nitrate salts	5	Seminar
UNIT IV: **SMALL SCALE CHEMICAL INDUSTRIES**			
	Electrothermal and electrochemical industries: electroplating – surface coating industries	5	Lecture
	Oils, fats and waxes – soaps and detergents – cosmetics. Match industries and fire works	5	ICT
	manufacture of some industrially important chemicals like potassium chlorate, and red phosphorus – metal powders	5	Seminar
UNIT V: **SUGAR AND AGRO CHEMICALS**			
	Sugar: Cane sugar manufacture, recovery of sugar from molasses, sugar estimation, sugar industries in India	5	Lecture
	Important categories of insecticides, fungicides, herbicides	5	ICT
	Mode of action and synthesis of common pesticides like Gammexane, DDT, alathrin, Parathion, Malathion, Baygon, DDVP, Warfarin.	5	Seminar / peer teaching/ quiz

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	4	4	4	4	1	4	4	4	3	4	3.2
CO2	4	4	3	4	1	4	4	4	3	4	3.5
CO3	4	4	3	3	1	4	4	4	3	3	3.3
CO4	4	4	4	3	1	4	4	4	3	4	3.5
CO5	4	4	4	3	1	4	4	4	3	4	3.5
Mean Overall Score											3.4

Result: The Score for this Course is 3.4 (High Relationship)

UNIT	Part A(5X5=25m)	Part B (5 X 10 = 50m) Either or Pattern
I	K1 / K4	K2 / K3
II	K3 / K4(2.5m), K3(2.5m)	K1/ K4
III	K3(2.5m) ,K4(2.5m) / K1	K4 / K2
IV	K2 / K3	K3 / K3(5m), k4(5m)
V	K4 / K2	K3(5m), k4(5m) / K1

Programme :M.Sc Chemistry **SEC -I**
Semester : I **Hours : 2 /W, 30 Hrs/S**
Sub. Code : P2SED1 **Credits : 2**

TITLE OF THE PAPER: ANALYSIS OF SOIL, FOOD AND COSMETICS PRACTICAL

Pedagogy	Hours	Lab session//Demonstration class/Viva voce	
	2	2	
PREAMBLE: The objective of the course is to make the student understand the analysis of soil, food and cosmetics.			
COURSE OUTCOME: At the end of the Semester, the Students will be able to		Unit	Hrs.
CO1: demonstrate the analysis of soil		1	10
CO2: analyse the food adulterants, proteins, estimation of benzoic acid in food items and isolate casein and lactose from milk		2	15
CO2: determine Ca^{2+} and Zn^{2+} in talcum powder and sulphates in deodorants.		3	5

SKILL ENHANCEMENT COURSE I (PRACTICAL) - ANALYSIS OF SOIL, FOOD AND COSMETICS

UNIT 1- ANALYSIS OF SOIL

1. Determination of total Ca^{2+} and Mg^{2+} ions in soil as $CaCO_3$ complexometric titration method
2. Determination of soil organic carbon by Walkley-Black chromic acid wet oxidation method.

UNIT 2- ANALYSIS OF FOOD

3. Quantitative estimation of benzoic acid in food items.
4. Identification of adulterants in some common food items (coffee powder, turmeric powder, chilli powder, Asafoetida)
5. Qualitative determination and coagulation of protein in food items (egg, milk, bread)
6. Isolation of casein and lactose from milk.
7. Spectrophotometric identification and determination of Caffeine and benzoic acid in soft drinks (Demonstration only)

UNIT 3 - ANALYSIS OF COSMETICS

8. Determination of Ca^{2+} and Zn^{2+} in talcum powder by complexometric titration method
9. Determination of sulphates in deodorants by gravimetric method (Demonstration only)

References

1. Analytical chemistry – skill enhancement course- Krishna Chattopadhyay & Manas Mandal, CBS Publishers and distributers Pvt Ltd, 2022
2. Methods For The Determination Of Total Organic Carbon (Toc) In Soils And Sediments - Brian A. Schumacher – 2002
3. The Food Chemistry Laboratory - *A Manual for Experimental Foods, Dietetics, and Food Scientists* - Connie M. Weaver, James R. Daniel – CRC press, 2nd edition 2005.

Internal: 40
External: 60

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	4	4	4	4	1	5	4	5	5	4	4
CO2	4	3	4	4	1	5	4	5	5	4	3.9
CO3	4	4	4	4	1	5	4	5	4	4	3.9
Mean Overall Score											3.9

Result: The Score for this Course is 3.9 (High Relationship)

Programme :M.Sc Chemistry **CORE 5**
Semester : II **Hours : 6 /W, 90 Hrs./S**
Sub. Code : P22CD5 **Credits : 4**

TITLE OF THE PAPER: INORGANIC CHEMISTRY II

Pedagogy	Hours	Lecture	Peer Teaching/Seminar//Discussion//Problem solving session/Quiz/videos/Library session.	ICT
	6	4	1	1

PREAMBLE: The objective of the course is to make the student understand the basics of nuclear chemistry, modes of radioactive decay, types of nuclear reaction and artificial transportation, disposal of radioactive wastes.

COURSE OUTCOME: At the end of the Semester, the Students will be able to	Unit	Hrs. /S
CO1: discuss electron transfer reactions, various types of ligand substitution reactions and mechanisms in different geometries and its applications	1	18
CO2: identify the organometallic compounds and explain the different catalytic reactions.	2	18
CO3: derive the spectroscopic term symbols, draw the orgel diagram for weak field Oh and Td complexes. Explain Tanabe-Sugano diagram for d^3 complexes, discuss charge transfer spectra.	3	18
CO4: discuss nuclear spin and movements, modes of radioactive decay, nuclear stability, detection and determination of radioactivity, nuclear reactions.	4	18
CO5: discuss artificial transportation, methods of producing projectiles, activation, analyses and radiometric titration, radio isotopes and disposal of radioactive wastes.	5	18

UNIT I

REACTION MECHANISM OF COORDINATION COMPLEXES (18 Hours)

Electron transfer reactions – Inner sphere (ISET) and outer sphere (OSET) electron transfer processes. Role of bridging ligand with ISET reaction – tunneling transfer – multiple bridging in the activated complex in the ISET process. Complimentary and non complimentary ET reactions. Cross reactions in Marcus Hush theory.

Types of Ligand substitution reactions- mechanism. Dissociative mechanism (D), Associative mechanism (A), interchange mechanism (I), Labile and inert complexes- Substitution reactions in octahedral complexes – General mechanism, general rate law for A, D and I – Distinction between D, I and A pathways. Replacement of coordinated water, Anation reaction – Mechanism of acid hydrolysis, base hydrolysis- DCB mechanism- direct and indirect evidences in favour of the mechanism. Ligand substitution reactions without cleavage of M-L bond. Substitution in square planar complexes – general mechanism, trans effect - theories of trans effect - Applications of trans effect – synthesis of isomers of Pt (II) complexes – applications of substitution reactions in the synthesis of Pt and Co complexes.

UNIT II
CATALYSIS IN COMPLEXES (18 Hours)

Catalysis- General principles of catalysis – basic reactions involved in the catalysis by organometallic compounds. Hydrogenation of olefins (Wilkinson´s catalyst), hydroformylation of olefins using Cobalt or Rhodium catalyst (OXO Process), Oxidation of olefins to aldehydes and ketones (Wacker process): polymerization (Ziegler - Natta catalyst), Monsanto acetic acid synthesis from menthol, Cyclo oligomerisation of acetylene using nickel catalyst (Reppe′s catalyst). Synthetic gasoline by using ZSM-5 catalyst (Fischer- Tropsch and Mobil process), polymer bound catalyst.

UNIT III
ELECTRONIC SPECTRA OF COMPLEXES (18 Hours)

Spectroscopic term symbols for d^n ions – derivation of term symbols and ground state term symbols, Hund's rule, selection rules – breakdown of selection rules, spin-orbit coupling, band intensities, weak and strong field limits- correlation diagram, energy level diagrams. Orgel diagram for weak field Oh and Td complexes. Tanabe-sugano diagram for d^3 $[Cr(NH_3)_6]^{3+}$ complex. Charge transfer spectra.

UNIT IV
NUCLEAR CHEMISTRY I (18 Hours)

Fundamental particles- Nuclear spin and moments - n/p ratio –Binding energy and stability-Origin of nuclear forces - modes of radioactive decay-orbital electron capture-Nuclear isomerism - Internal conversion- Auger effect. Nuclear structure and stability- packing fraction- Mass Defect-Binding energy - salient features of the liquid drop and shell model-Detection and determination of activity by Geiger-Muller and Scintillation counters- Wilson-Cloud chamber. Nuclear reactions - Types - Nuclear cross section - Q value, threshold energy - compound nuclear theory - Nuclear fission, fusion and spallation reaction - Thermo nuclear reactions - stellar energy.

UNIT V
NUCLEAR CHEMISTRY II (18 Hours)

Artificial transmutation - methods of producing projectiles - Types of Accelerators - linear & cyclic – cyclotron - synchrotron- Betatron -Van de Graaff Accelerator. Activation analysis and Radiometric titrations- Applications of radio isotopes –Nuclear pollution- Disposal of radioactive wastes - Dilute and Disperse method - Delay and Decay method- Concentrate and Contain method - reprocessing of spent Uranium fuel and its disposal- Recent method to dispose critically dangerous radio wastes- chemical methods of disposal- other methods- reprocessing, immobilization and by Vitrification.

References

1.J.E. Huheey, Ellen A. Kaiter, Richard L. Kaiter & Okhil K. Medhi, Inorganic Chemistry, Principles of Structure &Reactivity, 4th Ed., Pearson, 2011.
2. B.R. Puri, L.R. Sharma & K.C. Kalia, Principles of Inorganic Chemistry, Vishal Pub.33 ed., 2017.

3. R. Gopalan &V. Ramalingam, Concise Coordination Chemistry, 1st Ed., Vikas Pub. House Pvt. Ltd., 2001.
4. F.A. Cotton, G. Wilkinson, G.A. Murillo& M. Bochmann, Advanced Inorganic Chemistry, 1stEd., Wiley Student Edn, 2007.
5. H.J. Emeleus &A.G. Sharpe, Modern aspects of Inorganic Chemistry, 4th Ed., ISBN, 1974.
6. R.S. Drago, Physical Methods in Inorganic Chemistry, 1st Ed., Affiliated East-West Press Pvt. Ltd., 1971.
7. M.C. Day and J. Selbin, Theoretical Inorganic Chemistry, Affiliated East West Press Pvt. Ltd. 2nd Ed., 1985.
8. J.D. Lee, Concise Inorganic Chemistry, Wiley India.
9. S.F.A. Kettle, Coordination chemistry, ELBS Ed.,
10. K.F. Purcell and J.C. Koltz, Inorganic Chemistry, Holt Saunders, 1977.
11. U. Malik, G.D. Tuli and R.D. Madan, Selected topics in Inorganic Chemistry, 1992.
12. R.D. Madan & Satya Prakash, Modern Inorganic Chemistry (Revised), S. Chand.
13. Satya Prakash, G.D. Tuli, S.K. Basu & R.D. Madan, Advanced Inorganic Chemistry, 1st Ed., S. Chand & Co, 2008.
14. F. Basolo and R.G. Pearson - Mechanisms of Inorganic reactions - Wiley Eastern.
15. U. Malik, G.D. Tuli and R.D. Madan, Selected topics in Inorganic Chemistry.
16. R. Gopalan, Elements of Nuclear Chemistry, 1st Ed., Vikas Pub. Pvt. Ltd., 1999.
17.C.V. Shekar, Nuclear Chemistry, 1st Ed., Dominant Pub. 2005.
18. H.J. Arnikar, Essentials of Nuclear Chemistry, 4th Ed., New Age International (P) Ltd., 2011.
19. S. Glasstone, Source Book of atomic energy.
20. B.K. Sharma, Nuclear chemistry, Goel Pub.

UNITS	TOPIC	LECTURE HOURS	MODE OF TEACHING
UNIT 1: **REACTION MECHANISMS OF COORDINATION COMPLEXES**			
	Electron transfer reactions – Inner sphere (ISET) and outer sphere (OSET) electron transfer processes. Role of bridging ligand with ISET reaction – tunneling transfer – multiple bridging in the activated complex in the ISET process. Ligand substitution reactions without cleavage of M-L bond. Substitution in square planar complexes – general mechanism, trans effect - theories of trans effect	9	Lecture
	Labile and inert complexes- Substitution reactions in octahedral complexes – General mechanism general rate law for A, D and I – Distinction between D, I and A pathways. Replacement of coordinated water, Anation reaction – Mechanism of acid hydrolysis, base hydrolysis- DCB mechanism- direct and indirect evidences in favour of the mechanism.	3	Lecture

	Complimentary and non complimentary ET reactions. Cross reactions in Marcus Hush theory. Types of Ligand substitution reactions-mechanism. Dissociative mechanism (D), Associative mechanism (A), interchange mechanism (I),	3	ICT
	Applications of trans effect – synthesis of isomers of Pt (II) complexes – applications of substitution reactions in the synthesis of Pt and Co complexes.	3	Seminar
UNIT II: **CATALYSIS IN COMPLEXES**			
	Catalysis- General principles of catalysis – basic reactions involved in the catalysis by organometallic compounds. hydroformylation of olefins using Cobalt or Rhodium catalyst (OXO Process), Monsanto acetic acid synthesis from menthol, Cyclo oligomerisation of acetylene using nickel catalyst (Reppe′s catalyst).	13	Lecture
	Hydrogenation of olefins (Wilkinson´s catalyst), Oxidation of olefins to aldehydes and ketones (Wacker process): polymerization (Ziegler - Natta catalyst)	3	Seminar
	Synthetic gasoline by using ZSM-5 catalyst (Fischer- Tropsch and Mobil process), polymer bound catalyst.	2	Group discussion
UNIT III: **ELECTRONIC SPECTRA OF COMPLEXES**			
	Spectroscopic term symbols for d^n ions – derivation of term symbols and ground state term symbols, Hund's rule, selection rules – breakdown of selection rules, spin-orbit coupling, band intensities, weak and strong field limits-correlation diagram, energy level diagrams	9	Lecture
	Orgel diagram for weak field Oh and Td complexes. Tanabe-sugano diagram for d^3 [Cr $(NH_3)_6$]$^{3+}$ complex. Charge transfer spectra.	9	Lecture
UNIT IV: **NUCLEAR CHEMISTRY I**			
	Nuclear spin and movements, origin of nuclear forces, modes of radioactive decay and nuclear stability	5	Lecture
	Liquid drop and shell model of nucleus	5	ICT
	Detection and determination of radioactivity	5	Lecture
	Nuclear reactions	3	Lecture
UNIT V: **NUCLEAR CHEMISTRY II**			
	Methods of producing projectiles, types of accelerators	4	ICT

	Activation, analyses and radiometric titration, application of radio isotopes.	4	Lecture
	Disposal of radioactive wastes	10	Seminar

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	4	3	3	4	1	4	4	4	3	4	3.4
CO2	4	4	4	4	1	4	4	4	3	4	3.6
CO3	4	3	3	4	1	4	4	4	4	4	3.5
CO4	4	3	3	4	1	4	4	4	2	4	3.3
CO5	4	4	4	4	1	4	4	4	3	4	3.6
Mean Overall Score											3.48

Result: The Score for this Course is 3.48 (Relationship)

UNIT	Part A(5X5=25m)	Part B (5 X 10 = 50m) Either or Pattern
I	K2 / K4	K3(5m), k4(5m) / K3
II	K3 / K4(2.5m), K3(2.5m)	K2/ K4
III	K4 / K1	K1/ K2
IV	K1 / K3	K4 / K3(5m), k4(5m)
V	K4(2.5m), K3(2.5m) / K2	K3/ K1

Programme : M.Sc Chemistry **CORE 6**
Semester : II **Hours : 5 /W, 75 Hrs./S**
Sub. Code : P22CD6 **Credits : 4**

TITLE OF THE PAPER: ORGANIC CHEMISTRY II

Peda gogy	Hours	Lecture	Peer Teaching/seminar/role play/discussion/tutorial/problem solving session/quiz/lab session/videos/demonstration class/library session.	ICT
	5	3	1	1

PREAMBLE: The objective of the course is to make the student recognize and analyze electrophilic, nucleophilic addition reactions, additions to carbonyl compounds, stereochemical requirement for α,β and cis elimination and their mechanisms, Bredt's rule, various free radical reactions with their mechanisms, various electrophilic and nucleophilic rearrangement with their mechanisms, difference between configuration and conformation, conformation of acyclic compounds- ethane, propane, n-butane, halo alcohols and diols, physical methods of conformational analysis, reactivity of acycliccompounds, conformational analysis of cyclohexane, mono and di substituted cyclohexanes, reactivity of cyclohexyl systems towards E_2 and cis-elimination, NGP, oxidation, intramolecular rearrangement, ester hydrolysis, substitution reactions, preparation and properties of compounds with two hetero atoms in ring and synthesis of heterocyclic compounds containing two hetero atoms in a six-membered ring.

COURSE OUTCOME: At the end of the SemesterII, the Students will be able to	Unit	Hrs /S
CO1: explain various reactions of addition to c-c multiple bond and c– hetero multiple bond (carbonyls only).	1	15
CO2: ELIMINATION AND FREE RADICAL REACTIONS; explain elimination and free radical reactions with their detailed mechanism, stereochemistry and Bredt's rule.	2	15
CO3: MOLECULAR REARRANGEMENTS classify the rearrangements into electrophilic and nucleophilic with suitable examples and to identify the rearrangements involving C-C and C-N migrations	3	15
CO4: CONFORMATIONAL ANALYSIS OF ACYCLIC & CYCLOHEXYL SYSTEMS: Draw the conformations of ethane, propane, n-butane halo alcohols, glycols, butane-2,3-diols and explain the physical methods of conformational analysis, reactivity of acyclic compounds and conformational analysis and reactivity of cyclohexyl systems.	4	15
CO5: HETEROCYCLIC RINGS discuss the preparation, properties of pyrazole, oxazole, thiazole, synthesis of benzofuran, thianaphthene, pyridazine, barbituric acid, pyrimidine, thymine and cytosine	5	15

UNIT-I

ADDITION TO C-C MULTIPLE BOND AND C− HETERO MULTIPLE BOND (CARBONYLS ONLY) (15 Hours)

Electrophilic addition: Formation of π complexes - Stereochemical Consequences - addition to cyclic Alkenes - Effect of substituent on the rate of addition-Addition to hydrogen halide. Alkyne-Hydroboration, Epoxidation and hydroxylation, Ozonolysis-Addition to conjugated diene- Diel′s Alder reaction

Nueleophilic addition: Addition to acrylonitrile - unsaturated carbonyl compounds (Michael-addition)

Addition to carbonyl compounds: Mechanism of Aldol, Benzoin, Claisen, Dieckmann condensation-Perkin, Knoevenagal, Mannich, Cannizaro, Darzen′s and Reformatsky reaction -Wittig Reaction and its modification.

