Sadakathullah Appa College

(Autonomous)

(Reaccredited by NAAC at an 'A' Grade. An ISO 9001:2015 Certified Institution)

Rahmath Nagar, Tirunelveli- 11.

Tamil Nadu.

DEPARTMENT OF CHEMISTRY

CBCS SYLLABUS

Learning Outcomes-based Curriculum Framework for

CHEMISTRY (M.Sc.)

(Applicable for the students admitted from June 2021 as per the Resolutions of the Academic Council Meeting held on 20.03.2021)

CONTENTS

POSTGRADUATE DEPARTMENT OF CHEMISTRY

CBCS SYLLABUS

M.Sc. Chemistry (2021-2024)

COURSE STRUCTURE

I SEMESTER				II SEMESTER		
COURSE	**H/W**	**C**		**COURSE**	**H/W**	**C**
DSC –I	5	4		DSC –IV	5	4
DSC – II	5	4		DSC –V	5	4
DSC –III	5	4		DSC –VI	5	4
DSE-I	4	4		DSE-III	4	4
Practical-I	4	2		Practical – III	4	2
Practical-II	4	2		Practical - IV	4	2
IDC – I	2	2		SEC	2	2
Library Hour	1			Library Hour	1	
TOTAL	**30**	**22**		**TOTAL**	**30**	**22**
III SEMESTER				**IV SEMESTER**		
DSC-VII	5	4		DSC –X	5	4
DSC –VIII	5	4		DSC –XI	5	4
DSC –IX	5	4		Project	8	8
DSE –III	4	4		DSE -IV	4	4
Practical-V	4	2		Practical-VII	4	2
Practical-VI	4	2		Practical-VIII	4	2
IDC -II	2	2				
Library Hour	1					
TOTAL	**30**	**22**		**TOTAL**	**30**	**24**

DISTRIBUTION OF HOURS, CREDITS, NO. OF PAPERS & MARKS				
SUBJECT	**HOURS**	**CREDITS**	**NO. OF PAPERS**	**MARKS**
DSC+Project	63	52	12	1250
Practical	32	16	8	400
DSE	16	16	4	400
IDC	4	4	2	100
SEC-SWAYAM-NPTEL Course	2	2	1	50
Library Hour	3			
TOTAL	**120**	**90**	**27**	**2200**

POSTGRADUATE DEPARTMENT OF CHEMISTRY

M.Sc. Chemistry (2021-2024)

