DR. AMBEDKAR GOVERNMENT ARTS COLLEGE (AUTONOMOUS)

Vyasarpadi, Chennai – 600 039.

(Accredited by NAAC at level "B")

M.Sc. CHEMISTRY SYLLABUS

Under Choice Based Credit System

LEARNING OUTCOME BASED CURRICULUM FRAMEWORK (LOCF)

(With effect from the academic year 2022-2023)

PG & RESEARCH DEPARTMENT OF CHEMISTRY

Based on UGC – Learning Outcomes-Based Curriculum Framework

M.Sc Course Structure under Choice Based Credit System

(For the candidates admitted from the academic year 2022-2023 onwards)

Sem. No	Part	Course	Subject Code	Course Title	Ins. Hrs/ Week	Credit	Exam Hrs	Marks		Total
								Int	Ext	
I	A	CC-I	22PACHC1	Core –I : Inorganic Chemistry – I	5	4	3	25	75	100
	A	CC-II	22PACHC2	Core –II : Organic Chemistry – I	5	4	3	25	75	100
	A	CC-III	22PACHC3	Core –III : Physical Chemistry – I	5	4	3	25	75	100
	A	CCP*	Even Sem.	**Practical –Organic Chemistry**	5	-	-	40	60	100
	A	CCP*	Even Sem.	**Practical – Inorganic Chemistry**	5	-	-	40	60	100
	A	CEC-I	#	Any one from Elective-I Subjects	3	3	3	25	75	100
	B	SBE – I	22PASBE1	Employability Skills	2	2	3	25	75	100
				Total	**30**	**17**				
II	A	CC-IV	22PBCHC1	Inorganic Chemistry-II	5	4	3	25	75	100
	A	CC-V	22PBCHC2	Organic Chemistry – II	5	4	3	25	75	100
	A	CC-VI	22PBCHC3	Physical Chemistry - II	5	4	3	25	75	100
	A	CCP-VII	22PBCHC4	**Practical - Organic Chemistry**	4	3	6	40	60	100
	A	CCP-VIII	22PBCHC5	**Practical - Inorganic Chemistry**	4	3	6	40	60	100
	A	CEC-II	##	Any one from Elective-II Subjects	3	3	3	25	75	100
	A	EDS-I	22PBCHD1	Research Methodology	2	3	3	25	75	100
	B	SBE – II	22PBSBE2	SBE – II : Leadership and Communication Skills	2	2	3	25	75	100
				Total	**30**	**26**				
III	A	CC-IX	22PCCHC1	Inorganic Chemistry-III	5	4	3	25	75	100
	A	CC-X	22PCCHC2	Organic Chemistry – III	5	4	3	25	75	100
	A	CC-XI	22PCCHC3	Physical Chemistry- III	5	4	3	25	75	100
	A	CCP**	Even Sem.	**Practical - Physical Chemistry**	4	-	-	40	60	100
	A	CCP**	Even Sem.	**Practical - Organic Chemistry**	4	-	-	40	60	100
	A	CEC-III	###	Any one from Elective-III Subjects	3	3	3	25	75	100
	A	EDS-II	22PCCHD2	Environmental Chemistry	2	3	3	25	75	100

	B	SBE - III	22PCSBE3	Managerial Skills	2	2	3	25	75	100
	C	Internship	22PCINT1	Internship	-	2	-	-	-	-
				Total	**30**	**22**				
IV	A	CC-XII	22PDCHC1	Organic Chemistry-IV	5	4	3	25	75	100
	A	CC-XIII	22PDCHC2	Physical Chemistry-IV	5	4	3	25	75	100
	A	CCP-XIV	22PDCHC3	**Practical - Physical Chemistry**	4	3	6	40	60	100
	A	CCP-XV	22PDCHC4	**Practical - Inorganic Chemistry**	5	4	6	40	60	100
	A	CCP-XVI	22PDCHC5	**Practical - Organic Chemistry**	-	3	6	40	60	100
	A	CEC-IV	####	Any one from Elective-IV Subjects	5	3	3	25	75	100
	A			Project		3	-			
	B	SBE - IV	22PDSBE4	Personality Development	2	2	3	25	75	100
				Total	**30**	**26**				
				Overall Total	**120**	**91**				

***** -Examination will be conducted in the even semester

CORE ELECTIVE COURSES:

Elective-I (Any one subject of the following Core Elective chosen by the candidate)		**Elective-II** (Any one subject of the following Core Elective chosen by the candidate)		**Elective-III** (Any one subject of the following Core Elective chosen by the candidate)		**Elective-IV** (Any one subject of the following Core Elective chosen by the candidate)	
***Sub. Code**	**Core Elective Courses**	**#Sub. Code**	**Core Elective Courses**	**##Sub. Code**	**Core Elective Courses**	**##Sub. Code**	**Core Elective Courses**
22PACHE1A	Green Chemistry	22PBCHE2A	Petroleum Chemistry	22PCCHE3A	Material Chemistry	22PDCHE4A	Bio inorganic Chemistry
22PACHE1B	Modern synthetic strategies and renewable energy resources	22PBCHE2B	Polymer Chemistry	22PCCHE3B	Nano Chemistry	22PDCHE4B	Leather Chemistry

SEMESTER I

M.Sc., Degree programme in Chemistry

FIRST SEMESTER				
Course title		**INORGANIC CHEMISTRY- I**		
Course code		**22PACHC1**		
Course No.	Course Category Core/Elective	No. of credits	No. of hrs/week	Total marks (Int+Ext)
CC-I	**Core**	**4**	**5**	**25+75=100**

Course objectives:

To provide knowledge of basic and advanced concepts in bonding and enable the students to

Identify the structure and bonding of simple molecules.

To thorough the concept about band theory, semiconductors, and studies of diffraction.

To enable students to appreciate the structure of inorganic chain and cluster compounds.

To expose the structure and bonding in boron compounds.

UNIT I: Chemical bonding 15HRS

V.B. approach to bonding-Hitler-London, Pauling and Slater refinements, Concept of hybridization and structure of molecules, VSEPR theory shapes of molecules. M.O. approach to covalent bonding – symmetry and overlap of atomic orbitals – symmetry of molecular orbitals – sigma and pi bonding – energy levels in homo and heteronuclear diatomic systems – bond length, bond order, and bond energy, Application to small molecules such as $BeCl_2$, BCl_3, ionic character in a covalent bond-Pseudo halogens: Structure and bonding in ClF_3, BrF_3 BrF_5 IF_5, IF_7 etc. Oxides and oxyacids of halogens, Bonding in Noble gas compounds – $XeCl_2$, XeF_4, $XeOF_4$, XeF_6.

UNIT II: Chemistry of solid state I: structure 15 HRS

Weak Chemical forces: van der Waals forces, Hydrogen bonding, Close packing of atoms and ions HCP and BCC types of packing voids, radius ratio – derivation – its influence on structures. Lattice energy – Born-Lande equation - Kapustinski equation, Madelung constant.Representative structures of AB and AB_2 types of compounds - rock salt, cesium chloride, wurtzite, zinc blende, rutile, fluorite, antifluorite, cadmium iodide and nickel arsenide. Structure of graphite and diamond. Spinels -normal and inverse types and perovskite structures.

UNIT III: Chemistry of solid state II: Diffraction methods 15 Hrs

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

Difference between point group and space group – screw axis – glide plane - symmetry elements –the relationship between molecular symmetry and crystallographic symmetry – The Concept of

reciprocal lattice – X-ray diffraction single-crystal – rotating crystal – powder diffraction. Neutron diffraction: Elementary treatment – comparison with X-ray diffraction. Electron diffraction- Basic principle. Crystal Growth methods: From melt and solution (hydrothermal, Gel methods).

UNIT IV: Boroncompounds and clusters **15Hrs**

Chemistry of boron – boranes, higher boranes 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 of low molecularity metal clusters only, Structure of Re_2Cl_8; multiple metal-metal bonds.

UNIT V: Inorganic chain and cluster compounds **15 hrs**

Types of inorganic polymers, comparison with organic polymers, silanes, higher silanes, multiple bonded systems, silicon nitrides, and siloxanes. P-N compounds, cyclophosphazenes and cyclophosphazanes. S-N compounds – S_4N_4, $(SN)_x$.Isopoly and heteropoly acids – Structure and bonding of 6- and 12 – isopol and heteropoly anions. Structure of silicates - applications of Pauling's rule of electrovalence - isomorphous replacements in silicates – ortho, meta, and pyro silicates – one dimensional, two dimensional, and three-dimensional silicates.

Text books:

1. Selected topics in Inorganic chemistry, Dr. Wahid, U. Malik, Dr.G.D.Tuli, Dr. R.D. Madan, S. Chand and Co. Ltd., 8th Ed., 2014.
2. Advanced inorganic chemistry, Vol I & II, Satya Prakash, G.D. Tuli, S.K. Basu, R.D. Madan S. Chand and Co. Ltd. 19th Ed., 2010.
3. Coordination Chemistry, D. Banerjea, Asian Books Prints Ltd., IIIrd Ed., 2009.

Reference books:

1. D.E. Douglas, D.H. McDaniel and J.J. Alexander, Concepts and Models in Inorganic Chemistry, 3rd Ed, **1994**.
2. M.C. Day, J. Selbin, Theoretical Inorganic Chemistry, 2nd Ed, East West Press, **1985**.
3. L. Pauling, The Nature of the Chemical Bond, 3rd Ed., Cornell University Press, **1960**.
4. F.A. Cotton, G. Wilkinson, Advanced Inorganic Chemistry, 4th Ed, John Wiley & Sons, **1986**.
5. D.F. Shriver, P.W. Atkins, Inorganic Chemistry, 3rd Ed, **1999**.
6. A.G. Sharpe, Inorganic Chemistry, Pearson Education, **2008**.
7. N. H. Ray, Inorganic Polymers, Academic Press, **1978**.
8. A. R. West, Basic Solid State Chemistry, John Wiley, **1991**.
9. E.L. Mutteri, Polyhedral Boranes, Academic Press, NY, **1975**

Web Resources:

https://cbpbu.ac.in>file>

https://onlinelibrary.wiley.com>

Methodology of teaching

Class Lecturer, Group Discussion, Assignments, Field-based learning

Course Outcome (COs):

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

CO code	Course Outcomes	K-levels
CO1	Concept of hybridization structure of molecules. Outline VSEPR theory and MO approach in chemical bonding. Knowledge of pseudo halogens, inter-halogens, oxides, and oxyacids of halogens and noble gas compounds.	K1, K2,K3
CO2	Illustration of weak chemical forces, packing and arrangement patterns of atoms/ions in solids. Required knowledge of the structure of AB and AB_2 types of compounds with examples.	K1, K2 ,K3
CO3	Knowledge of Band theory, conducting properties of solids, and liquid crystals. Interpretation of point group, space group, molecular and crystallographic symmetry. Illustrate the chemistry of solid states using X-ray diffraction, powder diffraction, and neutron diffraction methods.	K1, K3,K5
CO4	Required knowledge of boron, boranes, borazines, boron nitride, and hydroborate ion chemistry. Summarize the types of carborantheir its properties structure of metallocarboranes, metal cluster multiple Metal-Metal bonds.	K1, K2,K3,K6
CO5	Classify the types of inorganic polymers and , compare them with organic polymers. Knowledge of, chain and cluster compounds of silanes, silicon nitrides, siloxanes, cyclophosphazanesand , S-N compounds. Illustrate the structure and bonding in isopolyacids, heteropoly acids and silicates.	K1, K2,K4
K1 – Remembering , K2– Understanding , K3 –Applying ,K4 –Analysing , K5–Evaluating , K6–Creating		

CO-PSO Mapping (Course Articulation Matrix)

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	1	1	1	1	1
CO2	3	2	1	1	1	2
CO3	2	1	1	1	1	1
CO4	3	2	1	1	1	1
CO5	3	2	1	1	1	1
Average	2.6	2	1	1	1	1.2

BLOOM TAXANOMY BASED QUESTION PAPER PATTERN

UG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1	A (Answer all the questions)	10 × 2	Short Answer (Two questions from each unit)	20
K1, K2, K3	B (**INTERNAL CHOICE**) EITHER (a) OR (b)	5 × 5	Question (a) OR (b) from the same Unit and same K Level	25
K3, K4, K5	C (Answer any three question from five questions)	3 × 10	One questions from each unit (No unit missing)	30
Grand Total				**75**

FIRST SEMESTER				
Course title		**ORGANIC CHEMISTRY-I**		
Course code		**22PACHC2**		
Course No.	Course Category Core/Elective	No. of credits	No. of hrs/week	Total marks (Int + Ext)
CC-II	**Core**	**4**	**5**	**25+75=100**

Course Objectives

- Understanding the fundamental mechanism involved in electrophilic reactions, nucleophilic reactions and reactions that involve transient species.
- Understanding the basic aspects of stereochemistry such as chirality, nomenclature, stereoselectivity Vs stereospecificity and Asymmetric synthesis.
- Understanding the conformational analysis of six membered ring systems.

UNIT-I: Reaction mechanism **15Hrs**

Kinetic and Non- kinetic methods of determining organic reaction mechanisms. Isolation and trapping of intermediates, Isotopic labelling studies. Primary Kinetic Isotopic effect. Hammett equation-simple problems and Taft equation. Significance of reaction as well as substituent constants. Ambident nucleophiles such as CN^-, NO_2^-, phenoxide and ambident dianions.

UNIT-II: Aliphatic nucleophilic substitution **15Hrs**

Mechanism of nucleophilic substitution reaction: S_N1, S_N2 and S_Ni mechanisms. Solvent and leaving group effects and neighbouring group participation (NGP). Substitution at carbonyl, vinylic and bridgehead system. Role of LDA, crown ethers and phase transfer catalysts (PTC) in nucleophilic substitution reactions.Generation of enolates, enolate selectivity (Kinetic Vs Thermodynamic), alkylation of enolates and stereochemistry of enolate alkylation. Mechanism of ester hydrolysis (only BAc^2, AAc^2 and AAl^1). Alkylation of active methylene compounds. Preparation and synthetic utility of enamines, Finkelstein reaction, Wurtz coupling.

UNIT-III: Aromatic electrophilic and nucleophilic substitutions **15Hrs**

Aromatic electrophilic substitution: mechanism of nitration, sulfonation, Friedel-Crafts alkylation and acylation reactions. Synthesis of di- and tri-substituted benzenes from benzene or mono-substituted benzenes. Haworth reaction (for naphthalene), Scholl reaction, Vilsmeier-Haack formylation, Gattermann reaction, Reimer-Tiemann and Bischler-Napieralskireactions.Aromatic nucleophilic substitution in aryl halides by Meisenheimer complex mechanism and benzyne mechanism. Reactions of aryldiazonium salts. Zeigler alkylation, Chichibabin and Schiemann reactions.

UNIT-IV: Reactive intermediates **15Hrs**

Organic reactive intermediates: Generation, stability and reactivity of carbocations, carbanions, free radicals, carbenes, carbenoids, benzynes and nitrenes.

UNIT-V: Stereochemistry **15Hrs**

Chirality, Symmetry elements, Asymmetric and Dissymmetric chiral molecules. Calculation of number of optical isomers. Stereochemistry of mono and di-substituted cyclopropane, cyclobutane, cyclopentane and cyclohexane. Stereochemistry of tri-substituted cyclopentane, tri-substituted pentane and tetra-substituted hexane. Description of various types of optically active compounds including allenes, spiranes, biphenyls.Compounds containing two asymmetric centers;Erythro and threo isomers. Conversion of Fischer projection into perspective forms. Erythro and Threo-Inter conversion of Fischer to Sawhorse and Newman projections. Interpretation of homotopic, enantiotopic and diastereotopic atoms and faces. Pro-chiral carbon. R & S nomenclature of simple compounds, allenes, spiranes and biphenyls. Stereospecific and Stereoselective reactionsAsymmetric Synthesis-Cram's rule. Conformational analysis of cyclohexane, di-substituted cyclohexanes and decalin.