UNIT-II

ELIMINATION AND FREE RADICAL REACTION (15 Hours)

α,β eliminations-E_2, E_1, E_1CB Mechanism - Stereochemical preferences-orientation of the double bond - Effect of substrate, base, leaving group and reaction medium - elimination Vs substitution - Pyrolytic cis elimination and their stereochemistry- Bredt′s rule.

α – Elimination –Carbenes – Singlet and triplet – generation – Reactions.

Free radical reaction: Halogenation, Addition, Oxidation, Reduction and Rearrangement reaction - Barton, Sandmeyer, Gomberg-Bechmann, Ullmann, Pschorr and Hunsdiecker reaction.

UNIT-III

MOLECULAR REARRANGEMENT (15 Hours)

Nucleophilic rearrangement - Nature of Migration - Migratory Aptitude - Memory effects – Longer Nucleophilic Rearrangements - Electrophilic Rearrangement - Mechanism of Wagner Meervain, Pinacol-Pinacolone, Benzil-Benzilicacid, Schmidt, Hoffmann, Wolff, Curtius, Fries, Favorskii, Stevens, Lossen, Beckmann, Neber, Demjanov, Dienone-Phenol, Bayer-Villiger, Claisen and Cope rearrangement.

UNIT-IV

CONFORMATIONAL ANALYSIS (15 Hours)

Configuration and conformation – conformation of acyclic compounds (Ethane, Propane, dimethyl propane, n-butane, 2,3-dimethyl butane, halo alcohols, glycols, 2,3-dibromo Butane, Butane–2,3-diol) - Physical methods for conformational Analysis – Conformation and Intra molecular Hydrogen Bonding - Reactivity.

Conformation of Monosubstituted and Disubstituted cyclohexanes. Conformation of cyclohexane - Monosubstituted cyclohexane -Disubstituted cyclohexane (1,1, 1,2, 1,3 & 1,4) - Reactivity - Examples of E_2 and Cis elimination, Neighbouring group participation, Oxidation, Intramolecular rearrangement, Ester-hydrolysis, S_N1, S_N2 and S_Ni reactions -Conformation of Decalins.

UNIT – V

HETEROCYCLIC COMPOUNDS (15 Hours)

Compounds with two Heteroatoms in ring -Preparation and properties of Pyrazole, Imidazole, Isoxazole, Oxazole, Thiazole, Isothiazole. Synthesis of Benzofuran, Thianaphthene, Isobenzofuran, Isothianaphthene.

Two Heteroatoms in a Six membered ring -Synthesis of Pyridazine, Barbituric acid, Pyrimidine, Thymine, Cytosine.

References

1 J. March, Advanced Organic Chemistry, 4thEdn, John Wiley, New York, 1992.
2. Peter Sykes, A Guidebook to Mechanisms in Organic Chemistry, 6thEdn., Longmans. Scientific and Technical, Essex, 1986.
3. F.S. Gould, Mechanism and Structure in Organic Chemistry, Holt, New York, 1959.
4 S.M. Mukerjee and S.P. Singh, Pericyclic Reactions, Macmillan, 1976.
5 E.L. Eliel, Stereochemistry of Carbon Compounds, McGraw Hill, 1962.
6 V.M. Potapov, Stereochemistry, MIR Publishers, Moscow 1979.
7 D. Nasipuri, Stereochemistry of Organic compounds, 2ndEdn, New Age International, New Delhi
8 E.L. Eliel, N.C. Allinger, S.J. Angyal and G.A. Morrison, Conformational Analysis, Interscience, New York, 1965.
9 R.M. Acheson, Chemistry of Heterocyclic Compounds, Wiley Eastern, 1992.
10 R.K. Bansal, Heterocyclic Chemistry – Synthesis, reactions and mechanism, Wiley Eastern, New Delhi, 1990.
11 V.K. Ahluwalia, Heterocyclic Chemistry, Revised Ed., Narosa Pub., 2016.

UNITS	TOPIC	LECTURE HOURS	MODE OF TEACHING
UNIT I: ADDITION TO C-C MULTIPLE BOND AND C− HETERO MULTIPLE BOND (CARBONYLS ONLY)			
	Stereochemical Consequences - addition to cyclic Alkenes - Effect of substituent on the rate of addition - Addition to hydrogen halide.	3	ICT
	Concepts of Electrophilic addition and Nueleophilic addition	10	Lecture
	Ozonolysis - Addition to conjugated diene- Diel′s Alder reaction	2	Seminar
UNIT II: ELIMINATION AND FREE RADICAL REACTION			
	α,β eliminations - E2, E1, E1CB Mechanism - Stereochemical preferences in elimination reactions, Bredt′s rule.	3	ICT
	α,β eliminations - E2, E1, E1CB Mechanism - Stereochemical preferences-orientation of the double bond - Effect of substrate, base, leaving group and reaction medium - elimination Vs substitution - Pyrolytic cis elimination and their stereochemistry - Bredt′s rule. α – Elimination –Carbenes – Singlet and triplet – generation – Reactions. **Free radical reaction:** Halogenation, Addition, Oxidation, Reduction and Rearrangement reaction - Barton, Sandmeyer, Gomberg-Bechmann, Ullmann, Pschorr and Hunsdiecker reaction	10	Lecture
	Carbenes – Singlet and triplet – generation – Free radical reactions	2	Seminar

Unit III: MOLECULAR REARRANGEMENT			
	Classification into electrophilic, nucleophilic, C-C & C-N migrations	4	ICT
	Various rearrangements with their detailed mechanism, suitable examples and synthetic utility.	11	Lecture
UNIT IV: CONFORMATIONAL ANALYSIS OF ACYCLIC AND CYCLOHEXYL SYSTEMS			
	Conformations of ethane, propane, n-butane halo alcohols, glycols, butane-2,3-diols, chair and boat conformations of cyclohexane, mono and di substituted cyclohexyl systems and decalins.	3	ICT
	Conformational analysis of of ethane, propane, n-butane halo alcohols, glycols, butane-2,3-diols, reactivity of acyclic compounds such as elimination, addition and substitution reactions with their stereo-electronic requirements. Conformational analysis of cyclo hexyl systems and their reactivity in elimination, NGP, oxidation, intramolecular rearrangement, ester hydrolysis, substitution reactions, conformational analysis of decalins.	10	Lecture
	Ball and stick model for conformations of acyclic and cyclohexyl systems	2	Demonstration with discussion
UNIT V: HETEROCYCLIC COMPOUNDS			
	Biological importance of benzofuran, thianaphthene, isobenzofuran, isothianaphthene, pyradizine barbituric acid, pyrimidine, thymine	4	ICT
	Preparative methods and explainations for the chemical properties of pyrazole, imidazole, isoxazole, thiazole, isothiazole, synthesis of benzofuran, thianaphthene, isobenzofuran, isothianaphthene, pyradizine barbituric acid, pyrimidine, thymine	11	Lecture

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	4	4	4	4	1	4	4.5	4.5	3	4.5	3.75
CO2	4	4.5	4	4	1	4	4.5	4.5	3	4.5	3.8
CO3	4	4	4	4.5	1	4	4.5	4.5	3	4.5	3.8
CO4	4	4	4	4.5	1	4	4.5	4.5	3.5	4.5	3.85
CO5	4.5	4	4	4.5	1	4	4.5	4.5	3.5	4.5	3.9
Mean Overall Score											3.82

Result: The Score for this Course is 3.82 (High Relationship)

UNIT	Part A(5X5=25m)	Part B (5 X 10 = 50m) Either or Pattern
I	K1 / K3	K4 / K2
II	K4(2.5m), K3(2.5m)/ K2	K1/ K4
III	K2 / K4	K3/ K3(5m), K4(5m)
IV	K3/ K3(2.5m) K4(2.5m)	K2 / K3
V	K4/K1	K3(5m), K4(5m) / K1

Programme : M.Sc Chemistry **CORE 7**
Semester : II **Hours : 6 /W, 90 Hrs./S**
Sub. Code : P22CD7 **Credits : 4**

TITLE OF THE PAPER: PHYSICAL CHEMISTRY II

Pedagogy	Hours	Lecture	Peer Teaching/Seminar/Discussion/Problem solving session/Quiz/Lab session/videos/Demonstration class/Library session.	ICT
	5	3	1	1

PREAMBLE: The objective of the course is to make the student to enlighten Quantum Chemistry, Group Theory, Thermodynamics, Phase rule, Chemical Kinetics, and Electrochemistry.

COURSE OUTCOME: At the end of the Semester, the Students will be able to	Unit	Hrs /S
CO1: Apply the Schrodinger wave equation to various systems	1	18
CO2: discuss the hybridization of atomic orbitals and representation of vibrational modes in non linear molecules and able to construct the character table for point groups C_2V and C_3V.	2	18
CO3: explain the laws of thermodynamics and apply the phase rule for various system	3	18
CO4: explain the various theories of chemical kinetics and kinetics in solution.	4	18
CO5: describe double layer model and Electrokinetic phenomena	5	18

UNIT I

QUANTUM CHEMISTRY II (18 Hours)

Particle in one dimensional and three-dimensional box –Rigid Rotor, Simple Harmonic Oscillator – Hydrogen atom – separation of variables – Radial and angular wave functions - quantum numbers.

UNIT II

GROUP THEORY II (18 Hours)

Applications of group theory - Hybridizations of atomic orbitals in CH_4, $[PtCl_4]^{2-}$. Determination of representations of vibrational modes in non-linear molecules H_2O, NH_3, BF_3 and CH_4 molecules. SALC procedure - Evaluation of energy and molecular orbitals of systems like ethylene and butadiene. Selection rules for vibrational IR and Raman spectra -electronic spectra of HCHO and ethylene.

UNIT III

THERMODYNAMICS AND PHASE RULE (18 Hours)

Law of mass action - Van′t Hoff Reaction isotherm - Temperature - dependence of equilibrium constant - The Van′t Hoff equation - Pressure dependence of equilibrium constant. Applications of phase rule to Fe-C system. Three component system Roozeboom plots acetic acid - chloroform - water system - plait point - system involving two solids and a liquid NaCl - Crystallization of pure components, formation of hydrates, formation of double salts with examples, salting out phenomenon.

UNIT IV **(18 Hours)**

CHEMICAL KINETICS I

Collision theory of Bimolecular reactions: ARR theory. Theories of unimolecular gaseous reactions – Hinshelwood theory, RRK theory, RRKM theory.

Kinetics in solution - Comparison between gas phase and solution - Collision in solution - ARR theory applicable to reactions between ions in solution - salt effect, primary & secondary and isotope effects.

UNIT V

ELECTROCHEMISTRY III **(18 Hours)**

Ion association - Bjerrum treatment of ion association - factors influencing ion association. Electrodics: electrode - electrolyte interface - formation of double layer- Helmholtz and stern model - Electrocapillarity - electrocapillary curves - Lipmann equation - Measurement of interfacial tension using Lipmann capillary electrometer - Lipmann potential. Electrokinetic phenomena –electroosmosis - Streaming potential – Electrophoresis - Zeta potential.

REFERENCES

1. G.R.Chatwal & S.K.Anand, Quantum Mechanics, 2nd Ed., Himalaya Pub. House, 1989.
2. R.K. Prasad, Quantum Chemistry, 4th , New Age International Publishers, Reprint 2015.
3. Puri, Sharma and Pathania, Principles of Physical Chemistry, Vishal publishers, 2014.
4. John O.M. Bockris & Amulya K.N.Reddy, Modern Electrochemistry Vol.1, 1st Ed., Plenum &Rosetta, Reprint 1977.
5. A.K. Chandra, Introductory Quantum Chemistry 3rd Ed., Tata McGraw Hill Pub. Reprint 1993.
6. K.V. Raman, Group Theory and its Applications to Chemistry, 1st Ed., Tata McGraw Hill Pub. Reprint 1994.
7. S. Swarnalakshmi, T.Saroja & R.M. Ezhilarasi, A Simple Approach to Group Theory in Chemistry, 1st Ed., Universities Press, Reprint 2012.
8. J. Rajaram&J.C.Kuriacose, Thermodynamics, 2nd Ed., Vishal Pub. 1993.
9. B.Viswanathan, R.Venkataraman, K.Rengarajan, D.Sundaram &P.S. Raghavan, Electrochemistry, 1st Ed., S. Viswanthan Pub. Pvt Ltd., 2007.
10. F. Albert Cotton, Chemical Applications of Group Theory, 3rd Ed., Wiley India Edition, Reprint 2010.
11. D.A. McQuarrie and J.D.Simon, Physical chemistry. A molecular Approach, Viva Books(p) Ltd.,
12. Ramakrishnan & Gopinathan, Group theory in chemistry, Vishal publication, 2005.
13. Keith J.Laidler, Chemical Kinetics, 2nd Ed., Tata McGraw Hill Pub. Co., Ltd., Reprint 1986.
14. Gurdeep Raj, Chemical Kinetics, 1st Ed., Goel Pub. House, 1985.
15. S.P.Singh , Chemical Kinetics, Goel Pub.
16. Subash and Satish, Chemical kinetics and Catalysis, Jeyaprakash & Co.

UNITS	TOPIC	LECTURE HOURS	MODE OF TEACHING
UNIT 1 : **QUANTUM CHEMISTRY II**			
	Schrodinger wave equation to Particle in one dimensional and three-dimensional box, Tunneling Degeneracy removal of degeneracy.	4	ICT

	Radial and angular wave functions and quantum numbers.	10	Lecture
	Solution for wave function to Rigid Rotor, Simple Harmonic Oscillator and Hydrogen atom.	4	Problem solving
UNIT 2 : **GROUP THEORY II**			
	Character table for point groups C_2V and C_3V. Hybrid orbitals in nonlinear molecules, Hybridisation of atomic orbitals in CH_4 and $[PtCl_4]^{-2}$.	10	Lecture
	SALC procedure - Evaluation of energy and molecular orbitals of systems like ethylene and butadiene.	4	ICT
	Representations of vibrational modes in non-linear molecules H_2O, NH_3 and BF_3 molecules. Selection rules for vibrational IR and Raman spectra.	4	Seminar
UNIT 3 : **THERMODYNAMICS AND PHASE RULE**			
	Law of mass action, Van′t Hoff Reaction isotherm, Temperature dependence of equilibrium constant, The Van′t Hoff equation, Pressure dependence of equilibrium constant Phase rule to Fe-C system, three component system Crystallization of pure components, formation of hydrates, formation of double salts with examples, salting out phenomenon.	12	Lecture
	Roozeboom plots acetic acid - chloroform - water system, plait point system involving two solids and a liquid NaCl.	4	ICT
	Crystallization of pure components, formation of hydrates, formation of double salts with examples, salting out phenomenon.	2	Seminar
UNIT 4 : **CHEMICAL KINETICS I**			
	Collision theory of Bimolecular reactions ARR theory. Theories of unimolecular and Bimolecular gaseous reactions Kinetics in solution, Comparison between gas phase and solution ARR theory between ions in solution. primary & secondary salt effect and isotope effects.	14	Lecture
	Collision theory of Bimolecular reactions ARR theory. Theories of unimolecular and Bimolecular gaseous reactions.	4	ICT

UNIT 5 : **ELECTROCHEMISTRY III**			
	Bjerrum treatment of ion association, factors influencing ion association. Electrodics, electrolyte interface, formation of double layer Helmholtz and stern model Electrokinetic phenomena, electro-osmosis, Streaming potential Electrophoresis Zeta potential. Electrocapillarity, electrocapillary curves, Lipmann equation, Measurement of interfacial tension using Lipmann capillary electrometer, Lipmann potential.	14	Lecture
	Formation of double layer Helmholtz and stern model Electrokinetic phenomena, electro-osmosis.	4	ICT

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	4	5	4	4	1	3	4	4	4	5	3.8
CO2	4	5	4	3	1	4	5	4	3	4	3.6
CO3	4	4	3	4	1	4	5	4	3	4	3.5
CO4	4	5	4	3	1	4	5	4	3	4	3.6
CO5	5	4	3	3	1	4	5	4	4	4	3.7
Mean Overall Score											3.64

Result: The Score for this Course is 3.64 (High Relationship)

UNIT	Part A(5X5=25m)	Part B (5 X 10 = 50m) Either or Pattern
I	K1 (5m)	K2 (10 m)
II	K2 (5m)	K1 (10 m)
III	K3 (5m)	K4 (10 m)
IV	K3 (5m)	K4 (10 m)
V	K3(2.5m)/K1(2.5m)	K3 (10 m)

Programme :M.Sc Chemistry **CORE 8**
Semester : II **Hours : 6 /W, 90 Hrs./S**
Sub. Code : P22CD8P **Credits :4**

TITLE OF THE PAPER: ORGANIC CHEMISTRY PRACTICAL

Pedagogy	Hours	Lab session//Demonstration class/Viva voce		
	6	6		
PREAMBLE: The objective of the course is to make the student to analyse the given mixture of organic compounds, synthesize organic compounds (double Stage) and to separate the mixture into components by paper/ TLC techniques.				
COURSE OUTCOME: At the end of the Semester, the Students will be able to			Unit	Hrs.
CO1: analyze the given mixture of organic compounds			1	70
CO2: synthesize organic compounds (double Stage) &Separate the mixture of organic compounds into individual componentsby paper/ TLC techniques.			2	20

I .ANALYSIS OF MIXTURE OF ORGANIC COMPOUNDS

Qualitative Organic analysis – Separation and characterization of the compounds in two component mixtures.

II. SYNTHESIS OF ORGANIC COMPOUNDS (involving double stage, any three)

1. p-Nitroaniline from acetanilide
2. Preparation of aspirin from methyl salicylate.
3. p-bromoaniline from acetanilide
4. m-nitrobenzoic acid from methyl benzoate

III: Separation of mixture of organic compounds by paper/TLC chromatographic technique (Demonstration)

References

1. Arthur I Vogel, A textbook of Practical Organic Chemistry including Qualitative Organic Analysis, 3rd Ed., English language book society and Longman Group Ltd, 1975.
2. B.B. Dey and M.V. Sitaraman, Laboratory manual of organic chemistry.
3. N.S.Gnanaprakasam, organic chemistry Lab Manual, 1st Ed., S.Viswanathan (Printers and Publishers), 2013.
4. G.Svehla, Vogel′s Quantitative Inorganic Analysis, 7th Ed., Pearson Education, 2003.