COURSE STRUCTURE

SEM	Course	Title of the Course	Sub. Code	H/W	L*	T*	P*	C	Marks		
									I	E	T
I	DSC-I	Inorganic Chemistry I	21PCCH11	5	5	0	-	4	40	60	100
	DSC- II	Organic Chemistry I	21PCCH12	5	5	0	-	4	40	60	100
	DSC- III	Physical Chemistry I	21PCCH13	5	5	0	-	4	40	60	100
	DSE I	Photochemistry	21PECH11A	4	4	0	-	4	40	60	100
		Medicinal Chemistry	21PECH11B								
		Chemistry of Corrosion	21PECH11C								
	P-I	Inorganic Chemistry Practical-I	21PCCH1P1	4	-	0	4	2	40	60	100/2
	P-II	Physical Chemistry Practical-I	21PCCH1P2	4	-	0	4	2	40	60	100/2
	IDC-I	Analytical Biochemistry	21PICH11	2	2	0		2	40	60	100/2
		Library Reading Hour		1	-	-	-	-			-
II	DSC-IV	Inorganic Chemistry II	21PCCH21	5	5	0	-	4	40	60	100
	DSC- V	Organic Chemistry II	21PCCH22	5	5	0	-	4	40	60	100
	DSC- VI	Physical Chemistry II	21PCCH23	5	5	0	-	4	40	60	100
	DSE II	Analytical Chemistry	21PECH21A	4	4	0	-	4	40	60	100
		Material Chemistry	21PECH21B								
		Forensic Chemistry	21PECH21C								
	P-III	Organic Chemistry Practical I	21PCCH2P1	4	-	0	4	2	40	60	100/2
	P-IV	Analytical Chemistry Practical	21PCCH2P2	4	-	0	4	2	40	60	100/2
	SEC	SWAYAM-NPTEL Course	21PSCH21	2	-	-	-	2	40	60	100/2
		Library Reading Hour		1	-	-	-	-	-	-	-
III	DSC-VII	Organic Chemistry III	21PCCH31	5	5	0		4	40	60	100
	DSC-VIII	Physical Chemistry III	21PCCH32	5	5	0		4	40	60	100
	DSC-IX	Research Methodology	21PCCH33	5	5	0		4	40	60	100
	DSE III	Spectroscopy	21PECH31A	4	4	0		4	40	60	100
		Chemistry of Milk	21PECH31B								
		Agricultural Chemistry	21PECH31C								
	P-V	Organic Chemistry Practical-II	21PCCH3P1	4	-	0	4	2	40	60	100/2
	P-VI	Physical Chemistry Practical II	21PCCH3P2	4	-	0	4	2	40	60	100/2
	IDC- II	Industrial Chemistry	21PICH31	2	2	0	-	2	40	60	100/2
		Library Reading Hour		1	-	-	-	-	-	-	-
IV	DSC X	Inorganic Chemistry III	21PCCH41	5	5	0	-	4	40	60	100
	DSC XI	Advanced Organic Chemistry	21PCCH42	5	5	0	-	4	40	60	100
	P	Project	21PPCH41	8	-	0	-	8	40	60	150
	DSE IV	Advanced Topics in Chemistry	21PECH41A	4	4	0	-	4	40	60	100
		Food Chemistry	21PECH41B								
		Polymer Science	21PECH41C								
	P-VII	Inorganic Chemistry Practical II	21PCCH4P1	4	-	0	4	2	40	60	100/2
	P-VIII	Green and Nano Chemistry Practical	21PCCH4P2	4	-	0	4	2	40	60	100/2
			Total	**120**				**90**			**2200**

*** L–Lecture Hours * T–Tutorial Hours * P–Practical Hours**

M.Sc. Chemistry
Programme Learning Outcomes

PLO	Upon completion of M.Sc. Degree Programme, the graduates will be able to:
PLO 1	**Disciplinary Knowledge** Acquire in-depth scientific knowledge in the core areas of study.
PLO 2	**Creative Thinking and Practical Skills / Problem Solving Skills** • Enrich skills of observation to draw logical inferences from scientific experiments/ programming and skills of creative thinking to develop novel ideas. • Hone problem solving skills in theoretical, experimental and computational areas and to apply them in real life situations.
PLO 3	**Sense of inquiry and Skilled Communicator / Research, Innovation and Entrepreneurship** • Develop the capability for raising appropriate questions relating to the current/emerging issues encountered in the scientific field and to plan, execute and express the results of experiments / investigations through technical writings as well as through oral presentations. • Design innovations for exploring the unexplored areas in diverse fields to accomplish socially relevant and economically beneficial innovative research projects. • Become a skilled entrepreneur for launching start-up / business ventures to improve the economy of the nation.
PLO 4	**Ethical Awareness / Team Work / Environmental Conservation and Sustainability** • Equip them for conducting work as an individual / as a member, or as a leader in diverse teams upholding values such as honesty and precision, and thus preventing unethical behaviors such as fabrication, falsification, misrepresentation of data, plagiarism etc., to ensure academic integrity. • Realise that environment and humans are dependent on one another and to know about the responsible management of our ecosystem for survival, and for the well-being of the future generation as well.
PLO 5	**Digital Literacy/Self-Directed Learning/Usage of ICT/Lifelong Learning** • Get access to digital resources, to use them judiciously for updation of knowledge and also to engage in remote/ independent learning. • Inculcate the habit of learning continuously through the effective adoption of ICT to update knowledge in the emerging areas in Sciences for inventions/discoveries so that the knowledge transferred from laboratory to land would yield fruitful results for the betterment of global society.