Text books

1. I. L. Finar, Organic Chemistry Vol 2: Stereochemistry and the Chemistry of Natural product, Dorling Kindersley India (P) Ltd, **2009.**
2. E. N. Eliel, Stereochemistry of Carbon Compounds, Tata McGraw Hill Ed, Reprint **2008.**
3. D. Nasipuri, Stereochemistry of Organic Compounds, New Age International (P) Ltd, Reprint, **2005.**
4. Kalsi. P. S, Organic Reactions: Stereochemistry and Mechanism through solved problems, New Age International (P)Ltd, 4th Ed, **2007.**E. L. Eliel and S. H. Wilen, Stereochemistry of Organic Compounds, Wiley India Ed, **2008.**

Reference Books:

1. Jerry March, Advanced Organic Chemistry, John Wiley & Sons, 5th Ed, **2001.**
2. F. Carey and R. J. Sundberg, Advanced Organic Chemistry-Part A and B, Springer Science + Business Media, 5 th Ed, **2007.**
3. M. B. Smith and Jerry March, Advanced Organic Chemistry, John Wiley & Sons, 5th Ed, **2001.**
4. J. Clayden, N. Greeves and S. Warren, Organic Chemistry, Oxford University Press, 2nd Ed, **2012**.
5. R. O. C. Norman and J. M. Coxon, Principles of Organic Synthesis, Chapman & Hall, 3rd Ed, **1993.**Stuart Warren, Organic Synthesis: Disconnection Approach, Wiley India (P) Ltd, **2007**.

Web Resources:

https://en.wikipedia.org/wiki/Reaction_mechanism
https://en.wikipedia.org/wiki/Stereochemistr
https://www.masterorganicchemistry.com/2017/07/11/electrophilic-aromatic-substitution-introduction/

Methodology of teaching

Class Lecture, Group Discussion, Assignments and Field-based learning

Course Outcome (COs):

On completion of the course the students able to

CO code	Course Outcomes	K-levels
CO1	Understand various kinds of reaction mechanism and apply in Hammett and Taft equation and interpretation of reaction and substituent constant.	K1,K2, K3,K5
CO2	Define various kinds of substitution reaction mechanism and evaluate the synthetic utility of organic reactions. Knowledge of ester hydrolysis, alkylation of active methylene compounds and synthetic utility of enamines, Finkelstein reaction and Wurtz coupling reaction.	K1,K2, K3
CO3	Exhibit the difference between aromatic electrophilic and nucleophilic substitution reaction mechanism. Aromatic nucleophilic substitution in aryl halides by Meisenheimer complex mechanism and benzyne mechanism.	K1,K3, K6
CO4	The required knowledge of Organic reactive intermediates: Generation, stability and reactivity of carbocations, carbanions, free radicals, carbenes, benzynes and nitrenes.	K1,K2, K3,K4
CO5	Illustration of Stereochemistry of mono and di-substituted cyclic compounds and apply in the field of synthetic routes of preparing new compounds. Interpretation of homotopic, enantiotopic and diastereotopic and concept of R and S nomenclature of allenes, spiranes and biphenyls	K1,K2, K6
K1 – Remembering , K2– Understanding , K3 –Applying ,K4 –Analysing , K5– Evaluating , K6–Creating		

CO-PSO Mapping(Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2	3	2	1
CO2	3	2	3	3	3	3
CO3	3	2	3	3	2	1
CO4	3	1	3	3	1	3
CO5	3	3	3	3	2	3
Average	3	2.2	2.5	3.0	2.0	2.2

BLOOM TAXANOMY BASED QUESTION PAPER PATTERN

UG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1	A (Answer all the questions)	10 × 2	Short Answer (Two questions from each unit)	20
K1, K2, K3	B (**INTERNAL CHOICE**) EITHER (a) OR (b)	5 × 5	Question (a) OR (b) from the same Unit and same K Level	25
K3, K4, K5	C (Answer any three question from five questions)	3 × 10	One questions from each unit (No unit missing)	30
Grand Total				**75**

FIRST SEMESTER				
Course title		**PHYSICAL CHEMISTRY-I**		
Course code.		**22PACHC3**		
Course No	Course Category Core/Elective	No. of Credits	No of hrs/week	Total marks (Int+Ext)
CC-III	**Core**	**4**	**5**	**25+75=100**

Course objectives:

- To understand the kinetics of chemical kinetics and explore the reaction kinetics of fast reactions to learn the various techniques and mechanism of involved in catalysis.
- To gain on understanding of the Ionic activity, ionic interactions, Debye-Hückel-Bjerrum model, Debye-Hückel limiting law.
- To study the Debye-Hückel theory of strong electrolytes. To study the Electrical double layer, electrocapillary phenomena, surfactants.
- The design and applications of the batteries and Fuel Cells, Corrosion and its Protection.

UNIT I:Chemical Kinetics **15**hrs

Absolute reaction rate theory -Thermodynamic Terms-Significance of entropy and volume of activation. Reactions in solution: factors determining reaction rates in solutions, effect of dielectric constant and ionic strength, - Bronsted –Bjerrum Equation-Primary and Secondary salt effect, influence of solvent on reaction rates.

UNIT II:Chemical Dynamics **15**hrs

Potential energy surfaces-Dynamics of unimolecular reactions-Lindemann Hinshelwood, Rice-Ramsperger- Kassel (RRK) theory.Rice-Ramsperger-Kassel -Marsus (RRKM) theory.Linear free energy relationship-Hammett equation, Taft Equation-Separation of polar, resonance and steric effects.

UNIT III:Acid-Base and Enzyme Catalysis **15** hrs

Homogeneous and Heterogeneous catalysis. Acid base catalysis-Bronsted relations.Industrial applications of catalysts. Enzyme catalysis and its mechanism, Michaelis-Menten equation, effect of pH and temperature on enzyme catalysis, Mechanism of enzyme inhibition.

UNIT IV: Electrochemistry – I **15** hrs

Deviation from ideal behaviour.ion-solvent and ion-ion interactions. Debye-Hückel-Bjerrum model, Ion association and triple ion formations.Expression for the mean activity coefficient.Debye-Hückellimiting law and its applications -Diverse ion effect.Van't Hoff factor and its relation to colligative properties.Debye-Hückel theory of strong electrolytes.Debye-Hückel length and potential around a central ion, its interpretation. Transport of ions in Solution: Electrolytic conduction- Debye - Hückel-Onsager treatment of strong electrolytes- ionic atmosphere- Anomalous conductance of non-aqueous electrolytes.

UNIT V: Electrochemistry- II **15** hrs

Electrical double layer - Electrocapillary phenomena - Surfactants - Lipmann's equation, Electrokinetic phenomena.Zeta potential and its applications.Structure of electrical double layer – Helmholtz-Perrin, Guoy-Chapmann and Stern models. Butler-Volmer equation for one electron

transfer reaction - equilibrium and exchange current densities- and symmetry factor - transfer coefficient.Cyclic voltammetry and Stripping voltammetry - principle – instrumentation-Corrosion and passivation of metals - Pourbaix diagram - Evans diagram –Batteries and Fuel cells-Ion selective electrodes.

Text Books:

1. Paula, Peter Atkins and Julio de, Elements of Physical chemistry, 5th Ed, Oxford U.P,**2012**. Mordechay Schlesinger, Modern Aspects of Electrochemistry: Issue 43, Springer, Netherlands, **2009**.
2. J. N. Gurtu and A. Gurthu, Advanced Physical Chemistry, PragathiPrakashan, Meerut, Revised, **2014.**

Reference Books:

1..J.Laidler, Chemical Kinetics, Harper and Row, New York,**1987**.

2. R.G. Frost and Pearson, Kinetics and Mechanism, Wiley New York, **1961**.

3. A.W.Anderson, Physical Chemistry of Surfaces, Wiley - Interscience, Newyork, 1990.

Web Resources

https://usiu-ke.libguides.com/PhysicalChemistry
https://epgp.inflibnet.ac.in

METHODOLOGY OF TEACHING

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students be able to

CO code	Course Outcomes	K-levels
CO1	**Acquire** thorough knowledge of absolute reaction rate theory, **Interpret** Thermodynamic Terms**Use**Significance of entropy and volume of activation**Describe**Reactions in solution, **Recognize**factors determining reaction rates in solutions, effect of dielectric constant and ionic strength.	K1, K2, K3
CO2	**Classify** Dynamics of unimolecular reactions,**Describe**Rice-Ramsperger- Kassel (RRK) theory, Rice-Ramsperger-Kassel - Marsus (RRKM) theory.**Define**Potential energy surfaces,**Illustrate**Linear free energy relationship-Hammett equation, Taft Equation.	K1, K2, K4
CO3	**Explain** Mechanism ofEnzymecatalysis,**define** Enzyme Catalysis,**Relate**effect of pH and temperature on enzyme catalysis, **Deduce**Michaelis-Menten equation**Infer**Mechanism of enzyme inhibition	K1, K2, K3, K5

CO4	**Illustrate** the concepts of Ionic interactions, theory of electrolytes, **Categorize** double layer models.**Analyse** Debye-Hückel limiting law	K1,K3,K6
CO5	**Understand and explore** the designs of Batteries, Fuel cells and ion selective electrodes	K1,K2,K5
K1 – Remembering , K2– Understanding , K3 –Applying ,K4 –Analysing , K5–Evaluating , K6–Creating		

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	2	1	2	2
CO2	3	2	3	2	2	2
CO3	3	2	2	3	2	2
CO4	3	3	3	2	3	3
CO5	3	3	2	3	2	3
Average	3	2.4	2.4	2.2	2.2	2.4

BLOOM TAXANOMY BASED QUESTION PAPER PATTERN
UG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1	A (Answer all the questions)	10 × 2	Short Answer (Two questions from each unit)	20
K1, K2, K3	B (**INTERNAL CHOICE**) EITHER (a) OR (b)	5 × 5	Question (a) OR (b) from the same Unit and same K Level	25
K3, K4, K5	C (Answer any three question from five questions)	3 × 10	One questions from each unit (No unit missing)	30
Grand Total				**75**

SECOND SEMESTER				
Course title		**PRACTICAL-ORGANIC CHEMISTRY**		
Course code.		**22PBCHC4**		
Course No	Course Category Core/Elective	No. of Credits	No of hrs/week	Total marks (Int+Ext)
CCP-VII	**Core**	**3**	**4**	**40+60=100**

OBJECTIVES:

- To separate individual organic compounds from its mixture by using diethyl ether.
- To find aromatic / aliphatic, saturated / unsaturated, elements present (N, X, S), functional groups and derivatives in a individual compounds.
- To determine the boiling point and melting point of organic compounds.
- To prepare various types of single stage organic reactions.

This comprises of TWO parts

I. Analysis of a mixture of organic Compounds.

The practical is designed as to give the students exposure to lab techniques in analysis of organic molecules and organic compounds.

1. Identification of components in a two component mixture and preparation of their derivatives.
2. Determination of b.p./ m.p. for components and m.p. for the derivatives.

II. Single stage organic preparations illustrating various types of reactions.

1. Salicylic acid from methyl salicylate(Hydrolysis)
2. 2,4,6-Tribromoaniline from aniline (Bromination)
3. m-Dinitrobenzene from nitrobenzene (Nitration)
4. Acetanilide from aniline (Acetylation)
5. 2-Naphthyl benzoate from 2-napthol (Benzoylation)
6. Benzoic acid from Benzyl alcohol (Oxidation)
7. Diethyl oxalate from oxalic acid (Esterification)
8. Sulphanilic acid from aniline (Sulphonation)

COURSE OUTCOMES:

On completion of the course the student will be able to:

CO No	COURSE OUTCOME	KNOWLEDGE LEVEL
CO1	Understand the basic principle organic reactions and analyse the organic substance systematically	K1,K2,K3,K4
CO2	Acquire analytical skill to identify the unknown organic substance based on aliphatic or aromatic and identify the various elements present such as nitrogen, halogen and sulphur present along with the functional groups.	K1,K2,K3,K4
CO3	Apply the skills to pursue higher studies and work with professional ethics in industries and research laboratories.	K2,K3,K4
Kl-Knowledge, K2-Understand, K3-Apply, K4-Analyze		

CO-PSO Mapping (Course Articulation Matrix)

CO/PSO	PSOl	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	1	1	2	3	2	1
CO2	3	3	1	3	2	3
CO3 .	2	3	2	1	3	3
Average	2.0	2.3	1.6	2.3	2.3	2.3

SECOND SEMESTER				
Course title		**PRACTICAL- INORGANIC CHEMISTRY**		
Course code.		**22PBCHC5**		
Course No	Course Category Core/Elective	No. of Credits	No of hrs/week	Total marks (Int+Ext)
CCP-VIII	**Core**	**3**	**4**	**40+60=100**

INORGANIC CHEMISTRY PRACTICAL:

1. Qualitative analysis employing semimicro methods and spot tests of mixtures of common cations plus ions containing the following less familiar elements W, Se, Te, Mo, Ce, Th, Ti, Zr, U, Be, V and Li.

   Preparation of the following complexes:-

   Potassium trioxalatoferrate (III) trihydrate.
   Hexamminecobalt (III) Chloride, Potassium trisoxalatochromate (III)
   Thiourea complexes of copper(I)
   Tetramminecopper (II) Sulphate

Complexometric Titrations using EDTA.

Estimation of Mg^{2+}, Zn^{2+} and Ca^{2+}

COURSE OUTCOMES:

On completion of the course the student will be able to:

CO Code	COURSE OUTCOME	KNOWLEDGE LEVEL
CO1	Acquire the knowledge on basic principles of qualitative analysis.	K1,K2,K3,K4
CO2	Learn the sill to prepare inorganic complexes	K1,K2,K3,K4
CO3	Learn the principle and applications of EDTA titrations.	K2,K3,K4
Kl-Knowledge, K2-Understand, K3-Apply, K4-Analyze		

CO-PSO Mapping (Course Articulation Matrix)

CO/PSO	PSOl	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	1	1	3	3	1
CO2	3	3	1	3	3	3
CO3 .	2	3	2	1	2	3
Average	2.6	2.3	1.3	2.3	2.6	2.3

FIRST SEMESTER				
Course title		GREEN CHEMISTRY		
Course code.		22PACHE1A		
Course No	Course Category Core/Elective	No. of Credits	No of hrs/week	Total marks (Int+Ext)
CCE-IA	**Elective**	**3**	**3**	**25+75=100**

Course Objectives:

This course aims to explain the basic concepts in Green ChemistryAlternative starting material, catalyst, reagentssolvents and processes can be carried outlearned environment friendly alternative chemical method of synthesis .Special designs , advantage and applications of green chemistry were explained.

UNIT- I Principles of green chemistry 9 Hrs

Introduction to green chemistry: Green chemistry-relevance and goals.Anastas twelve principles of green chemistry-Tools of green chemistry.Alternative starting materials ,reagents, catalyst,sovents and processes with suitable examples.

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UNIT-II Microwave mediated organic synthesis, Microwave –Neatreactions 9Hrs

Microwave mediated organic synthesis (MAOS) :Microwave activation-Advantage of microwave exposure-specific effects of microwave –Neat reactions-solid support reactions-fuctional group transformations –condensation reaction-oxidation-reduction reaction- multi component reactions.

UNIT III Ionic liquids and PTC introduction 9 Hrs

Ionic liquids and PTC Introduction-synthesis of Ionic liquids-physical properties-application in alkylation-hydroformylations-expoxidation-synthesis of ethers-Fridel Craft reaction-Diels Alder reactions-Knoevengal condensations-Wittig reactions- Phase transfer catalyst- synthesis – applications.

UNIT IV Supported catalyst and bio-catalyst for Green chemistry 9 Hrs

Supported catalyst and bio-catalyst for Green chemistry – Introduction- the concept of atom economy-supported metal catalysts- mesoporous silicas- the use of Biocatalysts for green chemistry-modified bio catalysts-fermentations and biotransformations- fine chemicals by microbial fermentation-vitamins and aminoacids. Microbial polyester synthesis.

UNIT V Alternative synthesis reagents and reaction conditions 9 Hrs

Alternative synthesic reagents and reaction conditions.A photochemical alternative to friedel crafts reactions-Dimethyl carbonate as a methylating agent- the design and applications of green oxidation- super critical carbondioxide for synthetic chemistry.

Text Books

1. Green Chemistry-Environmentally benign reactions-V.K.AhluwaliaAne Books India (publisher) (2006).
2. Green Chemistry-Designing Chemistry for the Environment- edited by Paul T. Anastas&TracyC.Williamson. Second Edition. (1998).

Reference books:

3. Green Chemistry –Frontiers in benign chemical synthesis and processes –Edited by Paul T.Anastas&Tracy C. Williamson Oxford University Press (1998).
4. Green Chemistry-Environment friendly alternative edited by Rashmi Sanghi& M.M Srivastava. Narora Publishing House (2003) .