UNITS	TOPIC	LECTURE HOURS	MODE OF TEACHING
UNIT I : ANALYSIS OF MIXTURE OF ORGANIC COMPOUNDS			
	Analyse the given mixture of organic compounds – Separation and functional group detection	70	Lab Session
	Analyse the given mixture of organic compounds – Separation and functional group detection	10	Demonstration
	Analyse the given mixture of organic compounds – Separation and functional group detection	10	Viva
UNIT II: SYNTHESIS OF ORGANIC COMPOUNDS (Double stage) & SEPARATION OF MIXTURE OF ORGANIC COMPOUNDS			
	synthesis of organic compounds (double stage)	50	Lab Session
	synthesis of organic compounds (double stage) separation of mixture of organic compounds	5	Demonstration
		5	Viva

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	4	4	4.5	4	1	5	5	4	4	4	3.95
CO2	4	4	4	4	1	5	5	4	5	4	4.0
Mean Overall Score											3.98

Result: The Score for this Course is 3.98 (High Relationship)

Programme : M.Sc Chemistry **ELECTIVE: 2**
Semester : II **Hours : 5 /W, 75 Hrs./S**
Sub. Code : P22DSD2 **Credits :4**

TITLE OF THE PAPER: MOLECULAR SPECTROSCOPY & ANALYTICAL CHEMISTRY II

Pedagogy	Hours	Lecture	Peer Teaching/Seminar//Discussion//Problem solving session/Quiz/videos/Library session.	ICT
	5	3	1	1

PREAMBLE: The objective of the course is to make the student to comprehend the principle, instrumentation and applications of various spectra such as UV, IR, Raman, Mass and Chromatographic techniques.

COURSE OUTCOME At the end of the Semester, the Students will be able to	Unit	Hrs./S
CO1: demonstrate the fundamentals of Nuclear Magnetic Resonance Spectroscopy	1	15
CO2: demonstrate the fundamentals of ^{13}C NMR, 2D NMR and ESR Spectroscopy.	2	15
CO3: explain the underlying principle of Mossbauer &Photoelectron spectroscopy.	3	15
CO4: explain the fundamentals of Thermoanalytical & Spectroanalytical techniques.	4	15
CO5: explain the principle, instrumentation and applications of Gas liquid chromatography, HPLC and Electrophoresis.	5	15

UNIT I NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY (15 hours)

Theory of Magnetic Resonance spectroscopy - population of energy levels - equation of motion of spin in magnetic fields - relaxation times – instrumentation - chemical shift- spin-spin coupling – ^{1}H NMR of simple AX and AMX type molecules- chemical shift, spin-spin coupling, coupling constants, factors influencing proton chemical shift - vicinal proton- proton coupling constant- spin decoupling - improving the NMR spectrum - shift reagents. Effect of changing magnetic field. Nuclear Overhauser effect - Applications to organic structures, a brief qualitative discussion of Fourier transform spectroscopy. Simple problems involving UV, IR and NMR to be solved.

UNIT II ^{13}C NMR, 2D NMR AND ESR SPECTROSCOPY (15 hours)

^{13}C resonance spectroscopy - Comparison of ^{13}C NMR and ^{1}H NMR - 13C NMR–difficulties in recording 13C NMR: Homo nuclear and heteronuclear coupling. Off Resonance decoupled spectrum identification of various types of carbon (functional groups) using 13C NMR. Origin of 13C satellite peaks. Chemical shift - Factors affecting chemical shift - Chemical shifts of aliphatic, olefinic, alkynic, aromatic, carbonyl carbons. Attached Proton Test (APT) & Distortionless enhancement by Polarization Transfer (DEPT) spectrum (DEPT-45, DEPT-90 and DEPT-135 - brief idea).

2D NMR spectroscopy (only elementary idea) about COSY. HOMO COSY (HOMCORR: 1H-1H connectivity, 13C-13C connectivity) HETCOR (Heteronuclear Correlation)

ESR spectroscopy - differences between ESR and NMR - Hyperfine splitting - relation between hyperfine splitting and unpaired electron density- McConnel equation. Applications of ESR spectroscopy - ESR instrumentation -ENDOR- ELDOR.

UNIT III

MOSSBAUER & PHOTOELECTRON SPECTROSCOPY (15 hours)

Principles of Mossbauer spectroscopy, Doppler shift, recoil energy, experimental techniques
Isomer shift, quadrupole splitting, magnetic hyperfine interaction- chemical applications - isomer shift and quadrupole splitting in iron complexes.

Photoelectron spectroscopy (PES): Principles of UV-PES and XPS, Auger electrons in XPS, applications of UV- PES and XPS.

UNIT IV

THERMOANALYTICAL & SPECTROANALYTICAL TECHNIQUES (15 hours)

Thermoanalytical techniques: Principle, Instrumentation (Block diagram only) and applications of TGA Principles and applications of DTA and DSC - Factors affecting TGA and DTA curves.

Spectro analytical techniques: Atomic Absorption Spectrometry, Flame Photometry –Atomic Emission Spectrometry.

UNIT V

POLARIMETRY (15 hours)

Optical rotatory dispersion, circular dichroism, Cotton effect, Dispersion curves - Recognition and location of a carbonyl group in an asymmetric environment. The octant rule and the haloketone rule.

References

1. Jag Mohan, Organic Analytical Chemistry, Theory and Practise, 1st Ed., Narosa Publishing House, Reprint 2012.
2. P.S. Kalsi, Spectroscopy of organic Compounds, 1st Ed., Wiley Eastern Limited, 1993.
3. Y.R. Sharma, Elementary Organic Spectroscopy, 1st Ed., S.Chand and Company Ltd, 2011.
4. William Kemp, Organic Spectroscopy, 2nd Ed., English Language Book Society, Macmillan, 1987.
5. C.N. Banwell, Fundamentals of Molecular spectroscopy, 3rdEd., Tata McGraw-Hill Publishing company limited, 1992.
6. B.K. Sharma, Instrumental methods of chemical Analysis, 29th Ed. Goel Publishing house, 2013.
7. A.K.Srivastava and P.C.Jain, Chemical Analysis: An Instrumental Approach, 4th Ed., 2009.
8. John R.Dyer, Applications of Absorption Spectroscopy of organic compounds, 1st Ed. Prentice Hall of India Private Ltd, Reprint 1987.
9. Skoog and West, Fundamentals of Analytical chemistry, 9th Ed., Saunders College Pub. 2004.
10. Robert M.Silverstein, G. Clayton Bassier& Terence C.Morrill, Spectrometric Identification of organic compounds, 1st Ed. Prentice Hall of India Pvt Ltd, Reprint 1987.
11. R. Gopalan, Elements of Analytical chemistry, Sultan Chand & Sons, 2002.
12. G.R. Chatwal, Analytical Spectroscopy, 1st Ed. Himalaya Publishing House, 1996.

UNITS	TOPIC	LECTURE HOURS	MODE OF TEACHING
UNIT 1: **NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY**			
	NMR Instrumentation	2	ICT
	Theory of Magnetic Resonance spectroscopy - population of energy levels - equation of motion of spin in magnetic fields - relaxation times – instrumentation - chemical shift- spin-spin coupling – ^{1}H NMR of simple AX and AMX type molecules- chemical shift, spin-spin coupling, coupling constants, factors influencing proton chemical shift - vicinal proton- proton coupling constant- spin decoupling - improving the NMR spectrum - shift reagents. Effect of changing magnetic field. Nuclear Overhauser effect - Applications to organic structures, a brief qualitative discussion of Fourier transform spectroscopy.	11	LECTURE
	Simple problems involving UV, IR and NMR to be solved.	2	Problem solving
UNIT 11 **^{13}C NMR, 2D NMR AND ESR SPECTROSCOPY**			
	^{13}C resonance spectroscopy - Comparison of ^{13}C NMR and ^{1}H NMR - Chemical shift - Factors affecting chemical shift - Chemical shifts of aliphatic, olefinic, alkynic, aromatic, carbonyl carbons. ESR spectroscopy - differences between ESR and NMR - Hyperfine splitting - relation between hyperfine splitting and unpaired electron density- McConnel equation. -ENDOR- ELDOR.	9	Lecture
	Applications of ESR spectroscopy -	3	Seminar
	2D NMR spectroscopy (only elementary idea) about COSY, ESR instrumentation	3	ICT
UNIT III **MOSSBAUER & PHOTOELECTRON SPECTROSCOPY**			
	Principles of Mossbauer spectroscopy, Doppler shift, recoil energy, experimental techniques Isomer shift, quadrupole splitting, magnetic hyperfine interaction- chemical applications - isomer shift and quadrupole splitting in iron complexes. Photoelectron spectroscopy (PES): Principles of UV-PES and XPS, Auger electrons in XPS.	9	Lecture

	applications of UV- PES and XPS	3	Peer teaching/seminar
	Principles of Mossbauer spectroscopy, Doppler shift, recoil energy, experimental techniques	3	ICT
UNIT IV **THERMOANALYTICAL & SPECTROANALYTICAL TECHNIQUES**			
	Thermoanalytical techniques: Instrumentation Spectroanalytical techniques: Atomic Absorption Spectrometry, Flame Photometry –Atomic Emission Spectrometry.	5	ICT
	Thermoanalytical techniques: Principle, and applications of TGA Principles and applications of DTA and DSC - Factors affecting TGA and DTA curves.	10	Lecture
UNIT V **POLARIMETRY**			
	Optical rotatory dispersion, circular dichroism, Cotton effect, Dispersion curves - Recognition and location of a carbonyl group in an asymmetric environment. The octant rule and the haloketone rule.	9	Lecture
	Recognition and location of a carbonyl group in an asymmetric environment.	3	Group discussion Seminar
	Optical rotatory dispersion, circular dichroism, Cotton effect	3	ICT

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	5	4	4	4	1	5	4	4	3	3	3.7
CO2	5	3	3	5	1	5	4	4	3	3	3.6
CO3	5	4	4	4	1	5	4	4	3	3	3.7
CO4	5	3	3	5	1	5	4	4	3	3	3.6
CO5	5	3	3	5	1	5	4	4	3	3	3.6
Mean Overall Score											3.64

Result: The Score for this Course is 3.64 (High Relationship)

UNIT	Part A(5X5=25m)	Part B (5 X 10 = 50m) Either or Pattern
I	K1 / K4	K2 / K3(5m), K4(5m)
II	K4 / K3	K1/ K2
III	K2 / K4	K3/ K1
IV	K4(2.5m), K3(2.5m)/K2	K4 / K3
V	K3/K1	K3(5m), K4(5m) / K4

Programme :M.Sc Chemistry **ELECTIVE: 2**
Semester : II **Hours : 5 /W, 75 Hrs./S**
Sub. Code : P22DSD2 **Credits :4**

TITLE OF THE PAPER: POLYMER CEMISTRY

Pedagogy	Hours	Lecture	Peer Teaching/Seminar//Discussion//Problem solving session/Quiz/videos/Library session.	ICT
	5	3	1	1

PREAMBLE: The objective of the course is to make the student understand the general structure and types of polymers, their mechanism, preparation properties and uses of various polymers, determine the molecular weight of the polymers, the chemistry behind various methods of polymer processing.

COURSE OUTCOME: At the end of the Semester, the Students will be able to	Unit	Hrs. /S
CO1: identify the repeat units of particular polymers and specify the isomeric structures which can exist for those repeat units and account for reaction mechanisms during radical, ionic and condensation polymerization.	1	15
CO2: describe the general method of preparation and uses of various industrially important polymers.	2	15
CO3: indicate how the properties of polymeric materials can be exploited and estimate the number- and weight-average molecular masses of polymer samples given the degree of polymerisation and mass fraction of chains present.	3	15
CO4: place emphasis on how the various synthetic techniques that are used to control structural features of polymer along with methods of degradation of polymers.	4	15
CO5: describe various processing methods of polymers.	5	15

UNIT I (15 Hours)

CLASSIFICATION OF POLYMERS AND CHEMISTRY OF POLYMERISATION

Classification of Polymers, linear polymers, non-linear or branched polymers, cross – linked polymers, homopolymers, co-polymers, block polymers and graft polymers.

Chemistry of polymerization: Types of polymerizations – mechanism – chain, Ionic, co-ordination, ring opening, metathetical, group transfer, polyaddition and polycondensation polymerizations.

UNIT II (15 Hours)

INDIVIDUAL POLYMERS

Individual Polymers: Monomers required general methods of preparation, repeat units and uses of the following polymers and resins, polystyrene, polyacrylonitrile, polymethyl, methacrylate, Polytetra–fluoroethylene, polybutadienes and polychloroprene, polyesters, polycarbonates, polyimides, polyamides (Kevlar), polyurethanes, polyethylene, glycols, phenol – formaldehyde, urea–formaldehyde, melamine–formaldehyde and epoxy resins.

UNIT III **(15 Hours)**

PROPERTIES OF POLYMERS

Intrinsic properties – processing properties – basic idea of isomerism of polymers – configuration of polymer chain – geometrical structure – syndiotatic, isotatic and atatic polymers.

Glass transition temperature: Definition – factors affecting glass transition temperature – relationships between glass transition temperature and (a) molecular weight, (b) melting point and (c) plasticizer – importance of glass transition temperature – heat distortion temperature.

Molecular weight and size of polymers: Number average, weight average, sedimentation and viscosity - average molecular weights – molecular weights and degree of polymerization – poly dispersity – molecular weight distribution in polymers – size of polymer molecules – kinetics of polymerization.

UNIT IV **(15 Hours)**

POLYMERISATION TECHNIQUES, DEGRADATION AND USES OF POLYMERS

PolymerisationTechniques: Bulk, solution, suspension, emulsion, melt condensation and interfacial polycondensation polymerizations, Degradation: Types of degradation – thermal, mechanical, ultrasonic and photodegradation – photo stabilizers – oxidative degradation – antioxidants – hydrolytic degradation. Uses of polymers in electronics and biomedicine

UNIT V **(15 Hours)**

POLYMER PROCESSING

Polymer processing: Plastics (thermo and thermosetting), elastomers, fibres, compounding, plasticizers, colorants, flame retardants. Compression and injection mouldings – film extrusion and calendaring – die casting and rotational casting – thermoforming – reinforcing.

References

1. V.R.Gowarikar, N.V. Viswanathan and Jayadev Sreedher, "Polymer Science", Wiley Eastern Ltd., New Delhi, 1986.
2. B.K.Sharma, "Polymer Chemistry", Goel Pub., House, Meerut 1989.
3. F.W.Billmeyer, "Text Book of Polymer Science", 3rd edn., John Wiley and sons, New York, 1984.
4. P.Bahadur, N.V.Sastry, Principles of Polymer Science, II nd Edn., Narosa Pub. House Pvt. Ltd., New Delhi, 2005.
5. G.S.Misra, Introductory Polymer Chemistry, New Age International Pub., New Delhi, 2005.

UNITS	TOPIC	LECTURE HOURS	MODE OF TEACHING
UNIT I: CLASSIFICATION OF POLYMERS AND CHEMISTRY OF POLYMERISATION			
	Classification of Polymers, linear polymers, non-linear or branched, cross linked polymers, homopolymers, co-polymers, block polymers and graft polymers.	5	Discussion / seminar/ peer teaching
	Types of polymerizations – mechanism – chain, Ionic, co-ordination	5	Lecture
	ring opening, metathetical, group transfer, polyaddition and polycondensation polymerizations.	5	ICT

UNIT II: INDIVIDUAL POLYMERS			
	Preparation and uses of polystyrene, polyacrylonitrile, polymethyl, methacrylate	4	Lecture
	Preparation and uses of Polytetra–fluoroethylene, polybutadienes and polychloroprene, polyesters, polycarbonates, polyimides, polyamides	6	Library session followed by discussion/ seminar/ tutorial
	Preparation and uses of polyurethanes, polyethylene, glycols, phenol – formaldehyde, urea–formaldehyde, melamine–formaldehyde and epoxy resins	5	ICT
UNIT III: PROPERTIES OF POLYMERS			
	Intrinsic properties – processing properties, isomerism of polymers, configuration of polymer chain, geometrical structure, syndiotatic, isotatic and atatic polymers	4	Lecture
	Glass transition temperature: Definition – factors affecting glass transition temperature, importance of glass transition temperature, heat distortion temperature	4	Seminar / assignment
	relationships between glass transition temperature and (a) molecular weight, (b) melting point and (c) plasticizer	2	Discussion / library session
	Molecular weight of polymers: Number average, weight average, sedimentation and viscosity - average molecular weights, molecular weights and degree of polymerization, poly dispersity, molecular weight distribution in polymers	3	Problem solving session/ quiz
	size of polymer molecules, kinetics of polymerization.	2	ICT
UNIT IV: POLYMERISATION TECHNIQUES DEGRADATION AND USES OF POLYMERS			
	Polymerisation Techniques: Bulk, solution, suspension, emulsion, melt condensation and interfacial polycondensation polymerizations	6	Lecture
	Degradation: Types of degradation – thermal, mechanical, ultrasonic and photodegradation – photo stabilizers	5	Seminar / peer teaching
	oxidative degradation – antioxidants – hydrolytic degradation. Uses of polymers in electronics and biomedicine.	4	ICT

UNIT V: POLYMER PROCESSING			
	Plastics (thermo and thermosetting), elastomers, fibres, compounding, plasticizers, colorants, flame retardants.	7	Lecture
	Compression and injection moulding, film extrusion and calendaring	4	Videos
	die casting and rotational casting, thermoforming, reinforcing.	4	ICT

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	4	3.5	3	3.5	1	4	3	3	4	4	3.3
CO2	4	3	3	4	1	4	4	3	3	4	3.3
CO3	4	3	4	4	1	4	4	3.5	3.5	4	3.5
CO4	4	3	3.5	4	1	4	4	3	3	4	3.35
CO5	4	3	3.5	4	1	4	3	5	4	3.5	3.45
Mean Overall Score											3.38

Result: The Score for this Course is 3.38 (High Relationship)

UNIT	Part A(5X5=25m)	Part B (5 X 10 = 50m) Either or Pattern
I	K1 / K4	K2 / K3
II	K3 / K4(2.5m), K3(2.5m)	K1/ K4
III	K3(2.5m) ,K4(2.5m) / K1	K4 / K2
IV	K2 / K3	K3 / K3(5m), k4(5m)
V	K4 / K2	K3(5m), k4(5m) / K1

Programme :M.Sc Chemistry **SKILL ENHANCEMENT COURSE II**
Semester : II **Hours : 2 /W, 30 Hrs./S**
Sub. Code : P22SED2P **Credits : 2**

TITLE OF THE PAPER: COMPUTATIONAL CHEMISTRY PRACTICAL

Pedagogy	Hours	Lab session//Demonstration class/Viva voce		
	2	2		
PREAMBLE: The objective of the course is to make the student gain basic idea and stepwise approach to Chemdraw, ACD/Chemsketch, Argus Lab, AVOGADRO, Molinspiration, preADMET, SwissADME, SwissDock, 1 – Click online server, SANJEEVINI, Autodock, and Crystal Explorer.				
COURSE OUTCOME: At the end of the Semester, the Students will be able to			Unit	Hrs.
UNIT 1 CO1: use computational software.			1	30

EXERCISES – The students are directed to do the following exercises using suitable computational software.