Programme Specific Outcomes (PSO)

PSO No.	Upon completion of M.Sc. Chemistry Programme, the students will be able to:	PLOs Mapped
PSO-1	Understand the broad theoretical and experimental aspects of Inorganic, Organic, Physical and Analytical Chemistry both quantitatively and qualitatively.	PLO-1, 2, 3
PSO-2	Acquire advanced level of knowledge on Material Science, Nano Science, Green Chemistry, Quantum Chemistry, Medicinal Chemistry and Intellectual Property Rights.	PLO-2, 3
PSO-3	Apply problem solving skill to analyze problems, provide solutions using appropriate techniques, use software tools and instruments by implementing safe handling of chemicals and apply eco-friendly strategies besides carrying out the interpretation of results.	PLO-3, 4, 5
PSO-4	Promote research skills by analyzing hypotheses through projects and provide scientific solutions with technical reports.	PLO-3, 4, 5
PSO-5	Develop interpersonal skills such as team work, social, scientific and ethical values by benefiting the society by means of contributing solutions to its challenges at the intersection of science and society.	PLO-3, 4, 5

Semester I

Course Title	**Inorganic Chemistry I**
Total hrs	75
Hrs/Week	5
Sub. Code	**21PCCH11**
Course Type	DSC-I
Credits	4
Marks	100

General Objective:

To study about the structure of crystals, chemical bonding, chains and rings, nuclear reactions, noble gases, pseudo halogens, interhalogens, metal carbonyls and clusters.

Course Objectives:

CO No.	**The learners will be able to**
CO - 1	Understand the structure of crystals.
CO - 2	Explain the theories of chemical bonding, chains and rings.
CO - 3	Comprehend the preparation and reactions of noble gases, pseudo halogens and interhalogens.
CO - 4	Illustrate the nuclear reactions.
CO - 5	Outline the structure of metal carbonyls and clusters.

UNIT I: SOLID STATE CHEMISTRY

Crystal structure - SF_6, Fluorite, Antifluorite, Perovskite, $CdCl_2$, Mg_2SiO_4, K_2NiF_4, Rh_4F_{20}, Spinel, Inverse Spinel and Rutile.

Electronic spectra of metal complexes - free ion terms and energy levels - Electron configuration, microstates - Calculation for p and d configuration, Russel Saunders (L-S coupling). Electronic spectra of $[Ti(H_2O)_6]^{3+}$, $[Cu(H_2O)_6]^{2+}$, $[V(H_2O)_6]^{2+}$.

Bragg's law and applications - Electronic band structure of solids.

UNIT II: CHEMICAL BONDING, CHAINS AND RINGS

Bent's rule - Apicophilicity of dπ-pπ bonds,

M.O theory - symmetry and overlap - M.O diagram of HF and BeH_2. Walsh diagram (triatomic molecules- BeH_2 and CO_2).

Chains catenation - heterocatenation - Intercalation chemistry - One-dimensional conductors - $(SN)_x$

Rings - Preparation, properties and structure of borazine, and phosphazene.

Cages - Preparation and structure of phosphorous cage molecules, Diboranes, Styx number, tetraboranes. Structures of B_5H_9, B_5H_{11}, B_6H_{10}, $[B_8H_8]^{2-}$- Structural relationships of closo, nido and arachno boranes.

Carboranes - Structure of nido-CB_5H_9, nido-2, 3-$C_2B_4H_8$, closo-1, 5-$C_2B_3H_5$ and closo-2,4-$C_2B_5H_7$.

UNIT III: NOBLE GASES, PSEUDO HALOGENS AND INTERHALOGENS COMPOUNDS

The reactions and structure of noble gases - Structure of xenon hydrate clathrate - Bonding of xenon with fluorides - Bonding of noble gases with other compounds.