COURSE OUTCOMES:

On completion of the course the student will be able to:

CO code	Course outcome	Knowledge level
CO1	Define the basic concepts and principles of green chemistry.Able to do alternative starting materials and processes with examples	K1 K2 K3 K4
CO2	Understand microwave mediated organic synthesis . Knowledge of microwave reaction such as functional group transformations, condensation reaction, oxidation, reductions, multi component reactions and its advantage	K1 K2 K3 K4
CO3	Learn about ionic liquids and phase transfer catalyst. Understand various chemical reaction synthesis and its applications of green chemistry	K1 K2 K3 K6
CO4	Understand the role of catalyst in green chemistry. Knowledge of basic concepts , various types ,synthesis and uses of Bio catalyst in green chemistry	K1 K2 K3

CO5	Explain alternative synthesis , reagents used and various reaction conditions applied in green chemistry	K1 K2 K3 K6
K1 – Remembering , K2– Understanding , K3 –Applying ,K4 –Analysing , K5–Evaluating , K6–Creating		

CO- PSO Mapping (Course Articulation Matrix)

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	2	3	2	2
CO2	3	2	2	3	2	2
CO3	3	2	2	3	2	2
CO4	3	2	2	3	2	2
CO5	3	2	2	3	2	2
Average	3	2.4	2.4	3	2.4	2.4

BLOOM TAXANOMY BASED QUESTION PAPER PATTERN

UG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1	A (Answer all the questions)	10 × 2	Short Answer (Two questions from each unit)	20
K1, K2, K3	B (**INTERNAL CHOICE**) EITHER (a) OR (b)	5 × 5	Question (a) OR (b) from the same Unit and same K Level	25
K3, K4, K5	C (Answer any three question from five questions)	3 × 10	One questions from each unit (No unit missing)	30
Grand Total				**75**

FIRST SEMESTER				
Course title		**MODERN SYNTHETIC STRATEGIES, GREEN CHEMISTRYAND RENEWABLE ENERGY SOURCES.**		
Course code		**22PACHE1B**		
Course No	Course Category Core / Elective /	No of Credits	No of hrs /week	Totalmarks (Int+Ext)
CEC- II B	**Elective**	**3**	**3**	**25 + 75=100**

Course objectives

- To understand the basic aspects of organic reactions in terms of acceptor and donor synthons.
- To acquire knowledge about the retrosynthetic analysis and various types of organic syntheses involved in accessing natural products.
- To illustrate the mechanism and synthetic utility of transition metal catalyzed organic reactions.
- To relate the concept of asymmetric synthesis with their applications.
- To identify the advantages of green reactions and their utility.

UNIT-I: SYNTHETIC METHODOLGY 9 HRS

Synthons (acceptor and donor)-synthetic equivaqlents and Retrosynthesis-Discoonnection approach- Umpolung, 1,3-Dipolar cycloaddition methodologies (Azide, nitrile oxide, azomethine ylides and carbonyl ylides). Definition,characteristics and classification of Tandem reactions in organic synthesis. Radical cyclization .

UNIT-II: NOVEL REAGENTS AND ASYMMETRIC SYNTHESIS 9 HRS

Typical reactions involving Heck, Negishi, Suzuki-Miyaura, Stille and Hiyama coupling for carbon-carbon bond formation reactions. Buchwald-Hartwig coupling for the carbon-heteroatombond formation reactions.

Asymmetric synthesis-Asymmetric induction-Resolution-Kinetic resolution reactions, Desymmetrization, Chiral auxiliary-Chiral catalysts. Generation of Asymmetric synthesis- Enders

RAMP/SAMP. Asymmetric dihydroxylation, epoxidation Sharpless, Jacobsen, Shi and Asymmetric reduction (Corey).

UNIT-III: NATURAL PRODUCTS 9 HRS

Definition- Biosynthesis involving carbohydrates- sources-medical uses.Isolation and purification.

UNIT-IV: ESSENTIALS OF GREEN CHEMSITRY 9 HRS

Introduction to green chemistry-definition, origin, history, needs, goals, twelve principles of green chemistry. Usage of Conventional and Green solvents-Advantages, Limitations and drawbacks. Green Synthesis – Designing, Choice of starting materials, choice of reagents, choice of catalysts: bio catalysts, polymer supported catalysts, choice of solvents. Synthesis involving basic principles of green chemistry. Examples: synthesis of adipic acid, methyl methacrylate, paracetamol. Microwave, Ultrasonication and Ultrasound assisted reactions .

UNIT-V: RENEWABLE ENERGY RESOURCES 9 HRS

Renewable energy sources: types of renewable energy sources. Solar cells: basic principles, types and their applications. Fuel cells: basic principles, types and their applications. Working principle and applications of Biofuel cells-brief introduction about hydroelectric, biomass, wind power and geothermal power and their applications and limitations-energy from some other natural source.

Text books

1. V. K. Ahluwalia, Methods and Reagents of Green Chemistry: An Introduction by Green Chemistry, Kluwer Academic Publisher & Anamaya Publishers, **2004**
2. I. L. Finar, Organic Chemistry Vol 2, Stereochemistry and the Chemistry of Natural Product, Dorling Kindersley India (P) Ltd, **2009.**

Reference Books:

3. R. O. C. Norman and J. M. Coxon, Principles of Organic Synthesis, Chapman & Hall, 3rd Ed, **1993.**
4. R. E. Gawley& J Aube, Principles of Asymmetric Synthesis, Elsevier, 2nd Ed, **2012.**

Web Resources

https://www.massey.ac.nz/~gjrowlan/chem312/tutorial.pdf

https://vikaspedia.in/energy/energy-basics/sources-of-energy

https://en.wikipedia.org/wiki/Natural_product

METHODOLOGY OF TEACHING

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students are able to

CO code	Course Outcomes	K-levels
CO1	Define the reaction reactions in terms of donors and acceptor synthons. Describe and design retro-synthetic analysis for simple organic compounds.	K1, K2,K3.
CO2	Interpret the mechanism and synthetic utility of transition metal catalyzed reactions. Connect the concept of asymmetric synthesis with their applications.	K3,K4
CO3	Learn and explain the syntheses involved in accessing natural products. Illustrate the isolation and purification of natural products.	K2,K5
CO4	Recognise the role of green chemistry in day today life.Designeco friendly catalysts and chemicals.	K2, K3,K6
CO5	Appraise the values of energy resources. Analyse the principle and limitations of the resources.	K5,K6
K1 – Remembering , K2– Understanding , K3 –Applying ,K4 –Analysing , K5–Evaluating , K6–Creating		

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2	3	3	3
CO2	3	3	3	3	2	3
CO3	3	3	2	2	3	3
CO4	3	2	3	3	3	3
CO5	3	3	2	3	3	3
Average	3	2.8	2.4	2.8	2.8	3

SEMESTER II

SECOND SEMESTER				
Course title		**INORGANIC CHEMISTRY II**		
Course code		**22PBCHC1**		
Course No.	Course Category Core/Elective	No. of credits	No. of hrs/week	Total marks (Int+Ext)
CC-IV	**Core**	**4**	**5**	**25+75=100**

Course Objective*:*

- To provide the knowledge of the stability of complexes, methods of determination ORD and CD applications.
- To learn about thermodynamic and stereochemical aspects of complex formation
- To learn the concepts of term symbols and energy level diagram of weak and strong field ligands, Charge-transfer spectra
- To learn about various mechanisms of substitution and electron transfer reactions.
- To study the recent development in the catalysis

UNIT-I: Stability of complexes 15 hrs

Stability of complexes- Factors affecting stability of complexes, Thermodynamic aspects of complex formation,Stepwise and overall formation constants, Stability correlations, statistical factors and chelate effect, Determination of stability constant and composition of the complexes: Formation curves and Bjerrum's half method, Potentiometric method, Spectrophotometric method, Ion exchange method, Polarographic method and Continuous variation method (Job's method)

Stereochemical aspects- Stereoisomerism in inorganic complexes- Isomerism arising out of ligand distribution and ligand conformation, Chirality and nomenclature of chiral complexes; Application of ORD and CD in the identification of complexes.

Macrocyclic ligands- Porphyrins, Corrins, Schiff's bases, crown ethers, etc.

UNIT-II: Metal ligand bonding 15 hrs

Crystal field theory – Splitting of d orbitals under various geometries – factors affecting splitting, CFSE, evidences for CFSE(Structural and thermodynamic effects), spectrochemical series, Jorgensen relation, Jahn Teller distortion – Dynamic and Static J.T. effect, Jahn Teller effect and chelation, Application of CFT – Magnetic properties, spectral properties and Kinetic properties, Limitations of CFT, Evidences for M-L overlap.

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, Magnetic properties of complexes. Comparison of CFT and MOT of bonding in octahedral complexes.

UNIT-III: Electronic spectra of complexes 15hrs

Spectroscopic term symbols for d^n ions – derivation of term symbols and ground state term symbol, 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 Modified orgel diagram – Limitiations of orgel

diagram Tanabe–Sugano(T-S) diagrams – Evaluation of Dq and B values for d^2 –d^8 complexes charge transfer spectra. Lanthanides and Actinides- Spectral properties.

UNIT IV: Inorganic reaction mechanism **15 hrs**

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

Reaction mechanism of coordination compounds – Types of ligand substitution reactions – mechanism; Dissociative mechanism (D), Associative mechanism (A) interchange mechanism (I), Labile and Inert complexes. Substitution Reaction in octahedral complexes – general mechanism, general rate law for A,D and I – distinction between D, Id, IA pathways, replacement of coordinated water, 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. Anation Reactions. Substitution in square planar complexes – General mechanism, Trans effect, influences of entering and leaving groups. Application of trans effect – synthesis of isomers of pt(II) complexes – theories of trans effect and cis-trans isomerisation reaction. Application of substitution reactions in the synthesis of Platinum and Cobalt complexes.

UNIT-V: Organometallic Chemistry **15**Hrs

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

Text books:

1. Selected topics in Inorganic chemistry, Dr. Wahid, U. Malik, Dr.G.D.Tuli, Dr. R.D. Madan, S. Chand and Co. Ltd., 8th Ed., 2014.
2. Advanced inorganic chemistry, Vol I & II, Satya Prakash, G.D. Tuli, S.K. Basu, R.D. Madan S. Chand and Co. Ltd. 19th Ed., 2010.
3. Coordination Chemistry, D. Banerjea, Asian Books Prints Ltd., IIIrd Ed., 2009.

Reference books:

1. H. J. Emelius and Sharpe, Modern aspects of Inorganic chemistry, Universal book stall, New Delhi,**1989**.
2. J. E. Huheey, E.A.Keiter and R.L.Keiter, Inorganic chemistry-Principles on structure and reactivity, 4th Ed, Pearson- education, **2002.**
3. F. A. Cotton and G. Wilkinson Advanced Inorganic Chemistry, Wiley Eastern, **1988.**

Web resources:

https://www.chem.uci.edu>
https://pslc.ws>macrog>

METHODOLOGY OF TEACHING

Class Lecturer, Group Discussion, Assignments, Field-based learning

Course outcome (COs):

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

CO code	Course Outcomes	K-levels
CO1	Describe the types, factors influencing, determination of stability of complexes, and its comparison. Summarize the stereochemical aspects of inorganic complexes, and nomenclature of chiral complexes. Learn the applications of ORD and CD in the identification of complexes with illustrations.	K1, K2, K3
CO2	Aquire knowledge of splitting in d-orbitals of various geometry, factors, and evidence. Summarize spectral and magnetic properties of complexes.	K1, K2,K5
CO3	Aquire knowledge of ground and other state term symbols. Outline of correlation diagram and Orgel diagram for the weak field of octahedral and tetrahedral complexes.	K1, K2
CO4	Outline the inner sphere and outer-sphere electron transfer reaction mechanism. Summarize the complimentary and non-complimentary reactions, cross-reactions and Marcus-Hush theory.	K1, K2,K6
CO5	Summarize general principles and reactions of organometallic compounds using catalysis. Aquire knowledge of hydrogenation of olefins, hydroformylation of olefins, Monsanto process using various organometallic catalysts.	K1, K2,K6
K1 – Remembering , K2– Understanding , K3 –Applying ,K4 –Analysing , K5–Evaluating , K6–Creating		

CO-PSO Mapping (Course Articulation Matrix)

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	1	1	1	1
CO2	3	2	2	1	1	1
CO3	3	1	2	2	1	1
CO4	3	2	2	1	1	1
CO5	3	2	2	2	1	1
Average	3	1.8	1.8	1.4	1	1

BLOOM TAXANOMY BASED QUESTION PAPER PATTERN

UG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1	A (Answer all the questions)	10 × 2	Short Answer (Two questions from each unit)	20
K1, K2, K3	B (**INTERNAL CHOICE**) EITHER (a) OR (b)	5 × 5	Question (a) OR (b) from the same Unit and same K Level	25
K3, K4, K5	C (Answer any three question from five questions)	3 × 10	One questions from each unit (No unit missing)	30
Grand Total				**75**

SECOND SEMESTER				
Course title		**ORGANIC CHEMISTRY-II**		
Course code		**22PBCHC2**		
Course No.	Course Category Core/Elective	No. of credits	No. of hrs/week	Total marks (Int +Ext)
CC-V	**Core**	**4**	**5**	**25+75=100**

Course Objectives

- Understanding addition and elimination reactions along with their mechanism and synthetic utility.
- Understanding rearrangement and name reactions along with their mechanism and synthetic utility.
- Understanding Various types of oxidation and reduction reactions along with their mechanism and synthetic utility.

UNIT-I: Addition to carbon-carbon double bond 15Hrs

Electrophilic addition to carbon–carbon double and triple bonds. Nucleophilic addition to carbon–carbon multiple bonds. Generation and addition of carbenes-Michael addition and Robinson annulation.

Hydroxylation of olefinic double bonds (OsO4, KMnO4); Woodward and Prevost oxidation. Epoxidation using peracids including Sharpless epoxidation, Ozonolysis. Hydrogenation (homogenous and heterogeneous) and Transfer hydrogenation. Hydration of carbon-carbon double and triple bonds.

UNIT-II: Addition to carbon-oxygen double bond 15Hrs

Nucleophilic addition to –C=O bond. A study of Mannich, benzoin, Darzensglycidic ester, Stobbe and Knovenagel condensation reactions; Wittig, Wittig-Horner olefination reactions;Sulfur and Sulfonium ylides and their reactions, Julia olefination & Peterson alkene synthesis.Asymmetric reduction of carbonyl functions (Corey's procedure).

UNIT-III: Elimination Reactions 15Hrs

Elimination reactions: E1, E2, E1cb and Ei-elimination. Conformation of mechanism; solvent, substrate, leaving group effects-Saytzeff's*Vs* Hoffman elimination; Stereochemistry of E_2 eliminations, Elimination in cyclohexane ring system; Mechanism of pyrolytic eliminations. Examples: Chugaev reactions and Cope elimination, Hofmann degradation and pyrolysis of esters.

UNIT-IV: Molecular rearrangements &Name reactions 15Hrs

A study of mechanism of the following rearrangements: Beckmann, Curtius, Hofmann, Schmidt, Lossen, Wolff, Pinacol, Wagner Meerwin, Demjanov, Dienone-Phenol, Favorski, Benzidine, Claisen, Cope, Sommlet-Hauser, Pummerer and Von-Richter rearrangements.

A study of the following name reactions: Dieckmann cyclization, Hofmann-Loffler Freytag reaction, Mitsunobu reaction, Shapiro reaction, Eschenmoser-Tanabe and Ramberg-Backlund reactions.

UNIT-V: Oxidation and reductions reactions 15Hrs

Oxidation with Cr (including PCC, PDC, Jones) and Mn (including MnO_2 and $BaMnO_4$) reagents; Oxidation with LTA, DDQ and SeO_2; Oxidation using DMSO either with DCC or Ac_2O or Oxalyl chloride; Oxidation using IBX and Dess-Martin Periodinane (DMP) reagent.

Reduction with $NaBH_4$, $NaCNBH_3$, $Zn(BH_4)_2$ $LiAlH_4$, $Li(^tBuO)_3AlH$, DIBAL-H, Red-Al, Et_3SiH and Bu_3SnH; Reduction using selectrides; Birch reduction.