A. Draw the structures of organic molecules, conformers and reaction schemes using **Chemdraw** or **ACD/Chemsketch**.

B. **Argus Lab** or **ACD/Chemsketch** or **Avogadro Molecular Editor** can be used for the following exercises. Minimum of six experiments is required to be carried out in this section.

1. Draw the structures and optimize the geometry of simple organic molecules.
2. Calculate the energy gap between HOMO and LUMO in simple molecules and visualize the molecular orbitals.
3. Calculate the dipole moment of polar organic molecules.
4. Calculate the electrostatic charges of atoms in organic molecules using population analysis.
5. Calculate the Resonance energy of aromatic compounds.
6. Predict the stability of *ortho*, *meta*, *para* products of an electrophilic substitution reaction in the aromatic ring using computational chemistry calculations.
7. Calculate the dimerization energy of carboxylic acids.
8. Perform the conformational analysis of an alkane of your choice using potential energy scan.
9. Find the transition state of simple organic reactions and plot the reaction profile.

10. Find the Gibbs free energy of simple gaseous phase reactions and calculate equilibrium constant.

11. Generate and analyze the UV, IR and NMR spectra of simple organic molecules.

12. Calculate the pKa of simple organic molecules and compare it with experimental values.

C. Prediction of molecular properties, bioactivity and molecular docking of drug molecules.

1. Predict the molecular properties and bioactivity of the simple drug molecules like aspirin, acetaminophen, or the drugs of your choices, using the online server **molinspiration.**

2. Predict the drug likeliness, ADME and Toxicity of the drug classes like antibiotics, analgesics, antihistamines, CNS depressants, or the drug classes of your choice, using online server **preADMET**or **SwissADME**or **SwissDock.**

3. Perform molecular docking (Ligand – Protein interaction) of your choice of drug molecules using **1-click docking online server tool** at mcule.com (Website: https://mcule.com/. First register at the site andperform molecular docking) or **Autodock tools** or **Autodock Vina** or **ArgusLab** or **SANJEEVINI** Molecular Docking platforms.

NOT FOR EVALUATION

D. Learn to generate Hirshfeld surfaces, study the interaction energies and draw the electrostatic potential map using **Crystal Explorer** Software (**Demonstration only**)

LINKS TO DOWNLOAD SOFTWARE

1-click docking online server: https://mcule.com/

ACD/Chemsketch :https://www.acdlabs.com/resources/freeware/chemsketch/index.php

ArgusLab :http://www.arguslab.com/arguslab.com/ArgusLab.html

Autodock Tools Link: http://mgltools.scripps.edu/downloads

Autodock Vina Link: http://vina.scripps.edu/

Avogadro Molecular Editor :https://avogadro.cc/

Crystal Explorer: https://crystalexplorer.scb.uwa.edu.au/

Discovery Studio Visualizer: https://www.3dsbiovia.com/products/co..

Molinspiration :https://www.molinspiration.com/

PreADMET :https://preadmet.bmdrc.kr/

SwissADME :http://www.swissadme.ch/index.php

REFERENCE BOOKS

1. Waren J. Hehre, Alan J. Shusterman and Janet E. Nelson, *The molecular modelling workbook for organic chemistry*, Wavefunction Inc., **1998**.

2. 3. James B. Foresman and Eleen Frisch, *Exploring Chemistry with Electronic Structure Methods*, Gaussian Inc., Second Edition, **1996**.

3. 4. James B. Foresman and Eleen Frisch, *Exploring Chemistry with Electronic Structure Methods,* Gaussian Inc., Third Edition, **2015**.

Internal: 40 marks External : 60 marks

UNITS	TOPIC	LECTURE HOURS	MODE OF TEACHING
UNIT I : COMPUTATIONAL CHEMISTRY PRACTICAL			
	Draw the structures of organic molecules, conformers and reaction schemes using **Chemdraw** or **ACD/Chemsketch**	10	Practical session
	Argus Lab or **ACD/Chemsketch** or **Avogadro Molecular Editor** can be used for the following exercises. Minimum of six experiments is required to be carried out in this section.	10	Practical session
	Prediction of molecular properties, bioactivity and molecular docking of drug molecules.	10	Practical session

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	4	4	3.5	3	1	3.5	4	3	4	3	3.4
Mean Overall Score											3.4

Result: The Score for this Course is 3.4 (High Relationship)

Programme :M.Sc Chemistry **CORE 9**
Semester : III **Hours : 6 /W, 90 Hrs./S**
Sub. Code : P22CD9 **Credits :5**

TITLE OF THE PAPER: INORGANIC CHEMISTRY-III

Pedagogy	Hours	Lecture	Peer Teaching/Seminar//Discussion//Problem solving session/Quiz/videos/Library session.	ICT
	6	4	1	1

PREAMBLE: The objective of the course is to make the student understand the importance of polyacids, inorganic polymers, structure and applications of metal clusters and hydrides, the chemistry behind lanthanides and actinides and functions of bioinorganic compounds

COURSE OUTCOME: At the end of the Semester, the Students will be able to	Unit	Hrs./S
CO1: identify the structural features, properties, correlation and applications of inorganic polymers, polyacids of Vanadium, Chromium, Molybdenum and Tungsten.	1	18
CO2: appreciate the chemistry of low molecularity metal clusters, examine the synthesis, structures, bonding and chemistry of specific boron hydrides.	2	18
CO3: demonstrate an understanding of chemistry of 'f ' block elements their properties and separation of lanthanides and actinides.	3	18
CO4: develop an appreciation for the structure and function of metal ions in the biological systems and explain how metal ions function as catalytic and structural centers in biological systems.	4	18
CO5: describe the flow and transformation of nitrogen through biological and physical process, gains insight into cutting edge developments that utilizes metal ions for medical purposes.	5	18

UNIT I

POLYACIDS AND INORGANIC POLYMERS (18 Hours)

1.1. Poly acids: Isopoly acids and heteropolyacids of Vanadium, Chromium, Molybdenum and Tungsten-Keggin, Well-Dawson structure.

1.2. Inorganic Polymers: Structure and classification of silicates - applications of Paulings rule of electrovalence - isomorphous replacements in silicates - molecular sieves - silanes, higher silanes, multiple bonded systems, silicon nitrides, siloxanes – polysulphur - nitrogen compounds S_4N_4, $(SN)_x$ – poly organophosphazenes - polycarbonates.

UNIT II

HYDRIDES AND METAL CLUSTERS (18 Hours)

Boron hydrides: Preparation, properties and structure of polyhedral boranes– B_4H_{10}, B_5H_9, $B_{10}H_{12}$and $B_{12}H_{12}$. borazines, boron nitrides, hydroborate ions – Preparation, properties and structure, STYX numbers, Wade's rules. Carboranes- Types such as nido-closo, arachno-preparation properties and Structure. Metallocarboranes-a general study

Metal clusters: Chemistry and molecularity of dinuclear and trinuclear metal clusters, Structure of Re_2Cl_8, metal- metal multiple bonds (quartet and quintet bonds with examples)

UNIT III

LANTHANIDES AND ACTINIDES (18 Hours)

Lanthanides - Electronic configuration - oxidation states - separation of lanthanides - chemical properties of +3 states - lanthanide contraction- colour and spectra - magnetic property- complexes, Lanthanide chelates.

Actinides - Electronic configuration- oxidation states - separation- magnetic property - Extraction of Thorium.

UNIT I V

BIO-INORGANIC CHEMISTRY I (18 Hours)

Transport proteins, Porphyrin ring system -Oxygen carriers- Haemoglobin- Myoglobin-structure and functions- Oxygenation- Biological redox systems- Cytochromes- classification, Cytochrome a,b,c, Cytochrome P450- structure and functions - Iron-Sulphur proteins- Rubredoxin and ferredoxin, Chlorophylls and photosynthesis. Copper containing proteins- Classification – blue copper proteins – plastocyanin - Ascorbic acid oxidase -Structure and functions- Ceruloplasmin and serum Albumin: Transport and storage of copper. Similarities between Iron and Copper in biological processes.

UNIT V

BIO-INORGANIC CHEMISTRY II (18 Hours)

5.1. Nitrogen fixation – Introduction - Thermodynamic and kinetic aspects of N_2 fixation , types of nitrogen fixing microorganisms- Role and composition of nitrogenase in nitrogen fixation- structural representation of metal clusters in nitrogenase- redox property- dinitrogen complexes- Nitrogen fixation via nitride formation and reduction of dinitrogen to ammonia.

5.2. Vitamin B_{12} –Chemistry of cobalamin, biochemical functions.

5.3. Antimicrobial activity of metal chelates – Anti-arthritic gold drugs and chrysotherapy- Anti-inflammatory effects of zinc and copper compounds

5.4. Anti-cancer agents, role of metal ion, Radio isotopes- Diagnosis and treatment.

References

1. J.E.Huheey, Ellen A.Kaiter, Richard L. Kaiter & Okhil K. Medhi, Inorganic Chemistry Principles of Structure & Reactivity, 4th Ed., Pearson, 2011.
2. F.A.Cotton, G.Wilkinson, G.A.Murillo & M. Bochmann, Advanced Inorganic Chemistry, 1stEd., Wiley Student Edn, 2007.
3. H.J.Emeleus & A.G.Sharpe, Modern aspects of Inorganic Chemistry, 4th Ed., ISBN, 1974.
4. K.F.Purcell and J.C.Koltz, Inorganic Chemistry, Holt Saunders, 1977.
5. B.R.Puri, L.R.Sharma & K.C.Kalia, Principles of Inorganic Chemistry, Vishal Pub.33 ed., 2017.
6. U.Malik, G.D.Tuli and R.D.Madan, Selected topics in Inorganic Chemistry, 1992.
7. R.D.Madan& Satya Prakash, Modern Inorganic Chemistry (Revised), S.Chand
8. Gurtu, Subash and Satish, Chemistry of Rarer elements, Vol I & Vol II, Pragati Prakashan.
9. G.N.Mukherjee and Arabindadas, Elements of Bio-Inorganic Chemistry.
10. Asim K.Das, Bioinorganic Chemistry, Books and Allied P Ltd.,

UNITS	TOPIC	LECTURE HOURS	MODE OF TEACHING
UNIT 1: POLYACIDS AND INORGANIC POLYMERS			
	Isopoly and heteropoly acids of Vanadium, Chromium, Molybdenum and Tungsten.	9	Lecture
	Silicates, Structure, properties correlation and applications. silanes, higher silanes, multiple bonded systems, silicon nitrides, siloxanes	3	ICT
	molecular sieves, polysulphur nitrogen compounds	3	library session/ quiz
	Polyorgano phosphazenes- polycarbonates	3	Seminar
UNIT II: HYDRIDES AND METAL CLUSTERS			
	Boron hydrides: Polyhedral boranes	7	Lecture
	hydroborate ions, carbonates and metallocarboranes	4	Seminar/ Peer teaching
	Metal clusters: Chemistry of low molecularity metal clusters (upto) trinuclear metal clusters;	4	ICT
	metal-metal multiple bonds.	3	Discussion
UNIT III: LANTHANIDES AND ACTINIDES			
	Lanthanides- Electronic configuration, oxidation states, separation of lanthanides	6	Lecture
	chemical properties of +3 states, lanthanide contraction, colour and spectra	3	ICT
	magnetic property- complexes, Lanthanide chelates	3	Seminar/ assignment
	Actinides - Electronic configuration- oxidation states - Extraction of Thorium	4	Lecture
	Separation and magnetic property of actinides	2	Group discussion
UNIT IV : BIO-INORGANIC CHEMISTRY I			
	Transport proteins, Porphyrin ring system Oxygen carriers- Haemoglobin-Myoglobin-structure and functions- Oxygenation- Biological redox systems	5	Lecture
	Cytochromes-classification, Cytochrome a,b,c, Cytochrome P450- structure and functions Chlorophylls and photosynthesis.	5	Lecture
	Iron-sulphur proteins- Rubredoxin and ferredoxin,	3	Seminar/ assignment
	Copper containing proteins- Classification – blue copper proteins –plastocyanin - Ascorbic acid oxidase -Structure and functions	3	ICT
	Ceruloplasmin and serum Albumin Transport and storage of copper. Similarities between Iron and Copper in biological processes	2	Group discussion

UNIT V: BIO-INORGANIC CHEMISTRY II			
	Nitrogen fixation – Introduction - Thermodynamic and kinetic aspects of N_2 fixation, types of nitrogen fixing microorganisms- Role and composition of nitrogenase in nitrogen fixation-	6	Lecture
	Structural representation of metal clusters in nitrogenase- redox property dinitrogen complexes- Nitrogen fixation via nitride formation and reduction of dinitrogen to ammonia.	5	Lecture
	Vitamin B_{12} –Chemistry of cobalamin, biochemical functions	2	ICT
	Antimicrobial activity of metal chelates – Antiarthritic Gold drugs and chrysotherapy. Anti-inflammatory effects of zinc and copper compounds	3	Seminar/ Peer teaching
	Anti-cancer agents, role of metal ion, Radio isotopes- Diagnosis and treatment.	2	library session/ assignment

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	4	3	3	3	1	4	4	3	2	3	3.0
CO2	4	3	2	3	1	4	4	3	2	3	2.9
CO3	4	3	3	4	1	4	2	3	3	4	3.1
CO4	4	4	4	3	1	4	4	4	3	4	3.5
CO5	4	4	4	4	1	4	4	4	3	4	3.6
Mean Overall Score											3.22

Result: The Score for this Course is 3.22 (High relationship)

UNIT	Part A(5X5=25m)	Part B (5 X 10 = 50m) Either or Pattern
I	K2 / K2	K2 / K2
II	K4 / K4	K4 / K4
III	K1/ K1	K1 / K1
IV	K3/ K3	K3 / K3
V	K3 & K4 / K3 & K4	K3 & K4 / K3 & K4

Programme :M.Sc Chemistry **CORE 10**
Semester : III **Hours : 6 /W, 90 Hrs./S**
Sub. Code : P22CD10 **Credits : 4**

TITLE OF THE PAPER: ORGANIC CHEMISTRY-III

Pedagogy	Hours	Lecture	Peer Teaching/Seminar/roleplay/ Discussion/Problem solving session/Quiz/Lab session/Videos/ Demonstration Class/Library session.	ICT
	6	4	1	1

PREAMBLE:

The objective of the course is to make the students acquire a sound and in-depth knowledge of the basic fundamental areas of Oxidation and Reduction, have thorough understanding of the important reagents used in Organic Synthesis, awareness of important organic name reactions and their mechanisms and develop a creative and critical thinking mind by learning retrosynthesis.

COURSE OUTCOME: At the end of Semester III, the students will be able to	**Unit**	**Hrs./S**
CO1: discuss the methods of oxidation in different environmental conditions	1	18
CO2: explain reduction reactions using different reducing agents.	2	18
CO3: select types of reagents used in various organic synthesis	3	18
CO4: identify organic name reactions and their mechanisms	4	18
CO5: plan new organic synthesis and carry out effectively.	5	18

UNIT I

OXIDATION **(18 Hours)**

Formation of C=C, C-C bonds by dehydrogenation (Thermal elimination, using Quinones, SeO_2, Ferricyanide); C-C bond in phenol coupling, Acetylenic coupling; Oxidation of alcohols(Jones reagent, Sarett's reagent, Pfitzer – Moffatt reagent), Allyl alcohols (MnO_2,SeO_2 , Ag_2CO_3,); Oxidation of Amines; Oxidation of olefinic double bond(Prevost reagent, Chromyl chloride); Bayer villiger oxidation, Dakin reaction ; cleavage of Acyloin; ozonolysis; oxidation of Alkyl group (Etards reagent) ; Oxidation of aldehyde (Chromic acid)

UNIT II

REDUCTION **(18 Hours)**

Catalytic reduction, Reduction by Hydrazins, Photochemical reduction, Homogeneous Hydrogenation, Reduction by Metal hydrides, Meerwein–Pondorff-Verley reduction – Hydrogen Transfer (Cannizaro reaction) - by dissolving metal.

UNIT III **(18 Hours)**

REAGENTS IN ORGANIC SYNTHESIS

Use of the following reagents in Organic synthesis – Metal hydrides, Raney Ni, Gilmann reagent, Lithium diisopropylamide, Trimethyl silyl iodide, tri n-butyl tin hydride, OsO_4, DDQ, SeO_2, Woodward Prevost hydroxylation, Peterson′s synthesis, 1,3-dithiane, Willkinson′s catalyst.

UNIT IV

NAME REACTIONS **(18 Hours)**

Arndt Eistert, Hoffmann – Loftler reaction Sharpless asymmetric epoxidation – Baylin Hillman, Biginelli, Mitsunobu, Friedlaendar, Hiyama coupling, Passerini, Petasis, Stille coupling, Suzuki coupling, Japp – Klingmann reaction, Heck, Buchwald Hartwig Cross coupling.

UNIT V

RETROSYNTHESIS **(18 Hours)**

Disconnection and FGI – Synthon and synthetic equivalent – Retron, Supraretron, Partial retron, Chiron, Umpolung– Protection and deprotection – order of events – one group C-X disconnection - Two one group C-X disconnection – 1,2, 1,3, 1,4, 1,5, and 1,6 difunctional compounds.