Pseudohalogens - Formation of pseudohalogens by oxidation, disproportionation and precipitation reactions, Electrochemistry of the pseudohalogens.

Interhalogens - Different interhalogen compounds by oxidation states - Structure of polyhalide ions - Structure of I_2Cl_6 - Halogen oxides and oxyfluorides - Halogen cations.

UNIT IV: NUCLEAR CHEMISTRY

Thermal and nuclear reactions - Q-value, capture cross section, threshold energy and excitation functions. Types of nuclear reactions - Spallation, fission and fusion - Fissile and fertile isotopes. Nuclear fission - Characteristics - product distribution - Nuclear fusion and stellar energy, nuclear reactions - nuclear materials and waste disposal. Radiation hazards and protection- Hydrated electrons: Hart and Boag's experiment for production hydrated electrons.

UNIT V: METAL CARBONYLS AND CLUSTERS

Metal carbonyl complexes - Preparation and properties (Ni $(CO)_4$, $Fe(CO)_5$, $Fe_2(CO)_9$, $Cr(CO)_6$, $Re_2(CO)_{10}$), Polynuclear carbonyl complexes ($Fe_3(CO)_{12}$, $Co_4(CO)_{12}$, $Os_4(CO)_{14}$,).

Carbonyl hydride complexes ($HCo(CO)_4$, $HRe(CO)_5$, $H_2Fe(CO)_4$, $[HCr(CO)_5]^-$, and $HMn(CO)_5$), Isolobal fragments.

Structure prediction for heteroboranes and organometallic clusters ($B_3H_7[Fe(CO)_3]_2$, $Rh_6(CO)_{16}$), Metal nitrosyls ($Fe(CO)_2(NO)_2$, $Co(CO)_3(NO)$, $Mn(CO)_4(NO)$, $(\eta^5\text{-}C_5H_5)Re(CO)_2NO]^+$ and $Co(NO)(CO)_3$)

Metal alkyls, carbenes, carbines and carbides alkyl complexes (Manganese and Iron complexes), Nonaromatic alkene (Platinum and Nickel complexes) and alkyne complexes (Cobalt complex), Allyl and pentadienyl complexes (Manganese and Nickel complexes).

Metallocenes, Molecular orbitals of Metallocenes.

Metal clusters - Dinuclear compounds (Rhenium, Molybdenum and Tungsten complexes) - Trinuclear clusters$(Re_3Cl_{12}]^{3-}$, Polyatomic zintl anions and cations.

REFERENCES:

1. Advanced Inorganic Chemistry, F. A. Cotton, R. G. Wilkinson, 6thEdn., Wiley, 1996.
2. Inorganic Chemistry, D.F. Shriver and P.W. Atkins, 4th Edn., Harper Collins, 1993.
3. Inorganic Chemistry - Principles, structure and reactivity, IV edition, James E. Huheey, Ellen A Keitier, Richard LKeiter Pearson Publication (2012).
4. Solid State Chemistry and its Applications, A.R. West, Wiley, 1984.

5. Concise Inorganic Chemistry, J. D. Lee, Elbs with Chapman and Hall, London.
6. Principles of Inorganic Chemistry, Puri, Sharma and Kalia, 32nd edition, Milestone Publishers, 2014.
7. Modern Inorganic Chemistry, Willam L. Jooly, Magraw-Hill, 1991.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Understand Explain the different types of crystal structures.	1, 3, 5	Understanding
CO-2	Construct the Molecular Orbital (MO) diagram for homo, hetero, and polyatomic molecules.	1, 3	Applying
CO-3	Compare the preparation and properties of noble gas compounds.	1, 2, 3, 4	Analyzing
CO-4	Appraise the properties of nuclear reactions involving fusion and fission.	3, 4	Evaluating
CO-5	Discuss the various types of metal carbonyls.	1, 2, 3	Creating