Text books

1. Jerry March, Advanced Organic Chemistry, John Wiley & Sons, 5th Ed, **2001.**
2. J. Clayden, N. Greeves and S. Warren, Organic Chemistry, Oxford University Press, 2nd Ed, **2012**.
3. M. B. Smith, Organic Synthesis, Academic Press, 3rd Ed, **2011.**
4. V. K. Ahluwalia, Oxidation in Organic Synthesis, CRC Press, 1st Ed, **2012.**
5. V. K. Ahluwalia, Reduction in Organic Synthesis,CRC Press, 1st Ed, **2012.**

Reference Books

6. R. O. C. Norman and J. M. Coxon, Principles of Organic Synthesis, Chapman & Hall, 3rd Ed, **1993.**
7. Stuart Warren, Organic Synthesis: Disconnection Approach, Wiley India (P) Ltd, **2007**.
8. F. Carey and R. J. Sundberg, Advanced Organic Chemistry-Part A and B, Springer Science + Business Media, 5 th Ed, **2007.**

Web Resources:

https://new.bhu.ac.in/Content/Syllabus/Syllabus_300631282020041403564 2.pdf

https://onlinelibrary.wiley.com/doi/10.1002/9780470084960.ch16

METHODOLOGY OF TEACHING

Class Lecture, Group Discussion, Assignments and Field-based learning

Course Outcomes (COs):

On completion of the course the students able to

CO code	Course Outcomes	K levels
CO1	Understand the reaction involving addition to carbon-carbon double bond.	
CO2	Describe Nucleophilic addition to –C=O bond.	K1,K2
CO3	Summarize the elimination reactions	
CO4	Study of mechanism of various molecular rearrangements	K1,K2,K3
CO5	Concept of oxidation and reduction with metal catalysts.	K1,K2,K3

K1 – Remembering , K2– Understanding , K3 –Applying ,K4 –Analysing , K5–Evaluating , K6–Creating

CO-PSO Mapping (**Course Articulation Matrix**)

CO / PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	3	3	2	1	2	2
CO2	3	3	2	1	2	1
CO3	3	3	3	3	3	2
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	2
Average	3.0	3.0	2.6	2.2	2.6	2.0

BLOOM TAXANOMY BASED QUESTION PAPER PATTERN
UG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1	A (Answer all the questions)	10 × 2	Short Answer (Two questions from each unit)	20
K1, K2, K3	B (**INTERNAL CHOICE**) EITHER (a) OR (b)	5 × 5	Question (a) OR (b) from the same Unit and same K Level	25
K3, K4, K5	C (Answer any three question from five questions)	3 × 10	One questions from each unit (No unit missing)	30
Grand Total				**75**

SECOND SEMESTER				
Course title		**PHYSICAL CHEMISTRY– II**		
Course code.		**22PBCHC3**		
Course No	Course Category Core/Elective	No. of Credits	No of hrs/week	Total marks (Int+Ext)
CC-VI	**Core**	**4**	**5**	**25+75=100**

Course objectives:

- To learn the principles of quantum mechanics of simple systems.
- To learn the quantum mechanical treatment of multi electron atoms.
- To learn the principles, instrumentation, interpretation and applications of micro wave, IR and Raman spectroscopy.
- To learn the principles, instrumentation and applications of Polarography, AAS, AES .

UNIT I:Quantum Chemistry-I **15** hrs

Black body radiation-Planck's quantum theory-Wave particle duality-Uncertainty Principle. Operators-linear, commutation, Hermitian and Hamiltonian operators. Eigen functions and Eigen Values-Postulates of quantum mechanics. Derivation of Schrodinger's time-independent wave equation and its application to particle in a one-dimensional box, particle in a three-dimensional box, harmonic oscillator, rigid rotor and hydrogen atom.

UNIT II:Quantum Chemistry-II **15 h**rs

Born-Oppenheimer approximation-Hydrogen molecule ion.LCAO-MO and VB treatments of the hydrogen molecule.Antisymmetry and Pauli's exclusion principle. Slater detrimental wave function, term symbols and spectroscopic states-Russell Saunders coupling.

The variation theorem and Perturbation theory.Applications of variation method and perturbation theory to the helium atom.Hybridization-determination of bond angles of sp, sp2 and sp3 hybridizations.Huckel pi electron (HMO) theory and its applications to ethylene, butadiene and benzene. A brief idea of Hartree and Hartree-Fockself consistent field theory.

UNIT III:Rotational Spectroscopy **15** hrs

Micro wave spectroscopy- Theory- selection rules, –Instrumentation; Energy levels in atoms and molecules- Fourier transformation Rotational spectra of diatomic and polyatomic molecules–P, Q, R branches- effect of isotopic substitution. Non-rigid rotator- Linear molecules. Theory of Rotational Raman spectra.

UNIT IV: Vibrational Spectroscopy 15hrs

Vibrational spectra of diatomic molecules – – selection rules –simple harmonic and anharmonic oscillator, rotational character of vibration spectra, Theory of Vibrational Raman Spectroscopy

UNIT V: Analytical Techniques **15** h rs

Principles, theory, instrumentation and applications of Polarography, Flame photometry, AAS, AES, interpretation of spectra-Merits and demerits.

Text Books:

1. G.M.Barrow, Introduction to Molecular Spectroscopy, McGrawHill, NewYork, **1988**.
2. D. A. McQuarrie, Quantum Chemistry, University Science Books, MilValley, California, **1998**.
3. A.K. Chandra, Introduction to Quantum Chemistry, Tata McGraw Hill, **1997**.
4. W. Levine, Quantum Chemistry, Prentice Hall, **1994**.
5. R. K. Prasad, Quantum Chemistry, Wiley Eastern, **1993**.
6. C.F. Banwell, Fundamentals of Molecular Spectroscopy, McGraw Hill, New York, **1966**.
7. R.S. Drago, Physical methods in chemistry, Reinhold, New York,**1968**.

Reference Books:

1. P.W. Atkins, Molecular Quantum Mechanics, Oxford University Press, Oxford, **1983.**
2. M.W.Hanna, Quantum Mechanics in Chemistry, W.ABenjamin Inc. London **1965.**
3. H. Eyring, J. Walter and G.Kimball, Quantum Chemistry, John Wiley and Sons, New York, **1944**.

Web Resources

https://www.unom.ac.in/webportal/uploads/library/gcl-opac/chemanalysis.html
https://usiu-ke.libguides.com/PhysicalChemistry
https://epgp.inflibnet.ac.in

Methodology of teaching

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students be able to

CO code	Course Outcomes	K-levels
CO1	**Summerize** the drawbacks of classical theory and the need for quantum theory. **Relate** the Schrodinger equation to get the solution for wave equation of microparticle like electron.	K1, K2, K3
CO2	**Use** the application of quantum theory to study the molecules based on theories like MO theory and VB theory. **Correlate** variation and perturbation theory to study the hybridization of orbitals of molecules.	K3, K4

CO3	**Explain** the Micro wave spectroscopy- Theory, **Classify**Instrumentation**, define** selection rules, **Identify** Energy levels in atoms and molecules	K1, K2, K3, K4
CO4	**Explain** Vibrational spectra of diatomic molecules, **Relate** rotational character of vibration spectra**Contrast**simple harmonic and unharmonic oscillator.	K1, K2, K3, K4, K5
CO5	**Explain** Principles, theory, instrumentation of Polarography, **Define** Flame photometry, **Classify** AAS and AES, **Interpret** the spectra from instruments, **Compare** the Merits and Demerits of instrumentational analysis	K1, K2, K3,K6
K1 – Remembering , K2– Understanding , K3 –Applying ,K4 –Analysing , K5–Evaluating , K6–Creating		

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	3	2	2	2	2	3
CO2	3	2	2	2	1	3
CO3	3	2	2	3	2	2
CO4	3	2	2	3	2	1
CO5	3	2	2	3	2	3
Average	3.0	2.0	2.0	2.6	1.8	2.4

BLOOM TAXANOMY BASED QUESTION PAPER PATTERN
UG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1	A (Answer all the questions)	10 × 2	Short Answer (Two questions from each unit)	20
K1, K2, K3	B (**INTERNAL CHOICE**) EITHER (a) OR (b)	5 × 5	Question (a) OR (b) from the same Unit and same K Level	25
K3, K4, K5	C (Answer any three question from five questions)	3 × 10	One questions from each unit (No unit missing)	30
Grand Total				**75**

SECOND SEMESTER				
Course title		Chemistry of Petroleum and Petro products		
Course code		**22PBCHE2A**		
Course No	Course Category Core / Elective /	No of Credits	No of hrs /week	Total marks (Int+Ext)
CEC III A	**Elective**	**3**	**3**	**25 + 75=100**

Course objectives

- To learn the chemistry of petroleum.
- To understand the cracking for production of gasoline
- To know the knocking character and testing methods.
- To acquire the knowledge synthetic petrol and lubricants.
- To know the concepts ofpetrochemical products.

Unit I :**Origin and exploration of petroleum** 9Hrs

Theories of origin of petroleum, inorganic origin and organic-characteristics of petroleum-physical and chemical properties-exploration of petroleum-geological background. Satellite imagery-drilling operations-safety precaution-refining and petrochemicals.

Unit II: **Cracking and Refining** 9Hrs

Theories of thermal, catalytic and hydro cracking-cracking for the production of gasoline-mechanism of catalytic cracking for primary and secondary reactions-reforming reaction-alklyation-mechanism of catalytic alkylation-isomerisation and hydro desulphurization-finishing processes-removal of water,sulphur and particular impurities-solvent refining.

Unit III: **Additives and testing** 9Hrs

Properties and additives for gasoline, kerosene, diesel oil-knocking character-octane and cetaine numbers-improvement of knocking characteristics-test methods of gasoline-kerosene diesel oils-flash point-aniline point-sulphur contents-ash contents-gum contents-viscosity-Reid vapour pressure.

Unit IV: **Synthetic petrol and lubricants** 9Hrs

Production of synthetic petrol-fisher-tropsch process-Bergius process-production and treatment of LPG-asphalt technology-chemical structure, action of heat. Lubricants-theories of friction-lubrication mechanism-classification-solid,semi-solid, liquid, synthetic-examples-general properties of lubricants.

Unit V: **Petrochemical products** **9**Hrs

Petrochemicals-aliphatic basic petrochemicals-methane, ethane, propane. Oleginic base chemicals-ehtylene and propylene-acetylene-diene chemicals-butadiene-isoprene-chloroprene-

cyclopentadiene-BTX. Aromatics- benzene, toluene, xylene, naphthalene, production of producer gas, water gas and synthesis gas.

Text books

1. SukumarMaiti, Introduction to petrochemicals, Oxford and IBH Pub. Company, 1992.
2. G.N. Sarkar, Advanced petrochemicals, RomeshChander Khanna Publisher, 2002.

References Books

3. Mohamed A Fahim, Taher A Al-Sahhaf, AmalElkiani, Fundamentals of Petroleum refining, Elsevier, 2009

Web Resources

https://theicct.org>default>files
https://www.eolss.net>sample-chapters>

METHODOLOGY OF TEACHING

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students are able to

CO code	Course Outcomes	K-levels
CO1	Summarize the origin of petrol, characteristics physical and chemical properties, exploration of oil, satellite imaginary drilling operations, refining and petrochemicals.	K1, K2,K3
CO2	Concepts of thermal, catalytic and hydro cracking, mechanisms of catalytic alkylation, isomerization and hydro desulphurization. Studies on removal of impurities and solvent refining.	K1,K2,K3,K6
CO3	Analyze the additives for gasoline, kerosene, and diesel. Concepts of knocking character, octane and cetane number. Summarize the test methods of oils.	K1,K2,K3
CO4	Required knowledge of production of synthetic petrol, Berguis process. Concepts of lubricants its mechanism, classifications synthesis and properties.	K1,K2,K5
CO5	Outline of petrochemicals aliphatic and oleginic base chemicals, concepts of aromatics, production of producer gas, water gas and industrial gases.	K1,K2,K3,K6
K1 – Remembering , K2– Understanding , K3 –Applying ,K4 –Analysing , K5–Evaluating , K6–Creating		

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	3	3	3	3
CO2	3	2	2	2	3	2
CO3	3	3	3	3	3	2
CO4	3	2	2	2	2	3
CO5	3	3	3	3	3	2
Average	3	2.6	2.6	2.6	2.8	2.4

BLOOM TAXANOMY BASED QUESTION PAPER PATTERN
PG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1, K2, K3, K4	A (Answer all the questions)	10 X 2	Short Answer (Two questions from each unit)	20
K1, K2, K3, K4, K5	B (INTERNAL CHOICE) EITHER (a) or (b)	5 X 5	Question (a) OR (b) from the same Unit and same K Level	25
K2, K3, K4, K5, K6	C (Answer any three questions from five questions)	3 X 10	One questions from each unit (No unit missing)	30
			Grand Total	**75**

SECOND SEMESTER				
Course title		Polymer Chemistry		
Course code		**22PBCHE2B**		
Course No	Course Category Core / Elective /	No of Credits	No of hrs /week	Total marks (Int+Ext)
CEC III B	**Elective**	**3**	**3**	**25 + 75=100**

Course objectives

- To learn the chemistry of polymeric materials.
- To know the structure and molecular weight of polymers.
- To understand thepolymerization kinetics.
- To acquire the knowledge natural and synthetic rubber
- To get knowledge about plastics and resins

Unit I :**Basic polymers and polymerization** 9Hrs

An introduction to polymers and macromolecules. Natural and synthetic polymers. Classfication of polymers-addition and condensation polymers. Polymerization through function groups, multiple bonds and ring opening. Coordination polymerization- mechanism of free radical, cationic and anionic polymerization reactions.

Unit II: **Structure and properties of polymers** 9Hrs

Linear, branched and crosslinked polymers, Stereochemistry of polymers-isotactic, syndiotactic and atactic. The crystalline melting point, the glassy state and glass transition temperature. Solubility of polymers. Polymer degradation-Thermal, mechanical, High energy radiation, oxidative and hydrolytic. Number average molecular weight and weight average molecular weight. Viscosity and molecular weight, light scattering and gel permeation chromatography.

Unit III: K**inetics of polymerization** 9Hrs

Kinetics of free radical polymerization, kinetics of cationic polymerization. Mean kinetic chain length. Degree of polymerization. Inhibition and retardation. Chain transfer. Adipic acid, sebacic acid, PMDA, hexamethylenediamine, caprolactum, bisphenol-A, epichlorhydrin, vinyl acetate, acrylonitrile and methyl methacrylate.

Unit IV: **Natural and synthetic rubbers** 9Hrs

Polythene, PTFE, Freons, PVC, PVA, chlorosulphonated polyethylene, polypropylene and polystyrene. Constitution of natural rubber, butyl, buna, buna-S, buna-N, Neoprene, SBR, Thiocol, Polyurethane and silicone rubbers, compounding of rubber, reclaimed rubber spongy rubber, foam rubber and thermocole polymers. Chlorinated rubber, oxidized rubber, cyclized rubber and ebonite.

Unit V:**Plastics and resins** **9**Hrs

Definitions of thermoplastics and thermosetting resins, constituents of plastics fillers, dyes, pigments, plasticizers, lubricants and catalysts. Important thermoplastic resins acrylics, polyvinyl and cellulose derivatives. Important thermo setting resins-phenolic resin, amino resins, epoxy resins, alkyd resins and silicone resins. Definition-polymer requirement for fibres polyamides-Nylon 66, Nylon 6 and Nylon6,10 polyesters-terylene.

Text books

1 V.R. Gowarikar, N.V.Viswanathan, Polymer science, Wiley Eastern Limited, New Delhi, 1986.

2 S.S. Dara, A Textbook in Engineering Chemistry, S. Chand & Company Ltd., New Delhi, 3rd Edition, 1992

References Books

3. A. Ravve, Organic Chemistry of Macromolecules, Marcel Dekker New York, 1967.
4. R.B. Seymour, Introduction to Polymer Chemistry, McGraw Hill, New York, 1971.
5. F.W. Billmeyer, Textbook of Polymer Science, Wiley interscience, New York, 1971.