References

1. F.S. Gould, Mechanism and Structure in Organic Chemistry, Holt, New York, 1959.
2. Principles of Organic Synthesis – R.O.C. Norman
3. R.E. Ireland, Organic Synthesis, Prentice Hall, 1969.
4. H.O. House, Modern Synthetic reactions, W.A. Benjamin Inc. California, 2nd Ed., 1972.
5. S. Warren, Designing Organic Synthesis – A programmed introduction to synthon approach, Wiley, New York, 1978.
6. S.M. Muherjee & S.P. Singh, Reaction Mechanism in Organic Chemistry, Mc Milan Ltd.,

UNITS	TOPIC	LECTURE HOURS	MODE OF TEACHING
UNIT I: OXIDATION			
	Formation of C=C, C-C bonds by dehydrogenation (Thermal elimination using Quinones, SeO_2&Ferricyanide)	3	Lecture, library session
	C-C bond in phenol coupling, Acetylenic coupling.	2	Lecture and assignment
	Oxidation of alcohols (Jones reagent, Sarett's reagent, Pfitzer – Moffatt reagent), Allyl alcohols (MnO_2, SeO_2, Ag_2CO_3), Oxidation of Amines.	6	Lecture and ICT
	Oxidation of Olefinic double bond (Prevost reagent, Chromyl chloride)	2	Lecture and seminar
	Bayer villiger oxidation, Dakin reaction	1	Lecture and assignment
	cleavage of Acyloin, ozonolysis	2	Lecture
	oxidation of Alkyl group (Etards reagent)	1	Lecture and Problem solving

	Oxidation of aldehyde (Chromic acid)	1	Lecture and discussion
UNIT II: REDUCTION			
	Catalytic reduction	3	ICT
	Various reducing agents	12	Lecture
	Hydrogen transfer and by dissolving metals	3	Seminar
UNIT III: REAGENTS IN ORGANIC SYNTHESIS			
	1. Metal hydrides 2. Raney Ni 3. Gilmann reagent 4. Lithium diisopropylamide 5. Trimethyl silyl iodide 6. tri n-butyl tinhydride 7. OsO_4 8. DDQ 9. SeO_2 10. Woodward Prevost hydroxylation 11. Peterson′s synthesis 12. 1,3-dithiane 13. Willkinson′s catalyst.	18	Lecture, ICT, Discussion, Seminar, Assignment, Problem Solving.
UNIT IV: NAME REACTIONS			
	Sharpless asymmetric epoxidation	3	ICT
	Various named reactions	6	Lecture
	1. Passerini2. Petasis 3. Stille coupling 4. Suzuki coupling 5. Japp - Klingmann reaction 6. Heck 7. Buchwald Hartwig Cross coupling	9	Lecture, ICT, Seminar, Assignment, Problem
UNIT V: RETROSYNTHESIS			
	Disconnection and FGI-synthon and synthetic equivalent -retron supra retiring, partial retron, Charon, umpolung.	2	ICT
	One group and two one group C-X disconnection	12	Lecture
	Protection de protection	4	Seminar

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	3	3	3.5	3.5	4	3	1.5	4	3.2
CO2	3	3	3	3	3.5	3	3	3	1	4	3
CO3	3	3	3	3	3.5	3	3	3.5	1	4	3.1
CO4	3	3	3	3	3.5	4	4	3	1	4	3.2
CO5	3	3	3	3	3.5	4	4	3.5	1	4	3.2
Mean Overall Score											3.14

Result: The Score for this Course is 3.14

UNIT	Part A (5X5=25m)	Part B (5 X 10 = 50m) Either or Pattern
I	K1 (5m)	K3 (5m) , K4 (5m)
II	K2 (5m)	K2 (5m), K1 (5m)
III	K4 (5m)	K4 (5m), K3 (5m)
IV	K3 (5m)	K4(5m), K1 (5m)
V	K4 (5m)	K2(5m), K4(5m)

Programme :M.Sc Chemistry **CORE 11**
Semester : III **Hours : 5 /W, 75 Hrs./S**
Sub. Code : P22CD11 **Credits :5**

TITLE OF THE PAPER: PHYSICAL CHEMISTRY-III

Pedagogy	Hours	Lecture	Peer Teaching/Seminar/Discussion/Problem solving session/Quiz/Lab session/videos/Demonstration class/Library session.	ICT
	5	3	1	1

PREAMBLE: The objective of the Physical course is to make the student understand, learn and have an in-depth idea about the advanced concepts of Quantum Chemistry, Chemical Kinetics, Statistical Thermodynamics, Polymer Science and Surface phenomena.

COURSE OUTCOME: At the end of the Semester, the Students will be able to	Unit	Hrs./S
CO1: discuss the advance concepts of Quantum Chemistry.	1	15
CO2: explain the Kinetics of fast reactions	2	15
CO3: express the objective of Statistical Thermodynamics.	3	15
CO4: explain the properties of Polymers.	4	15
CO5: discuss Surface phenomena applying adsorption method.	5	15

UNIT I

QUANTUM CHEMISTRY III **(15 Hours)**

Approximation methods – Variation method and perturbation theory – Application to the helium atom, Slater determinable wave functions, Pauli′s exclusion principle – Born- Oppenheimer approximation – LCAO – MO and VB treatments of hydrogen molecules. Huckel π- electron theory and its application to ethylene and butadiene and benzene

UNIT II

CHEMICAL KINETICS II **(15 Hours)**

Kinetics of fast reactions – Flow methods: Stopped flow method- continuous and quenched flow methods – Pulse method – flash photolysis – Pulse radiolysis – Microscopic kinetics – molecular beam method – Marcus theory of electron transfer processes.

UNIT III

STATISTICAL THERMODYNAMICS **(15 Hours)**

Objective of Statistical thermodynamics- Distinguishable and indistinguishable particles- ensemble and interactive systems – Microstates and macrostates - Maxwell - Boltzmann Bose-Einstein and Fermi-Dirac Statistics and their respective distribution functions.

Partition function, Evaluation of translational, Vibrational and rotational partition functions for mono, diatomic molecules - Calculation of thermodynamic functions – U, H, S and G – equilibrium constant and heat capacities from partition functions.

UNIT IV POLYMER SCIENCE (15 Hours)

Properties of polymers - Glass transition temperature - factors influencing the glass transition temperature - crystallinity in polymers - degree of crystallinity - effect of crystallinity in the properties of polymers. Molecular weight and size of polymers, Number average and weight average molecular weight, degree of polymerization. Determination of molecular weight of polymers, Osmometry - viscometry, Gel permeation chromatography, Electro polymerization & photopolymerization. Conducting polymers.

UNIT V SURFACE PHENOMENA (15 Hours)

Surface phenomena: Physisorption and Chemisorption - Adsorption of gases by solids - Factors influencing adsorption - Desorption activation energy - Langmuir theory of adsorption - BET theory of multilayer adsorption - Determination of Surface area - Determination of area of cross section of a molecule - Derivation of BET equation -Types of adsorption isotherms - Adsorption from solution - Gibbs adsorption isotherm - Insoluble surface films on liquids. Surfactants - Classification - Biosurfactants - Hydrophile - Lipophile Balance - Micelles formation - Shape and structure of micelle - Micellar aggregation number - Critical micelle concentration.

References

1. G.R.Chatwal&S.K.Anand, Quantum Mechanics, 2nd Ed., Himalaya Pub. House, 1989.
2. R.K. Prasad, Quantum Chemistry, 4th , New Age International Publishers, Reprint 2015.
3. Puri, Sharma and Pathania, Principles of Physical Chemistry, Vishal publishers, 2014
4. A.K.Chandra, Introductory Quantum Chemistry, 3rd Ed., Tata McGraw Hill Pub. 1993.
5. J.Rajaram&J.C.Kuriacose, Thermodynamics, 2nd Ed., Vishal Pub. 1993.
6. Gurdeep Raj, Chemical Kinetics, 1st Ed., Goel Pub. House, 1985.
7. S.P.Singh , Chemical Kinetics, Goel Pub.
8. Subash and Satish, Chemical kinetics and Catalysis, Jeyaprakash& Co.
9. Ahluwalia, Polymer Chemistry, Anes Books, 2010.
10. V.R. Gowrikar et al., Polymer Science, 1st Ed., Wiley Eastern Ltd.,
11. Gurdeep Raj, Surface Chemistry, Goel Pub.
12. Keith J.Laidler, Chemical Kinetics, 2nd Ed., Tata McGraw Hill Pub. Reprint 1986.
13. D.A. McQuarrie and J.D.Simon, Physical chemistry A molecular Approach, Viva Books (p) Ltd.,
14. D.Attwood and A.T.Florence, surfactant systems – Their chemistry, Pharmacy and Biology, Chapmann and Hall, New-York (1983).

UNITS	TOPIC	LECTURE HOURS	MODE OF TEACHING
UNIT I: QUANTUM CHEMISTRY III			
	Chemistry of Approximation methods	2	Lecture, Discussion
	Variation method and perturbation theory- Application to the helium atom	3	Lecture, ICT, Assignment
	Slater detrimental wave functions	2	Lecture, Seminar
	Pauli′s exclusion principle, Born- Oppenheimer approximation, LCAO, MO and VB treatments of H_2 molecule	1 1 3	Lecture, ICT, Tutorial and Problem Solving

	Huckel π- electron theory and its application to ethylene and butadiene	3	Lecture, Videos
UNIT II: CHEMICAL KINETICS II ; Kinetics of fast reactions			
	Flow methods: Stopped flow method, continuous and quenched flow methods, Pulse method	6	Lecture, ICT, Discussion and Problem Solving
	Flash photolysis, Pulse radiolysis	3	Lecture, Seminar
	Microscopic kinetics, molecular beam method, Marcus theory of electron transfer processes	6	Lecture, ICT, Assignment
UNIT III: STATISTICAL THERMODYNAMICS			
	Objective of Statistical thermodynamics, Distinguishable and indistinguishable particles, ensemble and interactive systems, Microstates and macrostates, Maxwell - Boltzmann	5	Lecture, ICT, Tutorial
	Bose-Einstein and Fermi-Dirac Statistics and their respective distribution functions	3	Lecture, Assignment
	Partition function, Evaluation of translational, Vibrational and rotational partition functions for mono, diatomic molecules	4	Lecture, ICT, Seminar
	Calculation of thermodynamic functions, U, H, S and G, equilibrium constant and heat capacities from partition functions	3	Lecture, Seminar, Videos
UNIT IV: POLYMER SCIENCE			
	Glass transition temperature, factors influencing the glass transition temperature	3	Lecture, Tutorial
	Crystallinity in polymers - degree of crystallinity, effect of crystallinity in the properties of polymers	3	Lecture, Discussion, ICT
	Molecular weight and size of polymers, Number average and weight average molecular weight, degree of polymerization	3	Lecture, Video, Seminar
	Determination of molecular weight of polymers, Osmometry, Viscometry, Gel permeation chromatography	3	Lecture,
	Electro polymerization, Photopolymerization	2	Seminar
	Conducting polymers	1	Lecture
UNIT V: **SURFACE PHENOMENA**			
	Physisorption and Chemisorption, Adsorption of gases by solids, Factors influencing adsorption, Desorption, activation energy	3	Lecture, Discussion

	Langmuir theory of adsorption, BET theory of multilayer adsorption, Determination of Surface area	3	Lecture, Seminar
	Determination of area of cross section of a molecule, Derivation of BET equation	3	Lecture, Assignment
	Types of adsorption isotherms Adsorption from solution - Gibbs adsorption isotherm	3	Lecture, Library Class, Quiz
	Insoluble surface films on liquids. Surfactants	2	Lecture, Seminar
	Classification - Biosurfactants, Hydrophile, Lipophile Balance, Micelles formation, Shape and structure of micelle, Micellar aggregation number, Critical micelle concentration.	1	Lecture, Video, Discussion

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	4	4	3	3	1	4	4	4	4	4	3.5
CO2	4	4	3	3	1	4	4	5	4	4	3.6
CO3	4	4	4	3	1	5	4	3	4	4	3.35
CO4	4	4	4	3	1	4.5	4	3	4	4	3.25
CO5	4	4	5	3	1	4	4	4	4	4	3.2
Mean Overall Score											3.38

Result: The Score for this Course is 3.38 (High Relationship)

UNIT	Part A(5X5=25m)	Part B (5 X 10 = 50m) Either or Pattern
I	K1 / K4	K2 / K3
II	K3 / K4(2.5m), K3(2.5m)	K1/ K4
III	K3(2.5m) ,K4(2.5m) / K1	K4 / K2
IV	K2 / K3	K3 / K3(5m), k4(5m)
V	K4 / K2	K3(5m), k4(5m) / K1

Programme :M.Sc Chemistry **CORE 12**
Semester : III & IV **Hours : 6 /W, 90 Hrs./S**
Sub. Code : P22CD12P **Credits : 4**

TITLE OF THE PAPER: PHYSICAL CHEMISTRY PRACTICAL

Pedagogy	Hours	Lab session//Demonstration class/Viva voce
	6	6

PREAMBLE: The objective of the course is to make the student to do the physical chemistry experiments independently – Electrical and Non-Electrical experiments.

COURSE OUTCOME: At the end of the Semester, the Students will be able to	Unit	Hrs.
CO1: do the non-electrical experiments skillfully.	1	45
CO2: do the electrical experiments confidently.	2	45

UNIT I: NON-ELECTRICAL EXPERIMENTS

CHEMICAL KINETICS

1. Determination of the rate constant of the reaction of acid catalysed iodination of acetone and determination of the order of the reaction with respect to acetone and iodine.
2. Study of kinetics of reaction between persulphate and potassium iodide.

PHASE RULE

3. Construction of phase diagram for a simple binary system forming simple eutectic mixture and to find the unknown composition of a given mixture.

DISTRIBUTION LAW

4. Determination of molecular weight and degree of association of benzoic acid in benzene by partition method.

THERMOCHEMISTRY

5. Determination of Heat of solution of KNO_3 by solubility method.

ADSORPTION ISOTHERM

6. Determination of adsorption of acetic acid from aqueous solution by charcoal and verify the validity of Freundlich adsorption isotherm. (Demonstration)

UNIT II : ELECTRICAL EXPERIMENTS

CONDUCTIVITY MEASUREMENTS

7. Determination of molar conductance of strong electrolyte at different concentrations and testing the validity of Onsager's theory as limiting law at high dilution.

8. Determination of molar conductance of a weak acid at different concentrations. Verification of Ostwald´s dilution law and determination of dissociation constant of weak acid.

9. Conductometric titrations of mixture of HCl and Acetic acid against sodium hydroxide.

10. Precipitation titrations: (mixtures of halides against silver nitrate (or) $BaCl_2$ Vs $(NH_4)_2SO_4$.

11. To determine the solubility product K_{sp} of a sparingly soluble salt PbI_2 using conductometry method.

POTENTIOMETRIC TITRATIONS

12. Potentiometric acid base titrations:

Titration of strong acid Vs Strong base, Titration of weak acid Vs strong base

Determination of pH of a given solution usingQuinhydrone (Demonstration).

13. Potentiometric redox titrations: Determination of strength of given ferrous sulphate using standard ferrous ammonium sulphate and link potassium dichromate.

14. Determination of the strength and the dissociation constant of a weak acid.

pH METRY

15. Determination of the strength of the unknown solution of HCl by titrating it with sodium carbonate using pH meter.

References

1. V.Venkatesan, R. Veerasamy andA.R.Kulandaivelu, Basic Principles of Practical Chemistry, S.Chand and Sons, 2004.
2. Physical Chemistry Laboratory manual compiled by. B.Viswanathan, V.R.Vijayaraghavan, T. Sundaravelu, Kamala Govindarajan, S.Vivekanandan and V.Kannappan, Centre of Science Education School of Chemistry, University of Madras.
3. Practical Chemistry by O.P.Pandey, D.N.Bajpal and S.Giri, Reprint 2005.
4. J.B. Yadav; "Advanced Practical Physical Chemistry" 6th Edn., Goel Pub. Meerut,1986.

UNITS	TOPIC	LECTURE HOURS	MODE OF TEACHING
UNIT 1: NON-ELECTRICAL EXPERIMENTS			
	Chemical kinetics, Phase rule, Distribution law, Thermochemistry and adsorption isotherm	40	Lab Session
	Chemical kinetics, Phase rule, Distribution law, Thermochemistry and adsorption isotherm	5	Demonstration &Viva
	Chemical kinetics, Phase rule, Distribution law, Thermochemistry and adsorption isotherm		
UNIT II: ELECTRICAL EXPERIMENTS			
	Conductivity Experiments, Potentiometric titrations & pH Metry	40	Lab Session

	Conductivity Experiments, Potentiometric titrations & pHMetry	5	Demonstration &Viva
	Conductivity Experiments, Potentiometric titrations & pH Metry		

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	4	4	4	3	1	4	4	4	4	3	3.4
CO2	4	4	4	4	1	4	4	4	4	3	3.6
Mean Overall Score											3.5

Result: The Score for this Course is 3.5 (High Relationship)

Programme :M.Sc Chemistry **ELECTIVE 3**
Semester : III **Hours : 5 /W, 75 Hrs./S**
Sub. Code : P22DSD3 **Credits : 4**

TITLE OF THE PAPER: NANOCHEMISTRY

Pedagogy	Hours	Lecture	Peer Teaching/Seminar//Discussion//Problem solving session/Quiz/videos/Library session.	ICT
	5	3	1	1

PREAMBLE: The objective of the course is to make the student understand, learn and have an in-depth idea about the advanced concepts of nanoscience and few nanomaterials.

COURSE OUTCOME At the end of the Semester, the Students will be able to	Unit	Hrs. /S
CO1: discuss the fundamentals of nanoscience and able to update the fundamentals to new nanomaterials.	1	15
CO2: extend the learnt methods for the synthesis of nanomaterials to new systems.	2	15
CO3: demonstrate the properties of nanomaterials.	3	15
CO4: explain characterization of nanomaterials by various techniques.	4	15
CO5: practice implication of nanotechnology to help the society and environment.	5	15

UNIT – I

INTRODUCTION TO NANOMATERIALS (15 Hours)

Definition – Natural nanomaterials- Classification of nanomaterials (Based on dimension and materials)- Surface area to volume ratio.

Carbon based nanomaterials – Fullerenes – type, Symmetry, Structure, Synthesis (Laser ablation, Electric arc discharge method) – applications.

Carbon nanotubes – types – difference between single walled CNTs and multi walled CNTs - Properties (Mechanical strength, electrical conductivity, Thermal stability)- Synthesis (Laser ablation, CVD) – applications.

UNIT – II

SYNTHESIS OF NANOMATERIALS (15 Hours)

Top down and Bottom up approach- Top down approach (arc discharge, ball milling and inert gas condensation) – bottom up approach (Laser ablation, chemical vapour deposition, sol gel method, hydrothermal synthesis)

UNIT – III

PROPERTIES OF NANOMATERIALS (15 Hours)

Introduction, Mechanical properties of nanomaterials; Elastic properties, Hardness and Strength, Ductility and toughness, Superplastic behavior.

Optical Properties; Surface Plasmon resonance and quantum size effects, Applications of optical properties of nanoparticles.

Electrical properties - Energy band structure of Nano and bulk materials.

Magnetic properties – Introduction – Effect of Temperature on magnetic susceptibility – Classification of magnetic properties of nanomaterials (Structure sensitive and structure insensitive) – Superparamagnetism.

UNIT – IV **(15 Hours)**
CHARACTERIZATION OF NANOMATERIALS

Spectroscopic Techniques – Interpreting UV-Visible data of gold nanoparticles.

X-ray Crystallography – Basic idea of Powder X-ray diffraction method - Determination of crystalline size using Scherrer's formula - Determination of crystalline size distribution using X-ray line shape analysis.
X–ray diffraction patterns of commercially important CuO and ZnO.
Electron microscopic techniques – EDX: Basic principle and its importance – SEM; Basic principle and its importance TEM; Basic principle and its importance.