Relationship Matrix

Semester	Course Code		Title of the Course			Hours			Credits	
I	21PCCH11		Inorganic Chemistry I			75			4	
Course Outcomes (COS)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO3	PLO4	PLO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓	✓	✓	✓		✓		✓
CO-2	✓	✓	✓	✓	✓	✓		✓		
CO-3	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO-4			✓	✓	✓			✓	✓	
CO-5	✓	✓	✓	✓	✓	✓	✓	✓		
	Number of matches (✓) = 37 Relationship = High									

Semester I

Course Title	Organic Chemistry I
Total hrs	75
Hrs/Week	5
Sub. Code	**21PCCH12**
Course Type	DSC-II
Credits	4
Marks	75

General Objective:

To study the basic concepts of reaction intermediates, types of reactions and stereochemistry.

Course Objectives:

CO No.	The learners will be able to
CO - 1	Familiarize themselves with the basic electronic factors, their impact on the acidity and basicity of organic acids and bases.
CO - 2	Analyze the aliphatic nucleophilic and electrophilic substitution reactions besides its role in directing the mechanism.
CO - 3	Categorize the various mechanisms of elimination reactions and its synthetic applications.
CO - 4	Acquire the knowledge of naming reactions.
CO - 5	Understand the tenets of stereochemistry.

UNIT I: REACTION INTERMEDIATES AND ELIMINATION REACTIONS

Reaction Intermediates

Generation, Structure, Stability and Reactivity - Carbocations - Carbanions - Free radicals - Carbenes and Nitrenes.

Elimination Reactions:

The E_2, E_1 and E_1CB Mechanisms, orientation of the double bond, reactivity effects, substrate structures, attacking base, the leaving group and the medium - Saytzeff rule, Pyrolytic syn-elimination, Bredt's rule and Hoffmann rule.

UNIT II: NUCLEOPHILIC SUBSTITUTION REACTIONS

Aliphatic Nucleophilic Substitution Reactions:

SN_2, SN_1 and SN_i Mechanisms, reactivity effects, substrate structure, attacking nucleophile, leaving group and reaction mediums - Neighboring group participations - Neighboring group participation by π and σ bonds - Anchimeric assistance - Phase transfer catalysis - ambient nucleophile and region selectivity.

Aromatic Nucleophilic Substitution Reactions

The SNAr, SN_1 and Benzyne Mechanisms, reactivity effects, substrate structure, attacking nucleophile, leaving group and reaction mediums - The Von-

Richter - Sommelet-Hauser reaction, Sandmeyer reaction and Smile rearrangements.

UNIT III: ELECTROPHILIC SUBSTITUTION REACTIONS

Aliphatic Electrophilic Substitution Reactions

SE_1, and SE_2 Mechanisms, reactivity effects, substrate structure, attacking nucleophile, leaving group and reaction mediums and electrophilic substitution accompanied by double bond shifts

Aromatic Electrophilic Substitution Reactions

Arenium ion mechanisms, reactivity effects, substrate structure, attacking nucleophile, leaving group and reaction mediums - The ortho/para ratio - Ipso attack - Orientation and reactivity in mono-substituted benzene rings - Orientation in benzene rings with more than one substituent - Vilsmeir-Haack reaction - Gattermann-Koch - Reimer-Tiemann and Pechmann condensation reactions.

UNIT IV: NAMING REACTIONS

General nature, method, mechanism and synthetic applications of the following reactions:

Simple Reactions

Michael addition - Darzen's glycidic ester synthesis - Mannich reaction - Dickmann reaction - Birch reduction - Wittig reaction - Knoevanagel reaction - Stobbe condensation - Jones oxidation - Swern oxidation - Vilsmeier-Haack reaction - Mitsunobu reaction.

Coupling reactions

Role of Palladium and Nickel catalyst in organic reactions. Both Pd(0), Ni(0) and Pd(II), Ni(II) complexes are included. Typical reaction involving Heck, Negishi, Suzuki -Miyaura, Sonogashira, Stille and Hiyama coupling for the carbon-carbon bond formation.