Web Resources

https://web.mit.edu>www>lec>poly

https://iopscience.iop.org>

METHODOLOGY OF TEACHING

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students are able to

CO code	Course Outcomes	K-levels
CO1	Concepts of polymers with classifications methods of preparation and mechanism of free radical cationic and anionic polymerization reactions.	K1, K2
CO2	Required knowledge of stereochemistry of polymers. To study the properties of polymers and to determine the molecular weight using various methods	K1,K2,K3
CO3	Illustration of degree of polymerization kinetics and chain transfer. Synthesis of reactants and intermediates	K1,K2,K6
CO4	Summarization of polyolefins like Freons, PVC, PVA etc., Concept of natural and synthetic rubber, polyurethane, silicon, thermocol etc.,	K1,K2,K5
CO5	Definition of thermoplastics and thermosetting resins. Importance of phenolic, amino, epoxy, silicon resins. To attain the knowledge on textile fibres like nylon and polyester.	K1,K2,K3,K5
K1 – Remembering, K2– Understanding , K3 –Applying ,K4 –Analysing , K5–Evaluating , K6–Creating		

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	3	3	3	3
CO2	3	3	3	3	2	3
CO3	3	3	3	3	3	2
CO4	3	2	2	2	2	3
CO5	3	3	2	3	3	2
Average	3	2.8	2.6	2.8	2.6	2.6

BLOOM TAXANOMY BASED QUESTION PAPER PATTERN
PG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1, K2, K3, K4	A (Answer all the questions)	10 X 2	Short Answer (Two questions from each unit)	20
K1, K2, K3, K4, K5	B (INTERNAL CHOICE) EITHER (a) or (b)	5 X 5	Question (a) OR (b) from the same Unit and same K Level	25
K2, K3, K4, K5, K6	C (Answer any three questions from five questions)	3 X 10	One questions from each unit (No unit missing)	30
			Grand Total	**75**

SECOND SEMESTER				
Course title		**RESEARCH METHODOLOGY**		
Course code		**22PBCHD1**		
Course No	Course Category Core / Elective /	No of Credits	No of hrs /week	Total marks (Int+Ext)
EDS-I	**Elective**	**3**	**3**	**25 + 75=100**

Course Objectives:

- To gain the knowledge of objectives of research, types of research and significance of research.
- To do research with help of primary, secondary and tertiary sources, research problems,selecting the problem and data collection.
- To understand how to write thesis, steps involved in thesis writing, report writing and selection of a research reports.
- To gain knowledge in the field of writing a research proposal, preparing grant proposal for research and budget proposal.
- To acquiring knowledge on Panel discussion, workshops and seminars and selection of a topic for presentation.

Unit -I OBJECTIVES OF RESEARCH 9 Hrs

Meaning of research-purpose and objective of research-steps in research (scientific approach)-types of research –analytical, applied, qualitative and qualitative, empirical research- significance of research-research methods and methodology- criteria of good research-qualification of a researcher-problems encountered by researchers in india.

Unit -II RESEARCH PROBLEM AND DATA COLLECTION 9 Hrs

Sources of literature - primary, secondary and tertiary sources. Research problems - selecting the problem - necessity of defining the problem.

Data collection-collection of primary data-interview method-collection of secondary data.

Unit – III THESIS WRITINGAND ASSIGNMENT WRITING 9 Hrs

Thesis or assignment writing – Steps involved in thesis or assignment writing - preliminaries, the text and end matter.

Report writing - significance of report writing-different steps in writing report - sections of a research reports-title page, abstract, table of contents, introduction, body, recommendations, references and appendices.

Unit -IV WRITING A RESEARCH PROPOSAL AND PREPARING GRANT PROPOSAL 9 Hrs

Writing a research proposal - introduction, literature review, methodology, expected results, budget and references. Preparing grant proposal for a research project-content of the summary

introduction to the organisation, statement of the problem, aims and objectives of the project, design of the project-evaluation of the project, future funding, budget proposal.

Unit -V PANAL DISCUSSION ,WORKSHOPS AND SEMINARS AND SELECTION OF ATOPIC FOR PRESENTATION 9 Hrs

Panel discussion - purpose, objectives, characteristics, advantages and limitations.

General meetings, workshops and seminars: conduct scientific session, the leader, selection of a topic for presentation

REFERENCE BOOKS:

1. Thesis and Assignment Writing – J Anderson, B.H. Dursten and M. Poole, Wiley Eastern (1977).
2. Statistical Method, Gupta S. P, Sultan Chand and Sons, New Delhi, 2004
3. Hand Book For Authors –Journal of the American Chemical Society Publications

Web Resources:

https://www.wisdomjobs.com/e-university/research-methodology-tutorial-355/objectives-of-research-11332.html

https://www.grammarly.com/blog/how-to-write-a-research-proposal/?gclid=Cj0KCQjw4uaUBhC8ARIsANUuDjW3EAx5M9mG_hPGuzzdjZSykfPc57xWko9ZV3v6RpPeUvAMAAfvXvEaAgpiEALw_wcB&gclsrc=aw.ds

https://files.eric.ed.gov/fulltext/EJ1140102.pdf

METHODOLOGY OF TEACHING

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students are able to

CO code	Course Outcomes	K-levels
CO1	Define and meaning of the research process, scientific approach of steps in research, analytical, applied, qualitative quantitative and empirical research.	K1, K2,K3.
CO2	Interpret the primary, secondary and tertiary sources of research. Identification of research problem, defining the research problem and primary and secondary data collection.	K1,K3,K4
CO3	Illustrate and explain the thesis writing, assignment writing and report writing. Significance of report writing. Selection of a research report.	K1,K2,K5
CO4	Recognize the writing of a research proposal, literature review. Preparing grant proposal for a research, statement of the problem, aims and objectives of the project, design of the project-evaluation of the project.	K2, K3,K6

CO5	Interpret the panel discussion-objectives, characteristics, advantages and limitations. Define the general meetings, workshops and seminars. Identify the slection of a topic for presentation.	K1,K5,K6
K1 – Remembering , K2– Understanding , K3 –Applying ,K4 –Analysing , K5–Evaluating , K6–Creating		

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	3	3	2	3	3	3
CO2	3	3	3	3	2	3
CO3	3	3	2	2	3	3
CO4	3	2	3	3	3	3
CO5	3	2	2	3	2	3
Average	3	2.6	2.4	2.8	2.6	3

BLOOM TAXANOMY BASED QUESTION PAPER PATTERN
UG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1	A (Answer all the questions)	10 × 2	Short Answer (Two questions from each unit)	20
K1, K2, K3	B (**INTERNAL CHOICE**) EITHER (a) OR (b)	5 × 5	Question (a) OR (b) from the same Unit and same K Level	25
K3, K4, K5	C (Answer any three question from five questions)	3 × 10	One questions from each unit (No unit missing)	30
Grand Total				**75**

SEMESTER III

THIRD SEMESTER				
Course title		**INORGANIC CHEMISTRY – III**		
Course code.		**22PCCHC1**		
Course No	Course Category Core/Elective	No. of Credits	No of hrs/week	Total marks (Int+Ext)
CC- IX	**Core**	**4**	**5**	**25+75=100**

Course objectives: To learn the photo electron spectroscopy of inorganic compounds.

- To study the theory, essential of Nuclear Chemistry and Radiation Chemistry
- To study the applications of IR, Raman and NMR spectroscopy in inorganic compounds
- To learn the detail study of synthetic organometallic complexes and their reactivity.
- To know about ESR and Mössbauer spectroscopy
-

UNIT I:Inorganic Photochemistry and Photoelectron Spectroscopy **15** hrs

Unimolecular charge-transfer photochemistry of cobalt (III) complexes – mechanism of CTTM, photoreduction – ligand-field photochemistry of chromium (III) complexes – Adamson's rules, photochemistry of ruthenium – polypyridine complexes, emission and redox properties.

Photoelectron Spectroscopy

PES - Theory, Types, origin of fine structures - shapes of vibrational fine structures – adiabatic and vertical transitions, PES of homonuclear diatomic molecules (N_2, O_2) and heteronuclear diatomic molecules (CO, HCl) and polyatomic molecules (H_2O, CO_2, CH_4, NH_3) – Koopman's theorem- applications and limitations.

UNIT II:Nuclear and Radiation Chemistry **15 h**rs

Properties of nucleus – different types of nuclear forces, nuclear structure and nuclear stability, nuclear models- – liquid drop model, shell model of nucleus, Radioactivity and nuclear reactions, nuclear reactions induced by charged particles – Q value – nuclear reaction cross section, significance and determination – theory of nuclear fission, nuclear fusion, stellar energy. Radiation hazards and therapeutics. Detectors and their principles. Tracer Application of radioisotopes in agriculture, industry and medicine. Isotope dilution and radio-activation methods of analysis.

UNIT III:Applications of IR, Raman and NMR Spectroscopy to Inorganic Compounds **15Hrs**

IR spectroscopy- Stretching frequency of some inorganic ions- effect of coordination on the stretching frequency- sulphato, carbonato, sulphito, aqua, nitro, thiocyanato, cyano, thiourea, DMSO complexes.

Raman spectroscopy –Introduction, combined applications of IR and Raman spectroscopy in the structural elucidation of N_2O, ClF_3, NO_3^-, ClO_4, metal carbonyls.

NMR spectroscopy- Introduction, structural assessment of simple inorganic compounds.

UNIT IV: ESR and Mossbauer Spectroscopy **15**hrs

ESRspectroscopy-Introduction, presentation of esr spectra g and A parameters, spin densities, Mc-Connell relationship, factors affecting the magnitude of g and A. Zero field splitting, Kramer's degeneracy, esr spectra of V(II), Mn (II) Fe (II), Co (II), Ni(II), Cu (II) complexes, bis(salicylaldimine)copper (II) , $[(NH_3)_5Co\text{-}O_2\text{-}Co(NH_3)_5]^{5+}$.

Mössbauer spectroscopy –Introduction, principle, instrumentation, recoil energy, Doppler effect, number of MB signals, isomer shift, quadrupole splitting, - applications to ^{57}Fe and ^{119}Sncompounds.

UNIT V: Catalysis by Organo Metallic compounds **15 hrs**

General principles of catalysis – basic reactions involved in the catalysis by organometallic compounds. Hydrogenation of olefins (Wilkinson's catalyst) ; Hydro formylation of olefins using Cobalt or Rhodium catalysts (OXO process); oxidation of olefins to aldehydes and ketones (wacker process) Monsanto acetic acid synthesis from methanol. Cyclooligomerisation of acetylene using Ni catalyst (Reppe's catalyst) Synthetic gasoline by using ZSM-5 catalyst (Fisher-Tropsch and mobil process) polymerization of olefins (Zeigler – Natta Catalyst), polymer-bound catalyst.

Text Books:

1. H. Kaur – "Spectroscopy", 3rd Ed., Pragati Prakasan Publications, Meerut, **2006**.
2. R.S. Drago, Physical methods in inorganic chemistry; Affiliated East-West Press Pvt. Ltd., New Delhi,**2012**.
3. C.N. Banwell, Fundamentlas of molecular spectroscopy 4th edition, McGraw Hill Education, Noida,**1994**.
4. H. J. Arniker, Essentials of Nuclear Chemistry, 2nd Ed, Wiley Eastern Co, **1987**.

Reference Books:

1.P.J.Wheatley, The determination of molecular structure, 2nd edition, Dover Publications, Mineola,**1981**.

2.G. Friedlander, J. W. Kennedy and J. M. Miller, Nuclear and Radiochemistry, Wiley, **1964**

Web Resources

https://www.ionicviper.org/web-resources/inorganic-chemistry https://usiu-ke.libguides.com/InorganicChemistry
https://www.researchgate.net/publication/265032548_Web-resources_in
https://epgp.inflibnet.ac.in

METHODOLOGY OF TEACHING

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students be able to

CO code	Course Outcomes	K-levels
CO1	**Correlate** the PES of homonuclear diatomic molecules (N_2, O_2) and heteronuclear diatomic molecules (CO, HCl) and polyatomic molecules (H_2O, CO_2, CH_4, NH_3).	K1, K2, K3, K4
CO2	**Relate** Tracer Application of radioisotopes in agriculture, industry and medicine. **Compare** theory of nuclear fission, nuclear fusion, stellar energy. **Illustrate**	K1, K2, K4,K5
CO3	**Explain** the IR spectroscopy-Introduction, **Classify**stretching frequency of some inorganic ions, **define** selection rules, **Identify** effect of coordination on the stretching frequency- sulphato, carbonato, sulphito, aqua, nitro, thiocyanato, cyano, thiourea, DMSO complexes. **Infer** applications of ^{1}H, ^{15}N,^{19}F, ^{31}P-NMRspectroscopy in structural problems	K1, K2, K3, K4
CO4	**Explain** ESR spectroscopy-Introduction, presentation of esr spectra g and A parameters **Relate**number of MB signals, isomer shift, quadrupole splitting **Illustrate** Mössbauerspectroscopyapplications to ^{57}Fe and ^{119}Sncompounds.	K1, K2, K3, K6,
CO5	**Explain** Types of organometallic compounds on the basis of the nature of M-C bond, **Define** EAN rule: 18e- and 16e- rules, **Classify** Structure of carbonyls (simple and polynuclear) ,**Interpret** Carbonyls – isolated concept.,**Compare**Nitrosyls – bridging and terminal nitrosyls, bent and linear nitrosyls, **Recognize** Alkyl and Aryl – preparation and properties.	K1, K2, K3,K5
K1 – Remembering , K2– Understanding , K3 –Applying ,K4 –Analysing , K5–Evaluating , K6–Creating		

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	2	3	2	2
CO2	3	3	2	2	2	3
CO3	3	2	2	3	2	2
CO4	3	2	2	3	2	2
CO5	3	2	2	3	2	1
Average	3.0	2.2	2.0	2.8	2.0	2.0

BLOOM TAXANOMY BASED QUESTION PAPER PATTERN

UG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1	A (Answer all the questions)	10 × 2	Short Answer (Two questions from each unit)	20
K1, K2, K3	B (**INTERNAL CHOICE**) EITHER (a) OR (b)	5 × 5	Question (a) OR (b) from the same Unit and same K Level	25
K3, K4, K5	C (Answer any three question from five questions)	3 × 10	One questions from each unit (No unit missing)	30
Grand Total				**75**

THIRD SEMESTER				
Course title		**ORGANIC CHEMISTRY – III**		
Course code.		**22PCCHC2**		
Course No	Course Category Core/Elective	No. of Credits	No of hrs/week	Total marks (Int+Ext)
CC-X	**Core**	**4**	**5**	**25+75=100**

Course Objectives

To understand the structural elucidation of organic compounds using UV, IR, NMR and Mass Spectral data.

Unit I: UV and IR Spectra of organic compounds **15Hrs**

Electronic absorption: Beer-Lamberts law, Types of electronic excitation. Chromophore and Auxochrome-Bathochromic and Hypsochromic shift. UV-vis spectra of simple organic compounds such as alkenes, phenols, anilines, carbonyl compounds and 1,3-diketones. Woodward-Fieser rule.

Infrared Spectra: Identification of functional groups in Organic Compounds, Finger print region. Inter and Intramolecular hydrogen bonding. Various factors affecting IR stretching frequencies.

Unit II: Nuclear magnetic resonance and their applications **15Hrs**

Origin of NMR spectrum-Nuclear spin states–NMR active nuclei–Nuclear magnetic moment–Larmor equation–Population density of nuclear spin states. Relaxation mechanisms, Chemical shift-Standards in NMR–Shielding and Deshielding–Factors affecting chemical shift–electronegativity, hybridization, hydrogen bonding-anisotropic effect–double bond, triple bond, aromaticcompounds,carbonyl compounds. Spin-spin coupling–splitting origin and rules–factors affecting coupling constant: cis, trans, gem, ortho, meta, para coupling–exchange with deuterium. Vicinity of the proton, Long range coupling, Karplus equation and curve. Two interacting nuclei: AB, AX, AA'BB', pair of doublet and AB quartet. Three interacting nuclei: AMX, ABX, ABC systems (only pattern is required).Double irradiation/Spin decoupling, Nuclear Overhauser Effect (NOE) and NMR imaging (MRI).

UNIT-III: ^{13}C NMR, ^{19}F NMR & ^{31}P NMR AND 2-D NMR Techniques 15Hrs

^{13}C NMR–difficulties in recording ^{13}C NMR: Homo nuclear and heteronuclear coupling. Off Resonance decoupled spectrum identification of various types of carbon (functional groups) using ^{13}C NMR. Origin of ^{13}C satellite peaks.Attached Proton Test (APT) &Distortionless Enhancement by Polarization Transfer (DEPT) spectrum (DEPT-45, DEPT-90). ^{19}F NMR–Precessional frequency and heteronuclear coupling. Identification of organofluoro compounds (CF_3CO_2Et and CF_3CH_2OH) using NMR. ^{31}P NMR– Chemical shift and heteronuclear coupling. Identification of organo phosphorous compounds such as $(Me)_3P$, $(EtO)_3P=O$ and Ph_3P. P-P bond in NMR.

Basic aspects of 2-D NMR techniques: Correlation spectroscopy (COSY). HOMO COSY (HOMCORR: ^1H-^1H connectivity, ^{13}C-^{13}C connectivity): HSQC and HETERO COSY (HETCORR): HMBC. 2D NOE Correlation Spectroscopy (NOESY).