UNIT –V
APPLICATIONS OF NANOMATERIALS **(15 Hours)**
(General applications only not specific)
Applications of nano materials in various fields - Medicine, Food, Agriculture, catalysis, water purification and environment.

References

1. S. Shanmugam, Nanotechnology, 1st Ed., MJP Publishers, 2011.
2. T. Pradeep, Nano The Essentials, 1st Ed., McGraw Hill Companies, 2007.
3. Charles P. Poole, Introduction to Nanotechnology, 1st Ed., Wiley Eastern Pvt. Ltd., 2014.
4. K.P. Mathur, Nanotechnology & Applications, Rajah Publications, New Delhi.
5. G. Mohankumar, Nanotechnology, nanomateraials and nanodevices, 1st Ed., Narosa Pub. House 2016.
6. K.K. Choudhary, Nanoscience and nanotechnology, 1st Ed., Narosa Pub. House 2016.
7. B.S. Murthy et. al., Text Bookof Nanoscience and Nanotechnology, 1st Ed., Universities, Press 2012.
8. G.B. Sergeev, Nanochemistry, 1st Ed., Elsevier, 2012.
9. Patrick Salomon, A Handbook to Nanochemistry, 1st Ed., Dominant Publishers, New Delhi, 2010.
10. M.A. Shah and Tokeer Ahmad, Principles of Nanoscience and Nanotechnology, 2nd ed., 2013.
11. Sulabha K. Kulkarni, Nanotechnology: Principles and Practices,3rd Ed., ISBN 978-3-319-09171-6 , 2015,Springer.
12. Indian Journal of Fiber and Textile Research, Vol. 33 (2008) 304 -317.
13. M.A. Shah, Tokeer Ahamed, Principles of Nanoscience and Nanotechnology, Narosa Publishing House, 2013.

UNITS	TOPIC	LECTURE HOURS	MODE OF TEACHING
UNIT 1: INTRODUCTION TO NANOMATERIALS			
	Definition – Natural nanomaterials- Classification of nanomaterials (Based on dimension and materials) Surface area to volume ratio	3	lecture
	Carbon based nanomaterials – Fullerenes – type Symmetry, Structure, Synthesis (Laser ablation, Electric arc discharge method) - applications.	6	Lecture and ICT
	Carbon nanotubes – types – difference between single walled CNTs and multi walled CNTs - Properties (Mechanical strength, electrical conductivity, Thermal stability)- Synthesis (Laser ablation, CVD) – applications.	6	Lecture, ICT and Seminar
UNIT II :SYNTHESIS OF NANOMATERIALS			
	Top down and bottom-up approaches.	2	lecture
	Top-down approach (arc discharge, ball milling and inert gas condensation)	6	Lecture, ICT and Seminar
	bottom up approach (Laser ablation, chemical vapour deposition, sol gel method, hydrothermal synthesis)	7	Lecture, ICT and Seminar
UNIT III: PROPERTIES OF NANOMATERIALS			
	Optical Properties	5	Lecture and ICT
	Mechanical properties	6	Lecture
	electrical and magnetic properties	4	Lecture, ICT and Seminar
UNIT IV: CHARACTERIZATION OF NANOMATERIALS			
	UV – Vis Spectroscopy	4	ICT
	XRD	5	Lecture
	EDX, SEM and TEM	6	Lecture, ICT and Seminar
UNIT V: APPLICATIONS OF NANOMATERIALS			
	Medicine, Food, Agriculture	7	Lecture, ICT and Seminar
	catalysis, water purification and environment	8	Lecture, ICT and Seminar

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	4	3	4	3	1	4	4	4	2	4	3.3
CO2	4	4	4	4	1	4	4	4	2	4	3.5
CO3	4	3	4	3	1	4	4	4	2	4	3.3
CO4	4	3	3	4	1	4	4	3	3	4	3.2
CO5	4	3	4	3	1	4	4	4	2	4	3.3
Mean Overall Score											3.32

R

Result: The Score for this Course is 3.32 (High Relationship)

UNIT	Part A(5X5=25m)	Part B (5 X 10 = 50m) Either or Pattern
I	K1 / K2	K1 / K2/ K4
II	K2 / K4	K2/ K3/ K4
III	K3 / K2	K3 / K2
IV	K2 / K3/ K4	K3 / K2
V	K3	K3 / K2

Programme :M.Sc Chemistry **ELECTIVE 3**
Semester : III **Hours : 5 /W, 75 Hrs./S**
Sub. Code : P22DSD3 **Credits :4**

TITLE OF THE PAPER: ENVIRONMENTAL CHEMISTRY

Pedagogy	Hours	Lecture	Peer Teaching/Seminar//Discussion//Problem solving session/Quiz/videos/Library session.	ICT
	5	3	1	1

PREAMBLE: The objective of the course is to make the student understand, learn and have an in-depth idea about the advanced concepts of environmental science.

COURSE OUTCOME At the end of the Semester, the Students will be able to	Unit	Hrs./S
CO1: Gain the knowledge about the toxic chemicals in the environment.	1	15
CO2: discuss about causes, effects and control measures of pollution.	2	15
CO3: Demonstrate the air monitoring techniques.	3	15
CO4: define various methods of managing and recycling of solid wastes.	4	15
CO5: explain the instrumental techniques in environmental chemical analysis.	5	15

UNIT I

CHEMICAL TOXICOLOGY **(15 Hours)**

Toxic chemicals in the environment- biochemical effects of trace elements - Ar, Pb, Cd, Cr, Hg, Mn, Sb, Be, Co,Cu, Zn, Se, F- Carcinogens.

UNIT II

POLLUTION **(15 Hours)**

Air pollution - Green House effect - Ozone layer depletion-photochemical smog-Effect of pollution on human beings and animals- (CO, SO_2, (NO)x, HF)-causes-automobiles and industries-methods and equipments used for controlling particulate emission.

Water pollution-types of pollutants-organic and inorganic- Acid rain- Eutrophication-Effect of pollutants on human beings and animals- alkalinity and acidity- chloride, fluoride, cyanide, sulphate, nitrate, nitrite, sulphide.

Soil pollution-Effect of pollution on human beings and animals-pesticides, insecticides, fungicides, herbicides, algicides, rodenticides. Radioactive pollution-pollutants.

UNIT III

MONITORING TECHNIQUES AND METHODOLOGY **(15 Hours)**

Air monitoring-atmospheric sampling and analysis-techniques-gravity filtration, precipitation-absorption, adsorption and great sampling. Estimation of atmospheric pollution-Dust fall jar

Determination of suspended particles with a high-volume sampler- determination of sulphation rate- estimation of hydrogen sulphide and sulphur dioxide-analysis of hydrocarbons (brief idea)
Water monitoring- water quality parameters and standard-oxygen demand- BOD, COD –method Winkler- membrane electrode method.

UNIT IV
WASTE MANAGEMENT AND RECYCLING (15 Hours)

Waste management and recycling- classification of wastewater treatment- preliminary-primary-sedimentation-coagulation-secondary-aerobic-trickling filters-activated sludge- anerobic.
Solid waste disposal- solid waste management by biotechnology- municipal solid waste- sanitary land fill, composting, vermicomposting, incineration, e-waste management.
Radioactive waste- disposal methods- reprocessing of spent fuel- ocean dumping.
Polymer recycling- use of virgin plastics.

UNIT V
INSTRUMENTAL TECHNIQUES IN ENVIRONMENTAL CHEMICAL ANALYSIS (15 Hours)
Spectroscopic techniques: Basic principle and applications of Neutron activation analysis- anodic stripping voltammetry- atomic absorption spectroscopy- inductively coupled plasma emission spectroscopy- X-ray fluorescence- nondispersive infrared spectrometry-Fourier transform infrared spectroscopy.
Electrochemical techniques: Basic principles and applications of conductometry, polarimetry, voltammetry, polarography and coulometry.

References

1. K.BhagavathiSundari, Applied chemistry, 1st edn, MJP Publishers,2006
2. B.K.Sharma, Industrial chemistry, 16thedn, Goel publishing house,2011
3. S.S.Dara, Text book of Environmental chemistry and pollution control, 7thedn, S.Chand and company – 2004
4. A.K.De,Environmental chemistry,1stedn, New age International Pvt Ltd, 2004
5. Koushik and Koushik, Perspectives in Environmental Science,4thedn, New age International Pvt Ltd.

UNITS	TOPIC	LECTURE HOURS	MODE OF TEACHING
UNIT I: **CHEMICAL TOXICOLOGY**			
	Toxic chemicals in the environment	4	Discussion
	- biochemical effects of trace elements - Ar, Pb,Cd, Cr,Hg	5	Lecture
	biochemical effects of trace elements - Mn, Sb, Be, Co, Cu, Zn, Se, F	4	Seminar / peer teaching
	Carcinogens.	2	ICT

UNIT II: **POLLUTION**			
	Air pollution - Green House effect - Ozone layer depletion-photochemical smog, causes-automobiles and industries	4	Discussion/ peer teaching
	Effect of pollution air, water and soil pollution on human beings and animals	2	ICT
	methods and equipments used for controlling particulate emission.	2	Lecture
	Water pollution-types of pollutants-organic and inorganic- Acid rain- Eutrophication, alkalinity and acidity- chloride, fluoride, cyanide, sulphate, nitrate, nitrite, sulphide.	4	Seminar / quiz
	Soil pollution, pesticides, insecticides, fungicides, herbicides, algicides, rodenticides. Radioactive pollution-pollutants.	3	Activity based learning quiz/assignment)
UNIT III: **MONITORING TECHNIQUES AND METHODOLOGY**			
	Air monitoring-atmospheric sampling and analysis-techniques-gravity filtration, precipitation-absorption, adsorption and great sampling	4	Seminar /assignment
	Estimation of atmospheric pollution-Dust fall jar Determination of suspended particles with a high-volume sampler	3	ICT
	determination of sulphation rate-estimation of hydrogen sulphide and sulphur dioxide-analysis of hydrocarbons	3	Lecture
	Water monitoring- water quality parameters and standard –method Winkler- membrane electrode method.	3	Library session followed by discussion
	oxygen demand- BOD, COD	2	Demonstration
UNIT IV: **WASTE MANAGEMENT AND RECYCLING**			
	Waste management and recycling- classification of wastewater treatment, sedimentation-coagulation, aerobic-trickling filters, activated sludge- anerobic.	5	Lecture
	Solid waste disposal- solid waste management by biotechnology- municipal solid waste- sanitary land fill, composting, vermicomposting, incineration	5	Seminar /Peer teaching
	e-waste management, Radioactive waste- disposal methods- reprocessing of spent fuel- ocean dumping. Polymer recycling- use of virgin plastics	5	ICT

UNIT V: **INSTRUMENTAL TECHNIQUES IN ENVIRONMENTAL CHEMICAL ANALYSIS**			
	Spectroscopic techniques: Basic principle and applications of Neutron activation analysis- anodic stripping voltametry- - inductively coupled plasma emission spectroscopy.	5	Lecture
	atomic absorption spectroscopy, X-ray fluorescence- nondispersive infrared spectrometry-Fourier transform infrared spectroscopy.	5	Seminar / assignment
	Electrochemical techniques: Basic principles and applications of conductometry, polarimetry, voltametry, polarography and coulometry	5	ICT

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	4	4	4	4	1	4	4	4	3	4	3.6
CO2	4	4	3	4	1	4	4	4	3	4	3.5
CO3	4	4	3	3	1	4	4	4	3	3	3.3
CO4	4	4	4	3	1	4	4	4	3	4	3.5
CO5	4	4	4	3	1	4	4	4	3	4	3.5
Mean Overall Score											3.48

Result: The Score for this Course is 3.48 (High Relationship)

UNIT	Part A(5X5=25m)	Part B (5 X 10 = 50m) Either or Pattern
I	K1 (5m)	K3 (5m) , K4 (5m)
II	K2 (5m)	K2 (5m), K1 (5m)
III	K4 (5m)	K4 (5m), K3 (5m)
IV	K3 (5m)	K4(5m), K1 (5m)
V	K4 (5m)	K2(5m), K4(5m)

Programme :M.Sc/M.A **NON MAJOR ELECTIVE**
Semester : III **Hours : 2 /W, 30 Hrs./S**
Sub. Code : P22NMEC1 **Credits : 2**

TITLE OF THE PAPER: COSMETOLOGY

Pedagogy	Hours	Lecture	Peer Teaching/Seminar/Discussion/Problem solving session/Quiz/Lab session/videos/Demonstration class/Library session.	ICT
	2	1		1

PREAMBLE: The objective of the course is to give the knowledge about skin types, skin aging, skin irritation, cosmetic products and cosmetology careers, ethics and regulations

COURSE OUTCOME At the end of the Semester, the Students will be able to	Unit	Hrs./S
CO1: describe the types of cosmetics, skin types, skin care products and role of calcium in the regulation of skin barrier homeostasis skin pH and skin flora.	1	6
CO2: explain skin aging, new trends in anti-aging cosmetic ingredients and treatments and skin tolerance principles of skin irritation.	2	6
CO3: discuss the skin base materials, baby care products, antiperspirants, deodorantsand perfumes.	3	6
CO4: discuss the hair Conditioners, nail cosmetics, lips cosmetics and eye cosmetics.	4	6
CO5: discuss Cosmetology occupations, training and licensing requirements, General concepts of Ethics in human testing, Safety and Trends in cosmetic regulations in the U.S.A. and European Union.	5	6

UNIT I

INTRODUCTION **(6 Hours)**

1.1 Cosmetics-Types – liquid or emulsions, anhydrous creams or sticks – Ingredients – Natural and mineral.

1.2. Skin types – Sensitive skin – Hydrating substances –skin care products - Role of calcium in the regulation of skin barrier homeostasis- skin pH and skin flora.

UNIT II

SKIN AGING AND SKIN IRRITATION **(6 Hours)**

2.1. Skin aging – New trends in anti-aging cosmetic ingredients and treatments – antioxidants, UV filters, sun protection and sunscreens, after sun products- skin organ culture models (brief idea only) – cosmetics for the elderly.

2.2. skin tolerance – principles of skin irritation – sodium lauryl sulphate induced irritation in the human face– anti-irritants – allergy and hypoallergenic products.

UNIT III

COSMETIC PRODUCTS FOR SKIN AND BODY (6 Hours)

(Definition and main ingredients only)

Skin- base materials - whitening agents – Moisturizers –Facial masks – sunscreens – Exfoliants – facial masks.

Baby care products.

Antiperspirants, Deodorants and perfumes. Cooling ingredients and their mechanism of action.

UNIT IV

COSMETIC PRODUCTS FOR HAIR, NAILS, LIPS AND EYES (6 Hours)

(Definition and main ingredients only)

Hair Conditioners, Shampoos, Hair dyes and Hair gels.

Nail cosmetics - The normal nail – Handle of nail care.

Lips cosmetics – Lip stick, Lip gloss, Lip balm.

Eye cosmetics – Eye liner and kajal, Eye shadow and Muskara.

UNIT V

COSMETOLOGY CAREERS, ETHICS AND REGULATIONS (6 Hours)

5.1. Cosmetology occupations: Training and licensing requirements - Hair Stylist, Theatrical and Performance Makeup Artist, Esthetician and Manicurist and Pedicurist.

5.2. General concepts of Ethics in human testing – Safety – Trends in cosmetic regulations in the U.S.A. and European Union.

References

1. AU COPS, Hand book of Cosmetic Science and Technology, 3rd edition edited by Andre O.Barel, Marc Paye and Howard I. Maibach.
2. www.making**cosmetics.**com/Formulas_ep_5.html
3. study.com**/cosmetologist.**html
4. https://en.wikipedia.org/wiki/**Cosmetics**

UNITS	TOPIC	LECTURE HOURS	MODE OF TEACHING
UNIT 1: INTRODUCTION			
	Cosmetics-Types, liquid or emulsions, anhydrous creams or sticks, Ingredients, Natural and mineral, Skin types, Sensitive skin, Hydrating substances and skin care products.	4	Lecture
	Role of calcium in the regulation of skin barrier homeostasis- skin pH and skin flora.	2	ICT
UNITII: SKIN AGING AND SKIN IRRITATION			
	sun protection and sunscreens, allergy.	2	ICT

	Skin aging, new trends in anti-aging cosmetic ingredients and treatments, antioxidants, UV filters, after sun products- skin organ culture models, cosmetics for the elderly. skin tolerance, principles of skin irritation, allergy and hypoallergenic products.	4	Lecture
UNIT III: COSMETIC PRODUCTS FOR SKIN AND BODY			
	Commercially available cosmetic products.	2	Material collection by students.
	Skin- base materials, Baby care products, Antiperspirants, Deodorantsand perfumes. Cooling ingredients and their mechanism of action.	4	Lecture
UNIT 1V **COSMETIC PRODUCTS FOR HAIR, NAILS, LIPS AND EYES**			
	Preparation of shampoo and conditioner.	2	ICT and demonstration.
	Hair Conditioners, Shampoos, Hair dyes and Hair gels, Nailcosmetics, Lipsand eye cosmetics.	4	Lecture
UNIT V: **COSMETOLOGY CAREERS, ETHICS AND REGULATIONS**			
	Training and licensing requirements	2	ICT.
	Cosmetology occupations: Hair Stylist, Theatrical and Performance Makeup Artist, Esthetician and Manicurist and Pedicurist. General concepts of ethics in human testing, Safety, Trends in cosmetic regulations in the U.S.A. and European Union.	4	Lecture

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	4	3.5	3	1	3	4	3	3	4	4	3.3
CO2	4	3	3	1	3	4	4	3	3	4	3.3
CO3	4	3	4	1	2	4	4	3.5	3.5	4	3.5
CO4	4	3	3.5	1	2.5	4	4	3	3	4	3.35
CO5	4	3	3.5	1	4	4	3	5	4	3.5	3.5
Mean Overall Score											3.39

Result: The Score for this Course is 3.39 (High Relationship)

UNIT	Part A (5X5=25m)	Part B (5 X 10 = 50m) Either or Pattern
I	K1 / K4	K2 / K3
II	K3 /K4(2.5m) K3 (2.5m)	K1 / K4
III	K3(2.5m), K4 (2.5m) / K1	K4 / K2
IV	K2 / K3	K3 /K3(5m), K4 (5m)
V	K4 / K2	K3 (5m), K4 (5m)

Programme :M.Sc Chemistry **CORE 13**
Semester : IV **Hours : 6 /W, 90 Hrs./S**
Sub. Code : P22CD13 **Credits : 4**

TITLE OF THE PAPER: ORGANIC CHEMISTRY IV

Pedagogy	Hours	Lecture	Peer Teaching/Seminar/ Discussion/Problem solving session/Quiz/Lab session/Videos/ Demonstration Class/Library session.	ICT
	6	4	1	1

PREAMBLE:

The objective of the course is to make the student attain a good and deep knowledge about Photochemistry, Pericyclic reactions, Steroids and Hormones, Carbohydrates and Flavonoids, Terpenoids and Alkaloids.