UNIT V: STEREOCHEMISTRY I

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 trisubstituted cyclopentane, tri-substituted pentane and tetra-substituted hexane - Description of various types of optically active compounds including allenes, cumulenes, spiranes, biphenyls, trans-cyclooctene.

REFERENCES:

1) Advanced Organic Chemistry Reaction, Mechanism and Structure, Jerry March, 4th Edn., Wiley, 2006.
2) Advanced Organic Chemistry, F. A. Carey and R. J. Sunberg, Plerum.
3) Structure and Mechanism in Organic Chemistry, C. K. Ingold, Correll University Press.
4) Stereo Chemistry - Conformational and Mechanism, Kalsi, New Age International (P) Ltd 2000.
5) Stereo Chemistry of Carbon Compounds, E. L. Elliel, McGraw Hill 1999.
6) Stereo Chemistry, V. M. Potapov, MIR Publications 1979.
7) Reaction Mechanism in organic Chemistry, S. M. Mukherjee and S. P. Singh, Macmillan India Limited, 2009.

8) A Guide book to mechanism in Organic Chemistry, Peter Sykes, ELBS 6th Edn., 2002.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Interpret the various reactions based on carbon intermediates.	1,4,5	Understanding
CO-2	Identify nucleophilic and electrophilic substitution reactions.	1,2,3	Applying
CO-3	Analyze the mechanism of elimination reactions.	1,4,5	Analyzing
CO-4	Appraise the mechanism for various naming reactions.	1,3,5	Evaluating
CO-5	Discuss the basic ideas about stereochemistry.	1,2,4,5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
I	21PCCH12	Organic Chemistry I	75	4

Course Outcomes (COS)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓	✓	✓	✓			✓	✓
CO-2	✓	✓	✓	✓	✓	✓	✓	✓		
CO-3	✓	✓	✓	✓	✓	✓			✓	✓
CO-4	✓	✓	✓	✓	✓	✓		✓		✓
CO-5	✓	✓	✓	✓	✓	✓	✓		✓	✓
	Number of matches (✓) = 41 Relationship = High									

Semester I

Course Title	Physical Chemistry – I
Total hrs	75
Hrs/Week	5
Sub. Code	**21PCCH13**
Course Type	DSC-III
Credits	4
Marks	100

General Objective:

To teach the properties of thermodynamics, various reactions of kinetics and the basic concepts of quantum mechanics

Course Objectives:

CO No.	The learners will be able to
CO - 1	Understand the thermodynamic properties and its relations.
CO - 2	Derive the thermodynamic relations.
CO - 3	Distinguish the kinetics of various reactions.
CO - 4	Explain the theories of reactions.
CO - 5	Discuss the basic concepts of quantum mechanics.

UNIT I CHEMICAL THERMODYNAMICS

Partial Molar quantities - partial molar volume - chemical potential - physical significance - variation of chemical potential with pressure and temperature - Gibbs Duhem equation - application - chemical potential of a pure solid or liquid and pure ideal gas - thermodynamic function and mixing of ideal gases - ΔG_{mix}, ΔS_{mix}, ΔH_{mix}, ΔV_{mix} and ΔA_{mix} Fugacity - determination of fugacity of a real gas (obeying Van der Vaals equation) - Physical significance. Activity - concept of activity - activity coefficient - Maxwell's thermodynamics relation - Applications - Thermodynamics equation of states - Applications.

UNIT II IRREVERSIBLE THERMODYNAMICS AND CHEMICAL EQUILIBRIUM

Irreversible thermodynamics: Onsager Reciprocal relation - Entropy production - Heat flow, Chemical reactions, Open systems- Flux and Force - Microscopic reversibility - Verification of Onsager's relation - Knudsen effect - application of irreversible thermodynamics to biological and non linear systems.