UNIT-IV: Mass Spectrometry 15Hrs

Origin, basics and bloc diagram of Mass spectrum-Various types of Ionization techniques-Stability of Molecular ions, Meta stable ions. Base peaks and Isotope peaks. Fragmentation patterns of organic molecules such as benzenes, phenyl halides, phenols, benzyl alcohols, benzyl halides, aliphatic alcohols, aliphatic as well as aromatic aldehydes, ketones, acids, esters and amides. Fragmentation patterns of aliphatic/aromatic nitro and amine compounds. Fragmentation patterns of heterocyclic compounds (furan, pyrrole and pyridine only). McLafferty rearrangements of organic molecules.

UNIT-V: Identification of organic compounds using analyticaland spectral data15Hrs

Determination of molecular formula of organic compounds using elemental (CHN) analysis data. Structural determination of simple organic compounds using UV, IR, NMR and Mass spectral data.

Text books

1. R. M. Silverstein, F. X. Webster and D. Kiemle, Spectrometric identification of Organic compounds, Wiley, 7th Ed, **2005.**
2. William Kemp, NMR in Chemistry: A Multinuclear Introduction, MacMillan, **1988**.
3. R. S. Macomber, A Complete Introduction to NMR Spectroscopy, Wiley, **1998.**
4. Jag Mohan, Organic Spectroscopy Principles & Applications, Alpha Science International Ltd, 2nd Ed, **2004.**

Reference Books:

5. William Kemp, Organic Spectroscopy, Macmillan Education UK, 3rd Ed, **1991**.
6. P.S. Kalsi, Spectroscopy of Organic Compounds, New Age International Publishers, 6th Ed, Reprint, **2005.**

7. R. M. Silverstein, G. C. Bassler and T. C. Morrill, Spectrometric identification of Organic compounds, John Wiley, 5th Ed, **1991.**

Web Resources

https://www.cureffi.org/2015/04/22/organic-chemistry-30/

https://en.wikipedia.org/wiki/Nuclear_magnetic_resonance_spectroscopy

https://www2.chemistry.msu.edu/faculty/reusch/virttxtjml/spectrpy/nmr/nmr1.htm

Methodology of teaching

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students be able to

CO code	Course Outcomes	K-levels
CO1	**Compare and Relate Electronic spectra and Infrared spectra.** Summarize Various factors affecting IR stretching frequencies.	K1, K2, K3, K4
CO2	Illustrate Origin of NMR spectrum-Nuclear spin states–NMR active nuclei–Nuclear magnetic moment–Larmor equation–Population density of nuclear spin states. Correlate Two interacting nuclei: AB, AX, AA'BB', pair of doublet and AB quartet. Three interacting nuclei: AMX, ABX, ABC systems (only pattern is required). Understand NMR imaging (MRI)	K1, K2, K3, K4
CO3	**Relate** ^{13}C NMR–difficulties in recording ^{13}C NMR: Homo nuclear and heteronuclear coupling. Understand ^{13}C NMR and origin of ^{13}C satellite peaks. **Illustrate**Identification of organo phosphorous compounds P-P bond in NMR.Explain basic aspects of 2-D NMR techniques.	K1, K2, K3, K4
CO4	**Explain**Origin, basics and bloc diagram of Mass spectrum. **Describe**fragmentation patterns of organic molecules and heterocyclic compounds **Define**McLafferty rearrangements of organic molecules.	K1, K2, K3, K4,

CO5	**Describe** the Determination of molecular formula of organic compounds using elemental (CHN) analysis data. **Illustrate** the Structural determination of simple organic compounds using UV, IR, NMR and Mass spectral data.	K1, K2, K3,K4
K1 – Remembering , K2– Understanding , K3 –Applying ,K4 –Analysing , K5–Evaluating , K6–Creating		

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	3	2	2	3	2	2
CO2	3	3	2	2	2	3
CO3	3	2	2	3	2	2
CO4	3	2	2	3	2	2
CO5	3	2	2	3	2	1
Average	3	2.2	2	2.8	2	2

BLOOM TAXANOMY BASED QUESTION PAPER PATTERN

UG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1	A (Answer all the questions)	10 × 2	Short Answer (Two questions from each unit)	20
K1, K2, K3	B (**INTERNAL CHOICE**) EITHER (a) OR (b)	5 × 5	Question (a) OR (b) from the same Unit and same K Level	25
K3, K4, K5	C (Answer any three question from five questions)	3 × 10	One questions from each unit (No unit missing)	30
Grand Total				**75**

THIRD SEMESTER				
Course title		**PHYSICAL CHEMISTRY– III**		
Course code.		**22PCCHC3**		
Course No	Course Category Core/Elective	No. of Credits	No of hrs/week	Total marks (Int+Ext)
CC-XI	**Core**	**4**	**5**	**25+75=100**

Course Objectives

- To know the limitations of classical thermodynamics in the evaluation of macroscopic properties.
- To understand the principles of activity and fugacity.
- To know the theories of kinetic activity.
- To study the techniques of Heat Capacity.
- To learn about the various applications of Quantum Statistics.
- To understand the concepts and applications of group theory

UNIT-I: Thermodynamics and non-ideal systems 15HRS

Concepts of Partial Molar Properties-Partial Molar Free Energy and Partial Molar Volume.Gibbs-Duhem equation, Chemical potential-Variation of chemical potential with temperature and pressure, Van't Hoff isotherm.

UNIT-II: Irreversible thermodynamics-I 15HRS

Nernst heat theorem-Third law of thermodynamics-Applications of third law-Entropy change-Calculation of absolute entropies-Apparent exceptions to third law- Non-equilibrium thermodynamics-Basic concepts-Forces and fluxes-Entropy of irreversible processes-Entropy production-Clausius inequality-Phenomenological equations-Onsager reciprocity relations-Coupled reactions. The principal of microscopic reversibility, the Onsager reciprocal relations – verification .Entropy production- rate of entropy production, entropy production in chemical reactions.

UNIT-III: Statistical thermodynamics I 15Hrs

Objectives of statistical thermodynamics, Concept of distributions, Types of ensembles. Thermodynamic probability, Most probable distribution Law- Classical statistics-Maxwell-Boltzmann (MB) statistics-Quantum statistics-Bose-Einstein (BE) and Fermi-Dirac (FD) statistics-Derivation of distribution function-MB, BE and FD statistics-comparison-

UNIT IV: Group theory-I 15 Hrs

Symmetry elements; symmetry operations**,**Abelian group-point groups-determination of point group- Group multiplication table - Matrix representation of symmetry operations-Similarity transformations; Mulliken symbols-reducible and irreducible representations; Symbols and rules of irreducible representations-reduction formula-direct product representation; Great orthogonality theorem; character table-construction of character tables $C_{2v,}$ and C_{3v}

UNIT V: Photochemistry **15Hrs**

Jablonski diagram, Primary and Secondary Processes, quantum yield and its determination-chemical actinometer. Excimers and exciplexes-Kinetics of collisional quenching-Stern -Volmer equations.Photosensitization, Chemiluminescence.Photosynthesis, solar energy conversions. Semiconductor photo catalysis, lasers.

Radiation Chemistry-linear energy transfer, G-value, dosimeters, radiolysis of water, solvated electrons.

Text Books:

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

Reference Books

6. A. Walton, Molecular and Crystal Structure Models,Ellis Horwood, Chichester, **1978**.
7. A. R. West, Solid State Chemistry and its applications**,** John Wiley and Sons, New York, **1984**.
8. M. C. Gupta, Statistical Thermodynamics, Wiley Eastern, New Delhi, **1990**.
9. J. Rajaram and J. C. Kuriacose, Irreversible Thermodynamics,Lal Nagin Chand, New Delhi, **1989**.
10. P. W. Atkins, Physical Chemistry,Oxford University Press, Oxford, **1990**.

COURSE OUTCOMES:

On completion of the course the student will be able to:

CO No	Course outcome	Knowledge level
CO1	Understand the basic concepts of partial molar properties and correlate the chemical potential with temperature and pressure	K1, K2
CO2	Understand the theories related to transport processes such as diffusion, heat flow etc., by means of driving forces and fluxes. Gains a good knowledge of entropy of irreversible process.	K1. K2
CO3	Know the limitations of classical thermodynamics in the evaluation of macroscopic properties. Apply the various applications of quantum statistics and compare the classical and quantum statistics. Understands the concept of distribution of particles among various energy states.	K1,K2.K3,K4,K5

CO4	Acquire knowledge on basic concepts and applications of Determine the selection rules for spectral transitions energies and molecular orbitals.	K2,K3,K4,K5,
CO5	Gains knowledge about the basic processes of photochemistry and their applications. Understands the principles and applications of radiation chemistry.	K1,K2,K3,K6
K1 – Remembering , K2– Understanding , K3 –Applying ,K4 –Analysing , K5–Evaluating , K6–Creating		

CO-PSO MAPPING

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2	3	2	3
CO2	3	3	2	2	2	3
CO3	3	3	2	2	3	3
CO4	3	2	1	1	2	3
CO5	3	3	3	3	3	3
Average	3.0	2.8	2.0	2.2	2.4	3.0

BLOOM TAXANOMY BASED QUESTION PAPER PATTERN

UG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1	A (Answer all the questions)	10 × 2	Short Answer (Two questions from each unit)	20
K1, K2, K3	B (**INTERNAL CHOICE**) EITHER (a) OR (b)	5 × 5	Question (a) OR (b) from the same Unit and same K Level	25
K3, K4, K5	C (Answer any three question from five questions)	3 × 10	One questions from each unit (No unit missing)	30
Grand Total				**75**

THIRD SEMESTER				
Course title		**MATERIAL CHEMISTRY**		
Course code		**22PCCHE3A**		
Course No	Course Category Core / Elective /	No of Credits	No of hrs /week	Total marks (Int+Ext)
CEC III A	**Elective**	**3**	**3**	**25 + 75=100**

Course objectives

- To understand the synthesis and characterization techniques of nanomaterials.
- To learn the theories of conducting properties of materials.
- To learn the structural important of industrially important materials.
- To acquire the knowledge about polymers, types of polymers, Mechanism and Kinetics of polymerization.
- To understand the Principles of Polymer reactivity and stereochemistry of Polymerization.
- To get deep knowledge about various methods of polymerization and specialty Polymers.

UNIT - I: Synthesis and applications of nanomaterials 15 Hrs

Preparation of nanomaterials – plasma arcing, CVD, electrodeposition, sol-gel synthesis, ball milling, uses of natural nanoparticles. Synthesis and applications of carbon nanotubes

Monolayer–protected metal nanoparticles – characterization Applications of Nanosensors – electrochemical sensors, sensors based on physical properties – nanobiosensors.

UNIT - II: Characterization of nanomaterials 15 Hrs

Electron microscopes – scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Scanning Transmission Electron Microscopy (STEM) -scanning tunneling microscopy (STM) –Atomic force microscopy (AFM) – scanning probe Lithography (SPL), Particle size analysis.

UNIT III: Polymers 20 Hrs

Polymers - definition - types of polymers - liquid crystalline polymers. Molecular mass - number and mass average molecular mass - determination of molecular mass (osmometry, viscosity and sedimentation methods).Definition and principles of linear stepwise polymerization - addition polymerization - free radical, cationic and anionic polymerization.Kinetics of copolymerization.Polymerization. Stereochemistry and mechanism of polymerization. Coordination Polymerization-Definition and principles.

UNIT IV: Processing and properties of polymers 15 Hrs

Polymer Processing: Plastics elastomers and fibres. processing techniques: Die casting, rotational casting, film casting, injection moulding, blow moulding extrusion moulding, thermoforming, foaming, reinforcing and fibrespinning.Polymer structure and physical properties –crystalline melting point T_m. Determination of T_g. Relationship between T_m and T_g..

UNIT V: Commercial polymers **10 Hrs**

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

Text books

1. R. Alcock and F. W. Lamber, Contemporary Polymer Chemistry, Prentice Hall, **1981**.
2. G. Hodes (Eds.), Electrochemistry of Nanomaterials, Wiley-VCH, **2001**.
3. V. R. Gowariker, N. V. Viswanathan and JayadevSreedhar, New Age International (P) Ltd, **2005**.

References Books

4. F. W. Billmeyer, Text Book of Polymer Science, 3rd Ed, John Wiley & Sons, New York, **2003**.
5. C. N. R. Rao, A. Muller and A. K. Cheetham (Eds.), The Chemistry of NanomaterialsVol.I&Vol.II, Wiley-VCH, **2004**.
6. R. J. Young and P. A. Lovell, Introduction to Polymers, 2nd Ed, Chapman and Hall, **2002**.

Web Resources

https://en.wikipedia.org/wiki/Nanomaterials
https://www.niehs.nih.gov/health/topics/agents/sya-nano/index.cfm

METHODOLOGY OF TEACHING

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students are able to

CO code	Course Outcomes	K-levels
CO1	Outline and explain the synthesis of nano materials.	K1, K2,K3.
CO2	Apply characterization techniques to analysenanomaterials and also to interpret..	KI,K3,K4
CO3	Get deep knowledge about various methods of polymerization. Understand the Principles of Polymer reactivity and stereochemistry of Polymerization. Acquire the Knowledge about polymers, types of polymers, Mechanism and Kinetics of polymerization.	K2,K3,K5
CO4	Understand the theories of conducting properties of materials. Get the knowledge on the structural importance of industrially important materials.	K2, K3,K6
CO5	Connect the properties with the application of polymers.	K2,K6
K1 – Remembering , K2– Understanding , K3 –Applying ,K4 –Analysing , K5– Evaluating , K6–Creating		

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2	3	3	3
CO2	3	2	3	3	2	3
CO3	3	3	2	2	3	3
CO4	3	2	3	3	3	3
CO5	3	3	2	3	2	3
Average	3	2.6	2.4	2.8	2.6	3

BLOOM TAXANOMY BASED QUESTION PAPER PATTERN
PG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1, K2, K3, K4	A (Answer all the questions)	10 X 2	Short Answer (Two questions from each unit)	20
K1, K2, K3, K4, K5	B (INTERNAL CHOICE) EITHER (a) or (b)	5 X 5	Question (a) OR (b) from the same Unit and same K Level	25
K2, K3, K4, K5, K6	C (Answer any three questions from five questions)	3 X 10	One questions from each unit (No unit missing)	30
			Grand Total	**75**

THIRD SEMESTER				
Course title		**NANOCHEMISTRY**		
Course code		**22PCCHE3B**		
Course No	Course Category Core / Elective /	No of Credits	No of hrs /week	Total marks (Int+Ext)
CEC III B	**Elective**	**3**	**3**	**25 + 75=100**

Course objectives

- To learn the chemistry of Nanomaterials
- To understand thetechniques to find nanoscale materials.
- To know about the biomineralization
- To acquire the knowledge about the fullerenes
- To get familarizeaboutsupermolecular assembly

Unit I :**Nanochemistry-An Introduction** 9 Hrs

Definition of nanodimensional materials-Some historical milestones in the saga of nano forms-Size effects-Importance of Nanomaterials-Classification of Nanomaterials-Simple examples of unique properties of nanosized materials-Elementary aspects of bionanotechnology-Some important recent discoveries in nanoscience and technology.

Unit II: **Techniques in Nanochemistry and electrochemistry of Nanoassemblies** 9Hrs

Techniques for characterization of nanoscale materials (Basic aspects) Atomic force Microscopy(ATM), Transmission electron microscopy(TEM)-Resolution and scanning transmission electron microscopy (STEM) Scanning tunneling microscopy (STM) Scanning nearfield optical microscopy (SNOM). Electrochemistry of semiconductors-Nano structures-Nanostructural oxide films modified with dyes and redox chromophores-Electrochemistry of metal nanostructures-Particles-Nanoelectrodes-Biosensors-Chemical Sensors.

Unit III: **Biomineralisation and Nanoporous materials** 9Hrs

Controller assembly of advanced materials in biology-Nucleation and crystal growth-Various biominerals-Calcium phosphate-Calcium carbonate-Amorphous silica, iron biominerals-Strontium and barium sulphates. Oxide nanoparticles-Oxomolybdates-Nanocatalysis-Porous silicon-Transition and Non transition metal phosphates.

Unit IV: **Carbon clusters and Nanostructures** 9 Hrs

Nature of carbon bond-new carbon structures-Carbon clusters-Discovery of C60-Alkali doped C60-Superconductivity in C60-Larger and smaller fullerenes. Carbon nanotubes-synthesis-Single walled carbon nanotubes- structure and characterization-Mechanism of formation-Chemically modified carbon nanotubes-Doping- Functionalizing nanotubes-Application of carbon

Unit V: **Organic films and supramolecular assembly** **9**Hrs

Organic films-Insulating and passivating layers-Electron transfer-Organic nanostructures-Optical properties-Organic semiconductors-Active organic devices. Polymerization-Sizes of polymers-Nanocrystals-Conductive polymers-Block Co-polymers. Supramolecular structures-Transition-metal-mediated types-Dendritic molecules-Supramoleculardendrimers-Micelles-Biological nanostructures.