COURSE OUTCOME: At the end of Semester IV, the students will be able to have a thorough and sound knowledge of the following given below:	**Unit**	**Hrs./S**
CO1: to apply Photo chemistry to new systems.	1	18
CO2: gain-in-depth knowledge in Pericyclic reactions.	2	18
CO3: able to plan the new synthesis of Steroids and Hormones.	3	18
CO4: Chemistry of Carbohydrates and Flavonoids.	4	18
CO5: Chemistryof Terpenoids and Alkaloids.	5	18

UNIT – I **(18 Hours)**

PHOTOCHEMISTRY

Photochemical Energy – Electronic Excitation – Excited States, Modes of Dissipation of Energy – (Energy transfer, Jablonski Diagram) – Quantum Efficiency – Photochemistry of Carbonyl compounds (Photo reduction, Norrish type I & II reaction, Photooxidation reactions, Reactions of cyclic ketones, The Paterno – Buchi reactions – photochemistry of α, β -unsaturated Compounds – photochemistry of Olefins – (Cis–Trans Isomerization) – Photo dimerization, Di – Π methane rearrangement)- Photo substitution reactions (Barton reaction, The Hofmann Loffler Freytag reaction) - Photorearrangement of cyclohexadienones (Zimmerman mechanism only, Photochemistry of natural product,α-santonin).

UNIT – II

PERICYCLIC REACTIONS **(18 Hours)**

Conservation of Molecular orbital Symmetry – Symmetry properties of Molecular orbitals [(1,3-butadiene, 1,3,5-hexatriene molecule)], Electrocyclic reactions- Correlation diagram and FMO method [cyclobutene – 1,3-butadiene, cyclohexadiene and 1,3,5-hexatriene system] – Cyclo addition reactions – Correlation diagram and FMO method (2S + 2S, 4S+ 2S system) - Sigmatropic Rearrangement – Suprafacial and antra facial processes- Analysis of [1,5] sigmatropic shift - Cope and Claisen rearrangement – Thermal isomerization ([1,3] and [3,3] sigmatropic shift) - Applications of PMO method to Pericyclic reactions (Electrocyclic reactions,Cyclo addition and Sigmatropic reactions) .

UNIT III STEROIDS AND HORMONES (18 Hours)

Stereochemistry of Steroids - Structural elucidation of cholesterol – syntheses of ergo calciferol (Structural elucidation is not included), Biosynthesis of Lanosterol

Hormones: Synthesis of Androsterone, Testosterone, Oestrone, and Progesterone.

UNIT – IV

CARBOHYDRATES AND FLAVANOIDS (18 Hours)

Disaccharides: Determination of the size of the ring in sugars – structural elucidation of Sucrose and Maltose – inversion of Sucrose – General studies of Lactose and Cellobiose.

Polysaccharides: General methods of elucidating the structure of Polysaccharides – Brief study of Cellulose & Starch.

General methods for the elucidation of structure of flavones – General study of Isoflavones and Anthocyanin – Synthesis of Quercetin.

UNIT – V

TERPENOIDS AND ALKALOIDS (18 Hours)

Isoprene rule – Isolation – classification of terpenoids with examples – General methods of Structural determination of terpenoids – Structure and Synthesis of Zingiberine – Santonin, Abietic acid, Camphor – Biosynthesis of Terpenoids.

Alkaloids Occurrence – Isolation – Classification – General methods of structural elucidation of Alkaloids – structure and synthesis of Cinchonine – Reserpine – Cocaine – Quinine

References

1 C.H. Depuy and D.L. Chapman, Molecular Reactions and Photochemistry, Prentice Hall, 1975

2 T.L. Gilchrist and R.C. Storr, Organic Reactions and Orbital Symmetry, 2nd Edn., Cambridge, 1972.

3 S.M. Muherjee and S.P. Singh, Pericyclic Reactions, Macmillan, 1976.

4 E.L. Eliel, Stereochemistry of Carbon Compounds, McGraw Hill, 1962.

5 V.M. Potapov, Stereochemistry, MIR Publishers, Moscow 1979.

6 D. Nasipuri, Stereochemistry of Organic compounds, 2nd Edn, New Age International, New Delhi, 1972.

7 E.L. Eliel, N.C. Allinger, S.J. Angyal and G.A. Morrision, Conformational Analysis, Interscience, New York, 1965.

8 O.P. Agarwal, Organic Chemistry Natural products Vol. I & II, HPH

9 S.M. Muherjee and S.P. Singh, Reaction Mechanism in Organic Chemistry, Mc Milan India Ltd., 1975.

10 R.T. Morrison and B. N. Boyd, "Organic Chemistry", 6th Edn., Prentice Hall of India, New Delhi, 1975.

11 I.L. Finar, Organic Chemistry, Vol. I and II, 5th edition ELBS. 1975.

12 R.B. Woodward and R. Hoffmann, The conversion of Orbital Symmetry, Verlog Academic Press 1971.

13 R. Chatwal, Organic Chemistry of Natural Products Vol I & II, Himalaya Publishing House.

UNITS	TOPIC	LECTURE HOURS	MODE OF TEACHING
UNIT 1:	**PHOTOCHEMISTRY**		
	Photo chemical energy, continuous electronic excitation, modes of dissipation of energy	4	ICT
	photochemistry of carbonyl compounds and olefins, Jablonski diagram	10	Lecture
	Energy transfer, photo rearrangements	4	Seminar
UNIT II	**PERICYCLIC REACTIONS**		
	Conservation of molecular orbital symmetry, symmetry properties of MO	4	ICT
	Electrocylic and cyclo addition reactions	11	Lecture
	Applications of PMO method to pericyclic reactions	3	Seminar
UNIT III	**STEROIDS AND HORMONES**		
	Stereo chemistry of steroid	4	ICT
	Structural elucidation of cholesterol and synthesis of steroids	8	Lecture
	Synthesis of 1. Androsterone 2. Testosterone 3. Oestrone 4. Estradiol and 5. Progesterone	6	Lecture, ICT, Seminar, Discussion
UNIT IV:	**CARBOHYDRATES AND FLAVONOIDS**		
	Determination of the size of the ring in sugar, Structural elucidation of Sucrose and Maltose, inversion of Sucrose, General studies of Lactose and Cellobiose.	4 5	Lecture and Library Class Lecture and Discussion
	General methods of elucidating the structure of polysaccharides, Brief study of Cellulose & Starch	4	Lecture, video and assignment seminar
	General methods for the elucidation of structure of Flavones General study of Isoflavones and Anthocyanin Synthesis of Quercetin	2 2 1	ICT, Tutorial and Discussion Lecture and Assignment Seminar
UNIT V:	**TERPENOIDS AND ALKALOIDS**		
	Isoprene rule, Isolation, classification of terpenoids with examples General methods of Structural determination of terpenes Structure and Synthesis of Zingiberine, Santonin, Abietic acid, Camphor, Biosynthesis of Terpenoids.	2 4 2 2	Lecture and Library Class Lecture and Discussion Lecture, ICT and Seminar

	Occurrence, Isolation, classification, General methods of structural elucidation of alkaloids Structure and Synthesis of Cinchonine, Reserpine, Cocaine, Quinine	4 4	Lecture and Video Lecture, ICT and Seminar

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	3	3	3.5	3	3	3	1	4	3.0
CO2	3	3	3	3	3.5	3	3	3	1	4	3.0
CO3	3	3	3	3	3.5	3.5	4	3.5	1	4	3.2
CO4	3	3	3	3	3.5	3.5	4	3.5	1	4	3.2
CO5	3	3	3	3	3.5	4	4	3.5	1	4	3.2
Mean Overall Score											3.1

Result: The Score for this Course is 3.1 (High Relationship)

UNIT	Part A(5X5=25m)	Part B (5 X 10 = 50m) Either or Pattern
I	K1 (5m)	K3 (5m) , K4 (5m)
II	K2 (5m)	K2 (5m), K1 (5m)
III	K4 (5m)	K4 (5m), K3 (5m)
IV	K3 (5m)	K4(5m), K1 (5m)
V	K4 (5m)	K2(5m), K4(5m)

Programme :M.Sc Chemistry **CORE 14**
Semester : IV **Hours : 5 P/W, 75 Hrs./S**
Sub. Code : P22CD14 **Credits :4**

TITLE OF THE PAPER: SELECTED TOPICS IN CHEMISTRY

Pedagogy	Hours	Lecture	Peer Teaching/Seminar//Discussion//Problem solving session/Quiz/videos/Library session.	ICT
	5	3	1	1

PREAMBLE: The objective of the course is to make the student understand basics of complex ionic structures and their characterization using XRD, know various physicochemical techniques used in analysis, importance of catalyst and applications of newer materials.

COURSE OUTCOME At the end of the Semester, the Students will be able to	Unit	Hrs./S
CO1: identify the structure of carbonyls, nitrosyls and identify various reactions of organometallic compounds	1	15
CO2: appreciate the importance of newmaterials like dielectrics, composites, aerospace, light emitting diodes and magnetic materials with interesting properties leading to newer applications	2	15
CO3: recognize the basic concept of Voltammetry, amperometry and Polarographic techniques in electroanalytical chemistry	3	15
CO4: illustrate the fundamentals of spectrophotometry, turbidimetry and fluorimetry and their instrumentation, explain the separation and quantification of ions using electro gravimetric method	4	15
CO5: acquire knowledge of physical & chemical characterization of catalyst and appreciate the vibrant role of catalyst in chemical reactions	5	15

UNIT-I, ORGANOMETALLIC CHEMISTRY (15 Hours)

Types of organometallic compounds on the basis of the nature of M-C bond. EAN rule: 18e- and 16e-rules – determinator of oxidation state, configuration, coordination number of the metal centre – Types and application 18e- / 16erules. Carbonyls – isolated concept - Structure of carbonlys (simple and polynuclear) Nitrosyls – bridging and terminal nitrosyls, bent and linear nitorsyls. Dinitrogen compounds donors – Alkyl and Aryl – preparation and properties; chain carbon donors – olefins, acetylene and allyl complexes – synthesis, structure and bonding; cyclic carbon donors – (metallocene) – synthesis, structure and bonding.

Important types of reactions of organometallic compounds – substitution – electrophilic and nucleophilic attack on ligands; carbonylation and decarbonylation; oxidative addition and reductive elimination, insertion and deinsertion(elimination). Template synthesis of macrocyclic ligands.

UNIT II

MATERIAL TECHNOLOGY (15 Hours)

Dielectric materials – Piezo electricity- effect of temperature- brief idea about optical property- Aerospace materials properties and applications (brief idea). Composite materials any one Preparation and uses –Chelates as light emitting diodes, polymer light emitting diodes, phosphorescent light emitting diodes, organic polymer solar cells (only preliminary idea) Magnetic properties of materials – classification paramagnetic, ferromagnetic, antiferromagnetic -Magnetic susceptibility – determination of magnetic susceptibility by Guoy balance.

UNIT III

ELECTROANALYTICAL CHEMISTRY (15 Hours)

Polarography – theory, instrumentation, DME, Diffusion, kinetic and catalytic currents, Current – Voltage curves for reversible and irreversible systems, qualitative and quantitative applications to inorganic systems.

Amperometric titrations – Theory, instrumentation, types of titration curves, Biamperometry applications.

Cyclic voltammetry – Theory, instrumentations, Applications to inorganic systems.

UNIT IV (15 Hours)

ELCTROGRAVIMETRY, PHOTOCHEMISTRY AND ELECTROCHEMICAL STUDIES

Theory of electro-gravimetric analysis – Electrolytic separation and determination of copper and nickel.

Spectrophotometry – spectrophotometric titration, determination of Fe(III) with EDTA and determination of Fe(III) in the presence of aluminium.

Turbidimetry – Principle, instrumentation, determination of sulphates and phosphates.

Fluorimetry – Principle, instrumentation, determination of quinine in toxic water.

UNITV

CATALYSIS (15 Hours)

Acid Base catalysis- Kinetics of Acid Base catalysis- Enzymes Catalysis – Michaelis Menton equation - Characteristics of enzyme catalysis – Factors affecting rates of enzyme reactions - influence of P^H – influence of temperature, effect of activator, effect of inhibitor.

Heterogenous Catalysis: Surface reactions – Langmuir- Hinselwood mechanism - Kinetics of surface reactions- Unimolecular surface reactions and bimolecular surface reactions- Auto catalysis and oscillatory reactions.

References

1. D.K.Chakrabarty&B.Viswanathan , Heterogenous Catalysis, New Age 2008.
2. Puri, Sharma &Pathania, Principles of physical Chemistry, Vishal publishers, ed.,2008.
3. J.C.Kuriacose, Catalysis, Mac Millan India Ltd.
4. J.D. Lee, Concise Inorganic Chemistry, Wiley India.

5. S.F.A. Kettle, Coordination chemistry, ELBS Ed.,
6. R. Gopalan & V.Ramalingam, Concise Coordination Chemistry, 1st Ed., Vikas Pub. House Pvt. Ltd., 2001.
7. R.D.Madan & Satya Prakash, Modern Inorganic Chemistry(Revised), S.Chand.

8. Satya Prakash, G.D. Tuli, S.K.Basu & R.D.Madan, Advanced Inorganic Chemistry, 1st Ed., S.Chand & Co, 2008.
9. F.Basolo and R.G. Pearson - Mechanisms of Inorganic reactions - Wiley Eastern.
10. U.Malik, G.D.Tuli and R.D. Madan, Selected topics in Inorganic Chemistry.
11. B. K. Sharma, Instrumental methods of Chemical Analysis
12. Qualitative inorganic analysis, Arthur Vogel, 7th edition

UNITS	TOPIC	LECTURE HOURS	MODE OF TEACHING
UNIT I: **ORGANOMETALLIC CHEMISTRY**			
	Types of organometallic compounds on the basis of the nature of M-C bond. EAN rule: 18e- and 16e- rules – determinator of oxidation state, configuration, coordination number of the metal centre – Types and application 18e- / 16e- rules.	4	Lecture
	Carbonyls – isolated concept.- Structure of carbonlys (simple and polynuclear) Nitrosyls – bridging and terminal nitrosyls, bent and linear nitrosyls. Dinitrogen compounds donors – Alkyl and Aryl – preparation and properties;	3	Lecture / library session
	Chain carbon donors – olefins, acetylene and allyl complexes – synthesis, structure and bonding; cyclic carbon donors – (metallocene) – synthesis, structure and bonding.	2	Discussion
	Important types of reactions of organometallic compounds – substitution – electrophilic and nucleophilic attack on ligands	3	Seminar/peer teaching
	Oxidative addition and reductive elimination, insertion and deinsertion (elimination). Template synthesis of macrocyclic ligands.	3	ICT
UNIT II: **MATERIAL TECHNOLOGY**			
	Dielectric materials – Piezo electricity- effect of temperature- brief idea about optical property	4	Lecture
	Aerospace materials properties and applications, Composite materials- Preparation and uses	3	Discussion/ peer teaching
	Chelates as light emitting diodes, polymer light emitting diodes, phosphorescent light emitting diodes, organic polymer solar cells	5	Seminar/ Quiz
	Magnetic properties of materials – classification		

	paramagnetic, ferromagnetic, antiferromagnetic - Magnetic susceptibility – determination of magnetic susceptibility by Guoy balance	3	ICT
UNIT III: **ELECTROANALYTICAL CHEMISTRY**			
	Polarography – theory, instrumentation, DME, Diffusion, kinetic and catalytic currents,	4	Lecture
	Current –Voltage curves for reversible and irreversible systems	3	Lecture
	Polarography – qualitative and quantitative applications to inorganic systems	2	Discussion
	Amperometric titrations – Theory, instrumentation, types of titration curves,	3	Seminar/Peer teaching
	Theory, instrumentation and application of Biamperometry, Cyclic voltammetry – Theory, instrumentations and Applications to inorganic systems.	3	ICT
UNIT IV: **ELECTROGRAVIMETRY, PHOTOCHEMISTRY AND ELECTROCHEMICAL STUDIES**			
	Theory of electro-gravimetric analysis – Electrolytic separation and determination of copper and nickel	4	Lecture
	Principle and instrumentation of Spectrophotometry	3	Lecture
	spectrophotometric titration, determination of Fe (III) with EDTA and determination of Fe(III) in the presence of aluminium.	3	Seminar/Peer teaching
	Turbidimetry – Principle, instrumentation, determination of sulphates and phosphates	2	Discussion
	Fluorimetry – Principle, instrumentation, determination of quinine in toxic water	3	ICT
UNIT V: **CATALYSIS**			
	Acid Base catalysis- Kinetics of Acid Base catalysis	3	Lecture
	Enzymes Catalysis – Michaelis Menton equation - Characteristics of enzyme catalysis – Factors affecting rates of enzyme reactions - influence of P^H – influence of temperature, effect of activator, effect of inhibitor.	4	Lecture
	Heterogenous Catalysis: Surface reactions –	2	Discussion
	Langmuir- Hinselwood mechanism - Kinetics of surface reactions	3	ICT
	Unimolecular surface reactions and bimolecular surface reactions- Auto catalysis and oscillatory reactions	3	Seminar/Peer teaching

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	4	3	2	3	1	4	3	3	2	3	2.8
CO2	4	2	3	4	1	4	4	4	2	3	3.1
CO3	4	4	4	3	1	4	4	3	3	4	3.4
CO4	4	3	4	3	1	4	4	3	3	4	3.3
CO5	4	3	3	4	1	4	3	3	3	4	3.2
Mean Overall Score											3.16

Result: The Score for this Course is 3.16 (High Relationship)

UNIT	Part A(5X5=25m)	Part B (5 X 10 = 50m) Either or Pattern
I	K4 / K4	K4 / K4
II	K3 & K4 / K3 & K4	K3 & K4 / K3 & K4
III	K2 / K2	K2 / K2
IV	K3 / K3	K3 / K3
V	K1/ K1	K1 / K1

Programme : M.Sc Chemistry **CORE 15**
Semester : III & IV **Hours : 6 /W, 90 Hrs./S**
Sub. Code : P22CD15P **Credits : 4**

TITLE OF THE PAPER: INORGANIC & ORGANIC QUANTITATIVE ANALYSIS PRACTICAL

Pedagogy	Hours	Lab session//Demonstration class/Viva voce		
	6	6		
PREAMBLE: The objective of the course is to make the student to do the estimation independently.				
COURSE OUTCOME: At the end of the Semester, the Students will be able to			Unit	Hrs
CO1: do the volumetric and gravimetric estimation skillfully.			1	40
CO2: do the complexometric titrations confidently.			2	20
CO3 do the organic estimation skillfully.			3	40
CO4do the colorimetric estimation skillfully.			3	20

I VOLUMETRIC AND GRAVIMETRIC ESTIMATION

1. Estimation of Copper & Nickel
2. Estimation of Iron & Nickel or Estimation of Copper & Zinc

II COMPLEXOMETRIC TITRATION

1. Estimation of Zinc / Magnesium.
2. Estimation of hardness of water.

III ORGANIC ESTIMATION

1. Estimation of Ethylmethylketone
2. Estimation of Glucose
3. Saponification of an oil
4. Estimation of Glycine

IV. COLORIMETRY

1. Estimation of Iron/Copper/Nickel.
2. Determination of unknown concentration of $KMnO_4/K_2Cr_2O_7$.

References

1. G.Svehla, Vogel′s Quantitative Inorganic Analysis, 7th Ed. Pearson Education, 2003
2. B.B. Dey and M.V. Sitaraman, Laboratory manual of organic chemistry –.
3. Gnanapragasam and Ramamurthy, Organic Chemistry Lab ManuaL, Viswanathan Publishers Pvt Ltd, 2006.
4. V.Venkatesan, R. Veerasamy, A.R.Kulandaivelu, Basic Principles of Practical Chemistry, S.Chand and Sons, 2004.
5. Practical Chemistry by O.P.Pandey, D.N.Bajpal and S.Giri, Reprint 2005.
6. Sundaram, P.Krishnan and P.S.Ragavan, Practical Chemistry, Viswanathan Printers and Publishers.,1993.
7. Subash-Satish, Advanced Inorganic Analysis.