Chemical equilibrium: Law of Mass action – Derivation - De Donder treatment of chemical equilibrium - Thermodynamic relation for chemical affinity - Van't Hoff equation and its significance - Le Chateliars Principle.

UNIT III CHEMICAL KINETICS I

Expression for rate constant of Reversible reaction, Parallel reactions, Consecutive reaction, Chain reaction - Third order reactions- Expression for rate constant - Theories of reaction rates - Perrin's theory - Lindemann's Time-Lag theory - Lindemann's collision mechanism - Postulates, Expression, Limitation - Activated complex theory - Hinshelwood theory - RRK theory - Marcus theory - RRKM theory.

Unit IV CHEMICAL KINETICS II

Kinetics of H_2 + Br_2 ----> 2HBr - Decomposition of acetaldehyde - Decomposition of ethane - Effect of temperature and catalyst on reaction rates - Arrhenius equation- Activation energy - Effect of pressure and volume- Hammond Principle - Ter-molecular reactions - 2NO + Cl_2 ----> 2NOCl.

Reactions in solution - Kinetics, Factors - Bronsted-Bjerrum equation - Primary salt effect - Secondary salt effect- Significance of salt effects - Effect of pressure and volume of activation.

Unit V QUANTUM CHEMISTRY I

Classical wave theory - black body radiation - Planck's quantum hypothesis -Photoelectric effect - Compton effect - Wave-particle duality - de Broglie wave equation - Uncertainty principle - Evidences, Experimental proof and Applications - Bohr's correspondence principle.

Schrodinger wave equation - Wave function - Properties, orthogonality and normalization.

REFERENCES:

1. Physical Chemistry, P. W. Atkins, Oxford University press, 7th Edition, 2002.
2. Physical Chemistry, G. M. Barrow, Tata-McGraw Hill, 5th Edition, 2003.
3. Advanced Physical Chemistry, D. N. Bajpai, S. Chand and Company Pvt Ltd., 2018.
4. Thermodynamics for Chemists, S. Glasstone, D. Van Nostrand, 1965.

5. Thermodynamics A Core Course, R. C. Srivastava, S. K. Saha and A. K. Jain, Prentice-Hall of India, II Edition, 2004.
6. Chemical kinetics, Keith J. Laidler, 198, Pearson.
7. Physical Chemistry, Alberty, R.A., and R.S. Silbey and M.G. Bawendi, 4th Edn., Wiley, 2005.
8. Quantum Chemistry, Donald A. Mcquire, Viva Books, 2011.
9. Quantum Chemistry, A.B. Samigrahi, Books and Allied Pvt. Ltd, 2010.
10. Introductory Quantum Chemistry, A.K. Chandra, 4th Edn., Tata McGraw Hill, 2001.
11. Quantum Chemistry, Ira N. Levin, Edition VI, PHI Learning PVT Ltd., New Delhi, 2009.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Understand the thermodynamic properties and its relations.	1, 3	Understanding
CO-2	Apply irreversible thermodynamics to biological processes.	1, 3, 5	Applying
CO-3	Analyze the rate constants for various reactions.	1, 3, 4, 5	Analyzing
CO-4	Assess the kinetics of chemical reactions.	1, 2	Evaluating
CO-5	Discuss the Schrodinger equation for different systems and find solutions.	1, 3	Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
I	21PCCH13	Physical Chemistry I	75	4

Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓	✓	✓	✓		✓		
CO-2	✓	✓	✓	✓	✓	✓		✓		✓
CO-3	✓	✓	✓	✓	✓	✓		✓	✓	✓
CO-4	✓	✓				✓	✓			
CO-5	✓	✓	✓	✓	✓	✓		✓		
	Number of matches (✓) = 35 Relationship = High									

Semester I

Course Title	Photochemistry
Total hrs	60
Hrs/Week	4
Sub. Code	**21PECH11A**
Course Type	DSE-IA
Credits	4
Marks	100

General Objective:

To familiarize the photochemical pathways of organic molecules, Nano particles and macromolecules in photochemical reactions.