Text books

1. C.N.R. Rao, A. Muller, A.K. Cheetam(Eds), The Chemistry of Nanomaterials, Vol 1, ao2, Wiley –VCH, Weinheim, 2004
2. T. Pradeep, Nano: The Essentials in understanding nanoscience and nanotechnology, Tat McGraw Hill, New Delhi 2007.

References Books

3. C.P. Poole, JR: F.J. Owens, Introduction to Nanotechnology Wiley Interscience, New Jersey, 2003.
4. BengtNolting, Methods in modern biophysics, Spriner-Verlarg, Berlin, First Indian Reprint, 2004
5. A.Nabok, Organic and Inorganic Nanostructures, Artech House, Boston, 2005.
6. J.M.Lehn, Supramolecular Chemistry-Concepts and Perspectives, V.C.H. 1995.

Web Resources

https://www.nanowerk.com>nanotechnology>introduction
https://www.fisica.uji.es>Nanobiosensors_word

METHODOLOGY OF TEACHING

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students are able to

CO code	Course Outcomes	K-levels
CO1	Classification, definition, elementary aspects of nanosized materials. Unique properties of Nanomaterials.	K1, K2
CO2	To study the characterization techniques involved in Nanosized materials. To study and apply AFM, TEM, STEM, STM, SNOM. The concepts of nano structural oxide films, metal nanostructures, nano electrodes, Biosensors and chemical sensors	K1,K2,K3
CO3	To know the concept of nucleation and crystal growth, various biominerals like calcium carbonate, calcium phosphate. Knowledge on oxide nanoparticles and nanocrystals	K1,K2,K5

CO4	Concept of carbon clusters, fullerenes. Synthesis of carbon nanotubes, doping and applications	K1,K2,K6
CO5	Illustration of organic nanostructure, organic semiconductor, nano crystals, dendritic molecules, superamoleculardendrimers and biological nanostructures	K2,K3,K6

K1 – Remembering, K2– Understanding , K3 –Applying ,K4 –Analysing , K5–Evaluating , K6– Creating

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	3	3	2	2	3	2
CO2	3	2	3	3	2	3
CO3	3	3	3	2	3	2
CO4	3	2	2	2	2	3
CO5	3	3	2	3	3	2
Average	3	2.6	2.4	2.4	2.6	2.4

BLOOM TAXANOMY BASED QUESTION PAPER PATTERN
PG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1, K2, K3, K4	A (Answer all the questions)	10 X 2	Short Answer (Two questions from each unit)	20
K1, K2, K3, K4, K5	B (INTERNAL CHOICE) EITHER (a) or (b)	5 X 5	Question (a) OR (b) from the same Unit and same K Level	25
K2, K3, K4, K5, K6	C (Answer any three questions from five questions)	3 X 10	One questions from each unit (No unit missing)	30
			Grand Total	**75**

THIRD SEMESTER				
Course title		**ENVIRONMENTAL CHEMISTRY**		
Course code.		**22PCCHD2**		
Course No	Course Category Core/Elective	No. of Credits	No of hrs/week	Total marks (Int+Ext)
CEC-V	**Elective**	**3**	**4**	**25+75=100**

Course Objectives:

- To know difference between renewable energy sources and non-renewable energy sources.
- To understand themajor air pollutants, effects of air pollution, Green house effect and Instrumental methods o measuring air pollution.
- To gain the knowledge about sources of soil pollution, industrial pollution, effect of insecticides fungicides on environment and effect of plastic and polymers on environment.
- To understand the effect of air pollution on human health, and health-effect of soil pollution on human health.
- To gain information of toxic elements and their effect on environment.

Unit I: Energy and Environment **12 Hrs**

Sources of energy: Renewable energy sources– solar energy –solar –water heating system-solar energy flow through ecosystem-hydro energy-tidal energy-wind energy-biomass energy-production of biogas-geothermal energy. Non-renewable energy sources-types of coal-pollution caused by coal-Petroleum - refining of petroleum by fractional distillation-products of fractional distillation-natural gas-natural gas as energy source-pollution caused by burning fossil fuels-Nuclear energy.

Unit II: Air Pollution **12 Hrs**

Major air pollutants-oxides of carbon, oxides of nitrogen, oxides of sulphur, particulates – sources and effects –smog and photochemical smog-sources of air pollution-Effects of air pollution-acid rain-green house effect-global warming-depletion of ozone-control of air pollution – Instrumental methods of measuring air pollution-HPLC and X-ray fluorescence spectroscopy.

Unit III: Soil Pollution and Noise Pollution **12 Hrs**

Soil Pollution: Sources of soil pollution-industrial pollution-urban and domestic wastes-radioactive pollutants-agrochemicals: Fertilizers-salination of soils-pesticides-insecticides: organochlorines, organophosphates, carbamates and pyrethroids-effects of insecticides on environment – Fungicides and herbicides-types and effects of fungicides

and herbicides on environment - plastic and polymers-effect of polymers and plastics on environment –waste treatment .

Noise Pollution: sources and effects of noise pollution-control of noise pollution.

Unit IV: Environmental Pollution and Health **12 Hrs**

Effect of air pollution on human health-water pollution and health-effect of soil pollution on human health-pollutants encountered at homes(indoor pollution)-pollutants encountered at work place.

Unit V: Environmental Toxicology **12 Hrs**

Chemicals in the environment: toxic chemicals in air-toxic elements in water-toxic waste in solids-biodegradibility-principles of biodegradation-microbial transformation: biooxidations-bioreductions-and biohydrolysis-impact of toxic chemicals on enzymes:biochemical effects of arsenic, cadmium, lead, mercury and carcinogens-some environmental episodes: Bhopal gas tragedy-chernobyl disaster, three mile island disaster and minamata disaster-better industrial process: green chemistry – designing a green synthesis.

Text Books:

Environmental Chemistry by V.K. Ahluwalia

Web Resources: https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SBAA1204.pdf

METHODOLOGY OF TEACHING

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students be able to

CO code	Course Outcomes	K-levels
CO1	**Correlate** renewable energy sources and non-renewable energy sources. **Compare** solar energy and nuclear energy. **Define** different kinds of energy.	K1, K2, K3, K4
CO2	**Classify**different kinds of air pollutants **and explain** the effect of air pollution.**Explain**the method of measuring airpollution.**Define** greenhouse effect and global warming.	K1, K2, K3, K4
CO3	**Explain** the Sources of soil pollution-industrial pollution.Defineagrochemicals. **Compare**pesticides and insecticides.**Define**organochlorines, organophosphates, carbamates and pyrethroids. **Compare** the effects of insecticides on environment and effects of fungicides and	K1, K2, K3

	herbicides on environment**. Explain**the sources and effects of noise pollution-control of noise pollution.	
CO4	**Relate** the Effect of air pollution on human health-water pollution and health-effect of soil pollution on human health. **Explain** pollutants encountered at homespollutants encountered at work place.	K1, K2, K3
CO5	**Explain** Chemicals in the environment and explain toxic chemicals in air-toxic elements in water-toxic waste in solids. **Compare**biooxidations, bioreductions.	K1, K2, K4

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	3	2	3	3	2	2
CO2	3	2	2	3	2	2
CO3	3	2	3	3	2	2
CO4	3	2	2	3	2	2
CO5	3	2	2	3	2	2
Average	3	2	2.4	3	2	2

BLOOM TAXANOMY BASED QUESTION PAPER PATTERN
PG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1, K2, K3, K4	A (Answer all the questions)	10 X 2	Short Answer (Two questions from each unit)	20
K1, K2, K3, K4, K5	B (INTERNAL CHOICE) EITHER (a) or (b)	5 X 5	Question (a) OR (b) from the same Unit and same K Level	25
K2, K3, K4, K5, K6	C (Answer any three questions from five questions)	3 X 10	One questions from each unit (No unit missing)	30
			Grand Total	**75**

SEMESTER IV

FOURTH SEMESTER				
Course title		**ORGANIC CHEMISTRY-IV**		
Course code.		**22PDCHC1**		
Course No	Course Category Core/Elective	No. of Credits	No of hrs/week	Total marks (Int+Ext)
CC-XII	**Core**	**4**	**5**	**25+75=100**

Course Objectives

- To understand photochemical reactions along with their mechanism and synthetic utility.
- To understand various types of pericyclic reactions with orbital symmetry based selection rule.
- To understand the synthesis and reactivity of five- as well as six-member heterocycles.
- To understand the structural elucidation, biosysnthesis and synthesis of natural products.

UNIT-I: Organic photochemistry **15 Hours**

Principles of Photochemistry and Photochemical reactions: Norrish type I & II reactions. Paterno-Büchi reaction; Photochemistry of enones and dienones: [2 + 2] photochemical cycloaddition; Photo Fries, di-π methane, oxa&aza di-π methane rearrangements.

UNIT II: Orbital symmetry & pericyclic reactions **15 Hours**

Selection rules (Woodward and Hoffmann rules) and stereochemistry of electrocyclic reactions, cycloadditions and Sigmatropic reactions-FMO approach, Correlation diagram approach, Huckel-Mobius approach and perturbation molecular orbital approach.

UNIT-III: Heterocycles and their reactivity **15 Hours**

Structure, synthesis and their reaction of the following systems; a) One heteroatom - Pyrrole, Furan, Thiophene, Pyridine; b) Benzo fused Heterocycles - Indole, Quinoline; c) Two heteroatom - Pyrazole, Imidazole, Pyrimidine, Pyrazine.

UNIT-IV: Natural products: terpenoids & steroids **15 Hours**

Terpenoids: Isolation and classification - general methods to elucidate the structure of terpenoids - methods of structural elucidation and synthesis as applied to zingiberene, eudesmol and abietic acid. Biosynthesis of terpenes.

Steroids: Structural elucidation of cholesterol. Synthesis of progesterone,androsterone and testosterone from Cholesterol.Biosynthesis of steroids and Synthesis of bile acids.

UNIT-V: Natural products: Alkaloids **15 Hours**

Structural elucidation and biosynthesis ofchinconine, morphine, reserpine, cocaine and nicotine.

Text books

Jagdamba Singh and Jaya Singh, Photochemistry and Pericyclic Reactions, New Age International (P) Ltd, 3rd Ed, **2012.**

1. P. L. Gilchrist and R. C. Storr, Organic Reactions & Orbital Symmetry, Cambridge [Eng.] University Press, **1972**.
2. I. L. Finar, Organic Chemistry Vol 1 & 2, Dorling Kindersley India (P) Ltd, **2009.**
3. A. Newman, Chemistry of Terpenes and Terpenoids,Academic Press, **1972.**

Reference Books

1. R. K. Bansal, Heterocyclic Chemistry, New Age International (P) Ltd, 5th Ed,**2014**.
2. Charles A. Depuy and Orville L. Chapman, Englewood Cliffs, Molecular reactions and Photochemistry,New Jersey: Prentice-Hall, **1972**.
3. Nicholas J Turro, V. Ramamurthy and J. C. Scaiano, Modern Molecular Photochemistry for Organic Molecules, University Science Books, 1st Ed,**2010**.

Web Resources:

https://en.wikipedia.org/wiki/Organic_photochemistry

https://en.wikipedia.org/wiki/Alkaloid

METHODOLOGY OF TEACHING

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students be able to

CO code	Course Outcomes	K-levels
CO1	Illustrate Photochemical reactions.RelateNorrish type I & II reactions. Paterno-Büchi reaction.	K1, K3, K4
CO2	Classify stereochemistry of electrocyclic reactions, cycloadditions and Sigmatropic reactions. Correlate FMO approach,Correlation diagram approach.	K1, K2,K3, K4
CO3	Describe and classify Structure, synthesis and their reaction of the following systems.	K1, K2, K3, K4
CO4	Describe Isolation and classification of terpenoids. Illustrate general methods to elucidate the structure of terpenoids.	

	Describe the biosynthesis of terpenes. Explain the biosynthesis of steroids.	K1, K2, K3, K4, K6
CO5	Explain and Compare the Structural elucidation and biosynthesis ofchinconine, morphine, reserpine, cocaineand nicotine.	K1, K2, K3,K5
K1 – Remembering , K2– Understanding , K3 –Applying ,K4 –Analysing , K5–Evaluating , K6–Creating		

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	3	2	3	3	2	2
CO2	3	2	2	2	2	3
CO3	3	2	2	3	2	2
CO4	3	2	2	3	2	2
CO5	3	2	2	2	1	1
Average	3	2.0	2.2	2.6	1.8	2

BLOOM TAXANOMY BASED QUESTION PAPER PATTERN
PG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1, K2, K3, K4	A (Answer all the questions)	10 X 2	Short Answer (Two questions from each unit)	20
K1, K2, K3, K4, K5	B (INTERNAL CHOICE) EITHER (a) or (b)	5 X 5	Question (a) OR (b) from the same Unit and same K Level	25
K2, K3, K4, K5, K6	C (Answer any three questions from five questions)	3 X 10	One questions from each unit (No unit missing)	30
			Grand Total	**75**

FOURTH SEMESTER				
Course title		**PHYSICAL CHEMISTRY - IV**		
Course code.		**22PDCHC2**		
Course No	Course Category Core/Elective	No. of Credits	No of hrs/week	Total marks (Int+Ext)
CC-XIII	**Core**	**4**	**5**	**25+75=100**

Course objectives

- ✓ To understand the concept of fugacity and activity.
- ✓ To gain knowledge on applications of Onsagar reciprocal relation such as thermo-osmosis, thermo – mechanical effects, thermos – electric effect and electro kinetic effect.
- ✓ To acquire knowledge on partition functions.
- ✓ To apply the basic principles of group theory to study hybrid orbitals.
- ✓ To understand and apply the basic principles of surface techniques like ESCA, SEM, TEM, AFM, STM and thermal techniques like DTA, TGA, DSC.

UNIT I Thermodynamics II **15hrs**

Fugacity–Determination of fugacity of gases by graphical method-Variation of fugacity with temperature and pressure -Lewis Randal rule-Duhem-Margules equation. Determination of activity and activity coefficient of non-electrolyte (e.m.f method)-Excess functions.

UNIT II Irreversible Thermodynamics II **15hrs**

Thermal osmosis- Thermoelectric phenomena- Electro kinetic and Thermo mechanical effects-Transference in aqueous solution of electrolytes. Application of irreversible thermodynamics to biological and non – linear systems

UNIT III Statistical Thermodynamics II **15Hrs**

Partition functions-Translational, rotational, vibrational and electronic partition function – Calculation of thermodynamic parameters and equilibrium constants in terms of partition function; Debye and Einstein heat capacity of solids.

UNIT IV GroupTheory-II **15Hrs**

Applications of group theory- Determination of representations of vibrational modes in non-linear molecules such as water, ammonia, BF_3, CH_4 and XeF_4.Determination of Hybrid orbitals in non-linear molecules – Examples: H_2O, NH_3, BF_3, CH_4 and XeF4.Electronic spectra of formaldehyde and ethylene.

UNIT V Surface and Thermal Analysis Techniques **15Hrs**

Principles, theory, instrumentation and applications of SEM, STM, TEM, AFM, ESCA - interpretation of spectra-Merits and demerits.Principles, theory and applications of TGA, DTA, DSC, DTG. Interpretation of various thermal analysis curves.

Text Books

1. V. Ramakrishnan and M. S. Gopinathan, Group theory in Chemistry, Vishal Publications, **1988**.
2. K.V. Raman, Group theory and its applications to Chemistry, Tata McGraw-Hill Publishing Company, **1990**.