UNITS	TOPIC	LECTURE HOURS	MODE OF TEACHING
UNIT I : VOLUMETRIC AND GRAVIMETRIC ESTIMATION			
	Estimation of Copper & Nickel, Estimation of Iron & Nickel or Estimation of Copper & Zinc	20	Lab Session
		5	Demonstration&Viva
UNIT II : COMPLEXOMETRIC TITRATION			
	Estimation of Zinc / Magnesium, Estimation of hardness of water.	12	Lab Session
		4	Demonstration&Viva
UNIT III ORGANIC ESTIMATION			
	Estimation of Ethylmethyl ketone, Estimation of Glucose, Saponification of an oil, Estimation of Glycine.	30	Lab Session
		5	Demonstration&Viva
UNIT IV COLORIMETRY			
	Estimation of Iron/Copper/Nickel, Determination of unknown concentration of $KMnO_4/K_2Cr_2O_7$.	12	Lab Session
		4	Demonstration& Viva

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	4	4	5	4	1	4	5	5	4	4	4.0
CO2	5	4	4	5	1	5	4	4	4	4	4.0
CO3	4	4	4	4	2	5	4	4	4	4	3.9
CO4	5	4	4	4	1	5	4	4	4	4	3.9
Mean Overall Score											3.95

Result: The Score for this Course is 3.95 (High Relationship)

Programme :M.Sc Chemistry **CORE 16**
Semester : IV **Hours : 8 /W, 120 Hrs./S**
Sub. Code : P22CDPW **Credits : 5**

INDIVIDUAL PROJECT

To plan and design, retrieve relevant literature, organize and conduct, process the data, record the observations and interpret. The work shall be conducted in the department under the guidance of the project supervisor or in other institutions or with interdisciplinary collaboration from external departments or institutions.

Programme :M.Sc Chemistry **ELECTIVE 4**
Semester : IV **Hours : 5 /W, 75 Hrs./S**
Sub. Code : P22DSD4 **Credits :4**

TITLE OF THE PAPER: GREEN CHEMISTRY

Pedagogy	Hours	Lecture	Peer Teaching/Seminar//Discussion//Problem solving session/Quiz/videos/Library session.	ICT
	5	3	1	1

PREAMBLE: The objective of the course is to make the student understand the concepts of green chemistry.

COURSE OUTCOME: At the end of the Semester, the Students will be able to	Unit	Hrs. /S
CO1: gain knowledge about the principles of green chemistry and about the green solvents.	1	15
CO2: discuss the organic reactions in solid-state	2	15
CO3: demonstrate alternative energy sources for the organic synthesis	3	15
CO4: choose appropriate reagents and catalysts for organic synthesis	4	15
CO5: realize the significance of green synthesis	5	15

UNIT – I INTRODUCTION TO GREEN SYNTHESIS (15 Hours)

Introduction – Principles of green chemistry – explanation of 12 principles of green chemistry

Organic synthesis in water – Advantages – Pericyclic reactions (Diels – Alder reaction, Hetero Diels – Alder reaction) – Claisen rearrangement – wittighorner reaction – Michael reaction – aldol condensation – knoevenagel reaction – pinacol coupling – benzoin condensation – claisen Schmidt condensation – benzoin condensation – oxidation (epoxidation, dihydroxylation, aldehydes, ketones) – reduction (C –C double bond, C-C triple bond, carbonyl compounds) Electrochemical synthesis (adiponitrile, sebacic acid)

Organic synthesis using ionic liquids – Introduction – properties of ionic liquids – types of ionic liquids – preparation of ionic liquids – Baylis Hillman reaction in ionic liquids - Horner Wadsworth – Emmons Reaction in ionic liquids – Biotransformation in ionic liquids (Synthesis of epoixed, Geranyl acetate, trans esterification of glucose and L –ascorbic acid) (mechanism is not included for all the reactions)

UNIT – II ORGANIC SYNTHESIS IN SOLID STATE (15 Hours)

Solid state reaction at room temperature: Aldol condensation, Grignard reaction, Reformatsky reaction - Synthesis of Quinoxalin derivatives, β - keto sulphones from ketones, α –tosyloxy β - keto sulphones

Solid state reaction using solid support : Protection and de protection (formation of acetals and dioxolanes, N- alkylation reactions) – Oxidation (alcohols, sulphides,aromatisation) – Reduction

(carbonyl compounds, crossed cannizaro reactions) – rearrangement (pinacol -pinacolone, Beckmann, Benzil–benzillic acid rearrangement) – Condensation reactions (Knoevenaga lcondensation, Wittig olefination reactions) - Synthesis of heterocycles (Aziridines, Benzimidazoles, pyrozoles,pyrroles, Azoles, Quinolines, β – lactams, Flavones)

(Mechanismis not included for allthe reactions)

UNIT – III USE OF ALTERNATE ENERGY SOURCES (15 Hours)

A. **Microwave assisted organic synthesis** – Introduction.

Microwave assisted reactions in water: Hofmann elimination – hydrolysis of benzamides, N – Phenyl benzamides, methyl benzoate – oxidation of toluene – coupling of amines – N – heterocyclisation

Microwave assisted reactions in organic solvents: Fries rearrangement – Diels Alder reaction – Claisen rearrangement – Baylis Hillman reaction – Synthesis of β lactams – catalytic hydrogenation – Ferrier rearrangement–pericyclic reactions – preparation of ferrocenyloxime – carbohydrates – radical reactions.

B. **Ultrasound assisted organic synthesis**– Introduction – Instrumentation – physical aspects – types of sonochemical reactions – homogeneous sonochemical reactions (curtius rearrangement, organo metallic reactions. Annulation, Grignard reactions, addition reactions) heterogeneous liquid liquid reactions (saponification, substitution, addition) - heterogeneous solid liquid reactions (oxidation, reduction)
(Mechanism is not included for all the reactions)

UNIT – IV ORGANIC SYNTHESIS USING GREEN REAGENTS AND GREEN CATALYST (15 Hrs.)

Green reagents: Singlet oxygen – ozone – hydrogen peroxide –dioxiranes – polymer supported reagents (PNBS, polymeric wittig reagent, EEDQ)

Green catalyst:

Phase transfer catalyst: Introduction – mechanism – types of Phase transfer catalyst – advantages of Phase transfer catalyst – Applications (Benzoin condensation, Darzen's reaction, Michael reaction, Williamson ether synthesis – the wittig reaction, Wittig Horner reaction, sulphurylides, oxidation ($KMnO_4$, hypochlorite, potassium ferricyanite)- reduction)

Crown ethers: Introduction – nomenclature – special features – synthetic application (Esterification, saponification, oxidation, substitution, elimination, displacement, superoxide anion, photocyanation, heterocyclisation, cation deactivation)

Biocatalyst: Introduction - advantage – classes of enzymes – specificity of enzymes – Biochemical or microbial oxidation (carbohydrates, steroids) – biochemical reduction – enzymes catalyzed hydrolytic processes – Application of enzymes.

(Mechanism is not included for all the reactions)

UNIT – V GREEN SYNTHESIS (15 Hours)

Green synthesis of Adipic acid, adiponitrile, Ibuprofen, Methyl metacrylate, sebatic acid, poly aspartate, 2 – aroylbenzofurans, cyclohexane oxime, Lauryl lactum, 6APA, 11 α –hydroxyl progesterone, 3-phenyl catechol, prednisolone.
(mechanism is not included for all the reactions)

References:
1.V.K. Ahluwalia, Green chemistry .
2. V.K. Ahluwalia, Green chemistry of environmentally benign reactions.

UNITS	TOPIC	LECTURE HOURS	MODE OF TEACHING
UNIT I: INTRODUCTION TO GREEN SYNTHESIS			
	Pericyclic reactions, Free radical brominations,	2	ICT
	Principles of green chemistry Organic synthesis in water and in super critical carbon di oxide	10	LECTURE
	Organic synthesis using ionic liquids	3	SEMINAR
UNIT II ORGANIC SYNTHESIS IN SOLID STATE			
	Solid state reactions at room temperature	2	ICT
	Organic reactions using solid support.	10	LECTURE
	Miscellaneous reactions	3	SEMINAR
UNIT – III USES OF ALTERNATE ENERGY SOURCES			
	Micro-wave assisted organic synthesis.	2	ICT
	Ultrasound assisted organic synthesis.	10	LECTURE
	Photo induced organic synthesis.	3	SEMINAR
UNIT – IV ORGANIC SYNTHESIS USING GREEN REAGENTS AND GREEN CATALYST			
	Crown ethers and PTC	2	ICT
	Green reagents	10	LECTURE
	Biocatalysts	3	SEMINAR
UNIT – V GREEN SYNTHESIS			
	Green synthesis of Ibu profen	2	ICT
	Green synthesis	10	LECTURE
	Lauryl lactum, 6-APA, Prednisolone	3	SEMINAR

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	4	4	3	4	1	3	4	4	4	4	3.5
CO2	4	3	4	4	1	4	3	4	3	4	3.4
CO3	3	4	4	4	1	3	4	4	4	4	3.5
CO4	4	3	4	3	1	4	4	4	3	4	3.4
CO5	4	4	4	3	1	3	4	4	3	4	3.4
Mean Overall Score											3.44

Result: The Score for this Course is 3.44 (High Relationship)

UNIT	Part A(5X5=25m)	Part B (5 X 10 = 50m) Either or Pattern
I	K1 , K3	K1/K2
II	K1 ,K2 / K4	K1 / K3
III	K1 ,K2 / K4	K1 ,K2 / K4
IV	K2 / K3	K3/ K4
V	K2 ,K3 / K4	K2 ,K3 / K4

Programme :M.Sc Chemistry **ELECTIVE 4**
Semester : IV **Hours : 5 /W, 75 Hrs./S**
Sub. Code : P22DSD4 **Credits :4**

TITLE OF THE PAPER: MEDICINAL AND PHARMACEUTICAL CHEMISTRY

Pedagogy	Hours	Lecture	Peer Teaching/Seminar//Discussion//Problem solving session/Quiz/videos/Library session.	ICT
	5	3	1	1

PREAMBLE: The objective of the course is to make the student understand fundamentals of medicinal and pharmaceutical chemistry		
COURSE OUTCOME: At the end of the Semester, the Students will be able to	Unit	Hrs /S
CO1: Gain knowledge about the fundamentals of medicinal chemistry, pharmacokinetics, concepts of prodrug and soft drug and drug design. To understand the development of QSAR.	1	15
CO2: To describe the structural features and SAR of penicillin G, cephalosporin, streptomycin, terramycin, erythromycin and chloramphenicol.	2	15
CO3: To classify chemotherapeutic agents and design the synthesis of antineoplastic agents and antitubercular drugs.	3	15
CO4: To employ the synthesis and therapeutic action and SAR of antihypertensive drugs.	4	15
CO5: Analysis of pharmaceutically important compounds using UV-vis, NMR, mass spectroscopy, TLC, HPLC and GC techniques.	5	15

UNIT I - FUNDAMENTALS OF MEDICINAL CHEMISTRY (15 Hours)

Introduction to the history of medicinal chemistry –Pharmacokinetics: Introduction to drug absorption, distribution, drug metabolism and elimination. Concept of prodrug and soft drug. Drug Design – Lead compounds, structure – activity relationship (SAR)and the development of Quantitative Structure Activity Relationship (QSAR).

UNIT II - ANTIBIOTICS AND ANTIBACTERIALS (15 Hours)

Structural features and SAR of the following antibiotics – penicillin G, cephalosphorin and their semisynthetic analogs (β – lactam), streptomycin (amino glycoside), terramycin (tetracycline), erythromycin (macrolide) and chloramphenicol.

UNIT III - CHEMOTHERAPEUTIC AGENTS (15 Hours)

Antineoplasticagents: Classification, synthesis, assay, e.g., cyclophosphamide, ifosfamide, clorambucil, busulfan, decarbazine, methotrexate, azathioprine, 6-mercaptopurine, 5-fluorouracil and cisplatin.
Antitubercular drugs: Classification, synthesis, assay, e.g., chloroquine, primaquine, amadodiaquine, mefloquine,progunailand pyrimethamine.

UNIT IV - SYNTHESIS AND THERAPEUTIC ACTION AND SAR OF ANTIHYPERTENSIVE DRUGS (15 Hours)

Nifedipine, Captopril, hydralazine, sodium nitroprusside, clonidine, methyldopa and guanothidine.

UNIT V - PHARMACEUTICAL ANALYSIS (15 Hours)

Principles, instrumentation and applications to the following: Absorption spectroscopy (UV, visible & IR). Principles and applications of NMR, Mass spectroscopy, Chromatographic methods – TLC, HPLC and GC.

References

1. Introduction to Medicinal Chemistry, A Gringuage, Wiley-VCH.
2. Wilson and Gisvold'sTextbook of Organic Medicinal and Pharmaceutical Chemistry, Ed Robert F. Dorge.
3. An Introduction to Drug Design, S.S. Pandey and J.R. Dimmock, New Age International.
4. Burger's Medicinal Chemistry and Drug Discovery, Sixth Edition, Ed.M.E.vWolff, John Wiley.
5. The Organic Chemistry of Drug Design and Drug Action, R.B. Silverman, Academic Press.
6. Finar, I. L. &Finar, A. L. Organic Chemistry Vol. 2, Addison-Wesley (1998)
7. Finar, I. L. Organic Chemistry Vol. 1, Longman (1998)
8. Gringauz, A. Introduction to Medicinal Chemistry: How Drugs Act and Why? John Wiley & Sons (1997).
9. Patrick, G. L. Introduction to Medicinal Chemistry Oxford University Press (2001).
10. Medicinal Chemistry,Sriram.D
11. Medicinal Chemistry,Kar.Ashuthosh
12. Introductory Medicinal Chemistry, J.B.Taylor and P.D.Kennewell, Ellisworth pub. 1985.
13. Medicinal Chemistry,Laxmi.C
14. Pharmaceutical Chemistry,B.Jeyasree Gosh
15. Text book of Pharmaceutical Organic Chemistry, Mohammed Ali.
16. Synthetic Drug, Gurdeep Chatwal.

UNITS	TOPIC	LECTURE HOURS	MODE OF TEACHING
UNIT I: FUNDAMENTALS OF MEDICINAL CHEMISTRY			
	Pharmacokinetics: Introduction to drug absorption, distribution, drug metabolism and elimination.	2	ICT
	Introduction to the history of medicinal chemistry. Concept of prodrug and soft drug. Drug	10	Lecture

	Design of Lead compounds, structure – activity relationship (SAR)		
	Development of Quantitative Structure Activity Relationship (QSAR).	3	Seminar
UNIT II: ANTIBIOTICS AND ANTIBACTERIALS			
	Structural features and SAR of penicillin G	2	ICT
	Structural features and SAR of cephalosphorin and their semisynthetic analogs (β – lactam), terramycin (tetracycline) and chloramphenicol.	10	Lecture
	Structural features and SAR of streptomycin (amino glycoside) and erythromycin (macrolide).	3	Seminar
UNIT III CHEMOTHERAPEUTIC AGENTS			
	Synthesis and applications of chloroquine and cisplatin.	2	ICT
	Synthesis of antineoplastic agents' assay, e.g., cyclophosphamide, ifosfamide, clorambucil, busulfan, decarbazine, methotrexate, azathioprine, 6-mercaptopurine, 5-fluorouracil and antitubercular drugs viz. primaquine, amadodiaquine, mefloquine and progunail pyrimethamine.	10	Lecture
	Classification of antineoplastic agents and antitubercular drugs	3	Seminar
UNIT IV SYNTHESIS AND THERAPEUTIC ACTION AND SAR OF ANTIHYPERTENSIVE DRUGS			
	Synthesis and therapeutic action of sodium nitro prusside.	2	ICT
	Synthesis and therapeutic action of Nifedipine, Captopril, hydralazine, clonidine, and guanothidine	10	Lecture
	Synthesis and therapeutic action of methyldopa	3	Seminar
UNIT V PHARMACEUTICAL ANALYSIS			
	Instrumentation of TLC, HPLC and GC	2	ICT
	Instrumentation and applications	10	Lecture

	to the following: Absorption spectroscopy (UV, visible & IR). Principles and applications of NMR, Mass spectroscopy,		
	Principles and applications of TLC, HPLC and GC.	3	Seminar

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	4	3	3	3	1	4	4	4	4	4	3.4
CO2	4	4	3	3	1	4	4	4	4	4	3.5
CO3	4	4	3	3	1	4	4	4	4	4	3.5
CO4	4	4	4	4	1	4	4	3	4	4	3.6
CO5	4	3	4	3	1	4	4	4	4	4	3.5
Mean Overall Score											3.5

Result: The Score for this Course is 3.5 (High Relationship)

UNIT	Part A(5X5=25m)	Part B (5 X 10 = 50m) Either or Pattern
I	K1 / K2	K1 / K2/ K4
II	K2 / K4	K2/ K3/ K4
III	K3 / K2	K3 / K2
IV	K2 / K3/ K4	K3 / K2
V	K3	K3 / K2