Reference Books

3. Yi-Chen Cheng, Macroscopic and Statistical Thermodynamics, World Scientific, **2006**.
4. S. Glasstone, Thermodynamics for Chemists, Affiliated East West Press, New Delhi, **1960**

COURSEOUTCOMES:

On completion of the course the student will be able to:

Code No	Course outcome	Knowledge level
CO1	Acquire knowledge on fugacity and its effect on variation of temperature and pressure. Understand the basic concepts of activity and activity coefficient of non-electrolytes.	K1, K2
CO2	Apply the verification of Onsagar reciprocal relation to thermoelectric effect, thermo- osmotic effect, thermo-mechanical and thermo -kinetic effect. Apply irreversible thermodynamics to biological and non-linear system.	K1. K2
CO3	Compare the various partition functions like translational, rotational and vibrational partition function in terms of energy. Understand the theory of heat capacities.	K2.K3,K4,K5
CO4	Apply the basic concepts of group theory to determine the vibrational modes in molecules. Interpret the electronic spectra of molecules.	K2,K3,K4,K6,
CO5	Understand the principle and instrumentation of surface technique like SEM,TEM,STM,AFM and ESCA and interpret thermal analysis curves of TGA,DTA, DSc and DTG	K2,K3, K5

MAPPING OF CO's – PSO's

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	2	2	2	3
CO2	3	2	1	2	1	3
CO3	3	3	2	3	3	3
CO4	3	2	2	3	3	3
CO5	3	3	3	3	3	3
AVERAGE	3	2.4	2	2.6	2.4	3

BLOOM TAXANOMY BASED QUESTION PAPER PATTERN
PG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1, K2, K3, K4	A (Answer all the questions)	10 X 2	Short Answer (Two questions from each unit)	20
K1, K2, K3, K4, K5	B (INTERNAL CHOICE) EITHER (a) or (b)	5 X 5	Question (a) OR (b) from the same Unit and same K Level	25
K2, K3, K4, K5, K6	C (Answer any three questions from five questions)	3 X 10	One questions from each unit (No unit missing)	30
			Grand Total	**75**

FOURTH SEMESTER				
Course title		**PRACTICAL-PHYSICAL CHEMISTRY**		
Course code.		**22PDCHC3**		
Course No	Course Category Core/Elective	No. of Credits	No of hrs/week	Total marks (Int+Ext)
CCP-XIV	**Core**	**3**	**4**	**40+60=100**

PHYSICAL CHEMISTRY PRACTICAL:

Any Twelve experiments from the following should be carried out.

KINETICS:

1. Kinetic study and comparison of acid strengths using acid catalysed hydrolysis of an ester.
2. Determination of Arrhenius parameters of acid catalysed ester hydrolysis
3. Determination of primary salt effect for the reaction between potassium persulphate and potassium iodide.
4. Determination of zero order rate constant of iodination of acetone.

PHASE STUDY:

5.Construction of phase diagram for a simple binary system : naphthalene – biphenyl, naphthalene –p-dichlorobenzene , naphthalene-diphenylamine.

6.Phase study of three component system.

ADSORPTION STUDY:

7. Study of the adsorption of acetic acid or oxalic acid on charcoal , verification of Freundlich isotherm and determination of concentration of given acetic acid or oxalic acid.

CONDUCTOMETRY:

8. Determination of strength of strong acid and weak acid present in a mixture.
9. Determination of equivalent conductance of a strong electrolyte at infinite dilution .
10. Determination of dissociation constant (K_a) of a weak electrolyte.
11. Determination of the strength of Barium Chloride solution .

POTENTIOMETRY:

12. Determination of strength of strong acid and weak acid present in a mixture.
13. Determination of dissociation constant of a weak acid using quinhydrone electrode.
14 .Determination of the strength of KI solution using $KMnO_4$ as link solution.
15. Determination of strength of KI and KCl present in a given mixture.

FOURTH SEMESTER				
Course title		**PRACTICAL-INORGANIC CHEMISTRY**		
Course code		**22PDCHC4**		
Course No	Course Category Core / Elective /	No of Credits	No of hrs /week	Totalmarks (Int+Ext)
CCP-XV	**Core**	**4**	**5**	**25+75=100**

1.**Preparation of Inorganic Complexes**

Sodium hexanitrocobaltate (III), Chloropentamminecobalt (III) Chloride, bis (acetyl acetonato) Copper (II), Hexamminenickel (II) chloride. Tris copper thiourea, Copper (I) chloride Trinitro triammine Cobalt (III) Sodium cuprous tiosulphate.

2.**Tritrimetry and Gravimetry**:

i. Estimation of copper and zinc present in a mixture, copper – Volumetrically Zinc Gravimetrically/Complexometrically.

ii. Estimation of copper and nickel present in a solution copper - Volumetrically nickel Gravimetrically/Complexometrically.

iii. Estimation of Calcium and Magnesium Calcium – Volumetrically Magnesium Complexometrically

iv. Estimation of Mg and Ni both complexometrically.

3.**Applied Analysis**

i. Analysis of any two of the following alloys – Brass, Bronze, Solder, Stainless steel.

ii. Analysis of any two of the following minerals – Dolomite, Pyreusite and Zinc blends.

4.Interpretation of spectra (IR, UV, Mossbouer, NQR etc.,)

FOURTH SEMESTER				
Course title		**PRACTICAL-ORGANIC CHEMISTRY**		
Course code.		**22PDCHC5**		
Course No	Course Category Core/Elective	No. of Credits	No of hrs/week	Total marks (Int+Ext)
CCP-XVI	**Core**	**3**	**4**	**40+60=100**

ORGANIC CHEMISTRY PRACTICAL:

Organic preparations involving two or three stages, quantitative estimation of organic compounds using known methods, basic training for extraction of compounds from natural products and then chromatographic separations.

I. ANY SIX PREPARATIONS FROM THE FOLLOWING INVOLVING TWO STAGES:

1.Sym-Tribromobenzene from aniline.

2.p-nitro aniline from acetanilide

3.m-Nitrobenzoic acid from methyl benzoate.

4.2, 4-Dinitrobenzoic acid from p-nitro toluene.

5.m-Nitro benzoic acid from benzaldehyde

6.p-bromoaniline from acetanilide

7.Anthraquionone from phthalic anhydride.

8.Phthalide from phthalic anhydride

9.2-phenyl indole from phenylhydrazine

10.2,4- Dinitrophenyl hydrazine from p-nitrochlorobenzene.

I. ANY FIVE ESTIMATIONS:

1. Estimation of aniline

2.Estimation of phenol

3.Estimation of glucose (Bertrands Methods)

4.Saponification of fat or an oil.

5.Iodine value of an oil.

6.Estimation of Kerocene

7.Estimation of amino group.

8.Estimation of amide group

9.Estimation of sulphur in an organic compound.

III.ANY<u>TWO</u> EXERCISES IN THE EXTRACTION OF NATURAL PRODUCTS:

1.Caffeine from tea leaves

2.Lactose from milk

3.Citric acid from lemon

4.Piperine from black pepper

IV.CROMATOGRAPHIC SEPARATIONS:

1. Column chromatography - separation of anthracene and acid from antharacene picrate.
2. Thin layer chromatography separation of green leaf pigments.
3. Paper chromatography

4 Identification of amino acids.

V. SPECTRAL INTERPRETATION OF ORGANIC COMPOUNDS.

UV, IR, PMR AND MASS SPECTRA OF ANY <u>TEN</u> COMPOUNDS.

1. 1, 3, 5-Trimethylbenzene
2. Pinacolonene
3. prophyl amine
4. p-Methoxybenzyl alcohol
5. Benzyl bromide
6. Phenyl acetone
7. 2-Methoxyethyl acetate
8. Acetone

9. Isopropyl alcohol

10. Acetaldehyde diacetate

11.N, N-Dimethylamino ethanol

12. Pyridine

13. 4-Picoline

14. 1, 3 dibromo-1, 1-dichloropropene

15. Cinnamaldehyde

FOURTH SEMESTER				
Course title		**BIOINORGANIC CHEMISTRY**		
Course code.		**22PDCHE4A**		
Course No	Course Category Core/Elective	No. of Credits	No of hrs/week	Total marks (Int+Ext)
CEC-IVA	**Elective**	**3**	**5**	**25+75=100**

Course objectives: To learn the Inorganic Elements in Biological Systems

- To study the theory, essential of hemoglobin and myoglobin
- To study the applications of Metals in Medicine
- To learn the detail study of Metal Ion Deficiency and Disease.
- To know about Metal Storage and Transport

UNIT I:Inorganic Elements in Biological Systems **15** hrs

Inorganic Elements in Biological Systems,Basic Bioenergetics and classification of enzymes. Active transport of cations across membranes, Sodium pump, Biology of calcium carriers and the role in muscle contraction.

UNIT II:Porphyrin Ring System **15 h**rs

Porphyrin Ring System – metalloporphyrin – hemoglobin and myoglobin – structures and work functions – synthetic oxygen carriers – cytochromes – structure and work functions – in respiration – chlorophyll – structure – photosynthetic sequence – iron-Sulphur proteins (non-heme iron protein).

UNIT III:Metal Ion Deficiency and Disease **15** hrs

Metal Ion Deficiency and Disease: Fe, Cu and Zn. Metal ion toxicity: Classes of toxic metal compounds – Cu, Cd, Fe, Pb, Ca and Hg toxicity – detoxification.

UNIT IV: Metals in Medicine and Biological Cycles **15 hrs**

Metals in Medicine: Au in rheumatic arthritis – Pt, Au and metallocene in anticancer drugs – metals in radio diagnosis and magnetic resonance imaging. Biological cycles: Nitrogen cycle – hydrogen cycle.

UNIT V: Metal Storage and Transport **15**hrs

Metal Storage and Transport: Fe, Cu, Zn and V storage and transport – metallothionein: transporting some toxic metals – Zn2+ ion complexes: carbonic anhydrase

Text Books:

1. S.J.Lippard&J.M.Berg. Principles of Bioinorganic Chemistry, PanimaPubl.Corpn. (2005)
2. E.I.Ochiai. Bioinorganic Chemistry –An Introduction, Allyn and Baccon Inc. (1977)
3. M.N.Huhes . The Inorganic Chemistry of Biological Processes, Wiley (1981)

Reference Books:

1. R.P.Hanzlik. Inorganic Aspects of Biological and Organic Chemistry, Academic Press (1976)
2. H.Kraatz&N.Metzler – Nolte (Eds). Concept and Models in Bioinorganic Chemistry, Wiley (2006)
3. I.Bertini, H.B.Gray,S.J.Dippard&J.S.Valentine, Bioinorganic Chemistry, Viva Books Pvt. Ltd. (2004)

Web Resources

https://www.ionicviper.org/topics-covered/bioinorganic-chemistry
https://bcs.wiley.com/he-bcs/Books?action=index&itemId=1119535212

METHODOLOGY OF TEACHING

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon cmpletion of this course, the students be able to

CO code	Course Outcomes	K-levels
CO1	**Summarize**Inorganic Elements in Biological Systems**Explain**Basic Bioenergetics, **Relate**Biology of calcium carriers and the role in muscle contraction. **Classify** the enzymes. **Correlate** Active transport of cations across membranes with Sodium pump	K1, K2, K3, K4
CO2	**Describe** the hemoglobin and myoglobin – structures and work functions, **Correlate** cytochromes – structure and work functions – in respiration, **Classify** iron-Sulphur proteins (non-heme iron protein). **Relate** chlorophyll – structure – photosynthetic sequence	K1, K2, K3, K4
CO3	**Explain** the Metal Ion Deficiency and Disease: Fe, Cu and Zn, **Classify**the Classes of toxic metal compounds – Cu, Cd, Fe, Pb, Ca and Hg toxicity,**Infer**detoxification.	K1, K2, K3
CO4	**Explain** Au in rheumatic arthritis **Correlate** Pt, Au and metallocene in anticancer drugs, **Relate** metals in radio diagnosis and magnetic resonance imaging.	K1, K2, K3,

	Compare Nitrogen cycle and hydrogen cycle.	K4,
CO5	**Explain** Fe, Cu, Zn and V storage and transport, **Define**metallothionein,**Illustrate**carbonic anhydrase, **Compare** transporting some toxic metals – Zn2+ ion complexes.	K1, K2, K4
K1 – Remembering , K2– Understanding , K3 –Applying ,K4 –Analysing , K5–Evaluating , K6–Creating		

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	3	2	3	3	2	2
CO2	3	2	2	3	2	2
CO3	3	2	3	3	2	2
CO4	3	2	2	3	2	2
CO5	3	2	2	3	2	2
Average	3	2	2.4	3	2	2

BLOOM TAXANOMY BASED QUESTION PAPER PATTERN
PG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1, K2, K3, K4	A (Answer all the questions)	10 X 2	Short Answer (Two questions from each unit)	20
K1, K2, K3, K4, K5	B (INTERNAL CHOICE) EITHER (a) or (b)	5 X 5	Question (a) OR (b) from the same Unit and same K Level	25
K2, K3, K4, K5, K6	C (Answer any three questions from five questions)	3 X 10	One questions from each unit (No unit missing)	30
			Grand Total	**75**

FOURTH SEMESTER				
Course title		**LEATHER CHEMISTRY**		
Course code		**22PDCHE4B**		
Course No	Course Category Core / Elective /	No of Credits	No of hrs /week	Total marks (Int+Ext)
CEC III B	**Elective**	**3**	**3**	**25 + 75=100**

Course objectives

- To understand thebasic terms and principle in leather chemistry.
- To know about the different types of tanning of leather.
- To learn the chemistry of chrome tanning.
- To acquire the knowledge about the processing and dyeing of leather.
- To get awareness about the tannery effluents and treatment.

Unit I :**Hides and Skins** 9 Hrs

Hides,skins,leather -An elementary knowledge of the structure and composition of hides and skins.Protein constituents of leather (an elementary concept)

Basic principle involved in pre-tanning such as soaking ,liming,deliming,bating,pickling involved in pre-tanning -depickling.

Unit II: **Vegetable and Mineral tanning** 9 Hrs

Types of tanning -vegetable and mineral tanning , different types of vegetable tanning – materials classification and chemistry of vegetable tanning. Factors and physico-chemical principle involved in vegetable tanning ,fixation of vegetable tanning. Synthetic tanning-their classifications.

Unit III: **Chrome tanning** 9Hrs

The preparation and chemistry of chrome tanning.Effect of adding tanning agents – role of pH in the reaction of chromium complexes with hide proteins. Factors governing chrome tanning. A brief survey of chemistry of other tanning like Al and Zr salts- their relative merit in contrast with chrome tanning.

Unit IV: **Curing and Preservation** 9Hrs

Chemical methods of curing and preservation of hides and skins in acid an alkaline solution.. Process of dyeing leather-use of mordants, dyeing auxillaries such as leveling, wetting and dispersing agents.

Unit V: **Animal Bye products and Tannery Effluents Treatment** **9**Hrs

Animal bye-products-their collecton, handing and preservation methods (such as hair, blood, bones, glands, Keratinous materials and their utilization). Types of water pollution-physical, chemical, physiological and biological. Different types of tannery effluents and wastes beam-house waste-liquors-tanning and finishing yard waste liquors, solid waste-origin and disposal.

Text books

1. Chemical Technology of Leather (ISI)
2. Publications of CLRI-Madras

References Books

3. Chemistry of Leather Manufacture-Mchanghills
4. Vegetable tanning materilas-Howes
5. Tanning processes-Crthmann

Web Resources

https://en.wikipedia.org/wiki/Tanning(leather)

https://www.academia.edu>Tanning_Industry_Process

METHODOLOGY OF TEACHING

Class lectures, Group Discussion, Assignments, Field-based learning.

Course Outcomes (COs):

Upon completion of this course, the students are able to

CO code	Course Outcomes	K-levels
CO1	Outline and explaining basic principles of pre-tanning, Knowledge on structure and composition of hides and skins.	K1, K2
CO2	Concepts of vegetable and mineral tanning. Different types and classifications.	K2,K3
CO3	Summarize the chemistry of chrome tanning liquids. Factors governing chrome tanning.	K1,K3,K5
CO4	Understand the chemical methods of curing preservation of hides and skin. Use of mordant and dying auxiliaries.	K2, K3,K6
CO5	Deduce the animal by products handling and preservation methods. To attain the required knowledge of tannery effluent, house waste, solid waste disposal and treatment.	K2,K5
K1 – Remembering, K2– Understanding, K3 –Applying ,K4 –Analysing , K5–Evaluating , K6–Creating		

CO- PSO Mapping (Course Articulation Matrix)

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	2	2	3	2
CO2	3	2	3	3	2	3
CO3	3	3	2	2	3	3
CO4	3	2	3	2	3	2
CO5	3	2	2	3	2	2
Average	3	2.2	2.4	2.4	2.6	2.4

BLOOM TAXANOMY BASED QUESTION PAPER PATTERN
PG Degree Pattern

Knowledge Level	Section	Marks	Description	Total Marks
K1,K2,K3,K4	A (Answer all the questions)	10 X 2	Short Answer (Two questions from each unit)	20
K1, K2, K3,K4	B (INTERNAL CHOICE) EITHER (a) or (b)	5 X 5	Question (a) OR (b) from the same Unit and same K Level	25
K2,K3, K4	C (Answer any three questions from five questions)	3 X 10	One questions from each unit (No unit missing)	30
			Total	**75**