Course Objectives:

CO No.	The learners will be able to
CO - 1	Illustrate the Jablonski diagram in terms of absorption, radiative and radiationless transitions.
CO - 2	Distinguish the different physical processes involved in photochemical reactions.
CO - 3	Explain the photochemical pathways of organic molecules.
CO - 4	Acquire the knowledge of different metals undergoing photochemical excitations.
CO - 5	Comprehend the principle behind semiconductors and the reactions of excitations.

UNIT I PHYSICAL PROCESSES IN PHOTOCHEMISTRY

Laws of photochemistry - Beer-Lamberts law, Grotthus-Draper law, Stark-Einstein law - Jablonski diagram - Internal conversion, Intersystem crossing - Fluorescence - Delayed fluorescence - P-type and E-type - Factors affecting fluorescence - Phosphorescence - Physical relaxation processes - Intramolecular, Intermolecular, electron transfer - Lifetime of excited states - singlet state, singlet radiative excited state, triplet state - Franck Condon Principle.

UNIT II PHYSICAL PROPERTIES AND TECHNIQUES

Physical properties of electronically excited molecules - excited state dipole moment - excited state redox potentials - Quantum yield - Quenching- Stern-Volmer equation and its applications - Experimental techniques in photochemistry - chemical actinometry, flash photolysis, Pulse methods, Phase shift method - Elementary aspects of photosynthesis.

UNIT III ORGANIC PHOTOCHEMISTRY

Thermal and Photochemical reaction - allowed and forbidden transition - Photo sensitization - Photochemistry of excited ketones (acetone, 2-hexanone, benzophenone) - Norrish type I & II reaction - Paterno Buchi reaction - Di π methane rearrangement - Photo reduction - Photochemistry of olefins - cis & trans isomerization.

UNIT IV INORGANIC PHOTOCHEMISTRY

Transition metal complexes - Excited states - Charge transfer, MLCT - Flourescence in inorganic complexes - Photosubstitution - Photoaquation, Photoanation, Photorearrangement - Geometrical isomerization, Racemization, Linkage photoisomerization, Photoexchange - Chemiluminescence in chromium and ruthenium complexes - Metallocenes - TiO_2 - Nanocrystalline, Density of unoccupied acceptor states (DOS).

UNIT V SEMICONDUCTOR PHOTOCHEMISTRY AND NANOPHOTONICS

SEMICONDUCTOR PHOTOCHEMISTRY: Photovoltaic cells - Solar energy, Conversion of solar energy - Dye sensitized conversion - Water splitting-Photocatalysis - Photoinduced Superhydrophilicity.

NANOPHOTONICS: Luminescent nano diamond, Cellular imaging application - Limitations - Upconversion Nanoparticle (UCNP) - Production, characterization, Applications, Limitations.

REFERENCES:

1. Physical, Inorganic Chemistry, Reactions, Processes, and Applications, Andreja Bakac, Wiley Publications, 2010.
2. Fundamentals of Photochemistry, KK. Rohatgi- Mukherjee, New Age International Publishers, 1978.
3. Principles and Applications of Photochemistry, Brian Wardle, Wiley Publications, 2009.
4. Nanochemistry, G. B. Sergeev, Elsevier, 2006.
5. Nanomaterials and Nanochemistry, Catherine Brechignac, Philippe Houdy, Marcel Lahmani, Springer-Verlag Berlin Heidelberg, 2007.
6. Nanomaterials Chemistry, Recent Developments and New Directions, C. N. R. Rao, A. Muller, A. K. Cheetham (edited), Wiley Publications, 2007.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Understand the physical processes involved in photochemistry.	1	Understanding
CO-2	Make use of different techniques to study the photochemical reactions.	1, 3	Applying
CO-3	Analyze the photochemical reactions of organic molecules.	1, 3, 5	Analyzing
CO-4	Appraise the applications of semiconductors and Nano photonics.	1, 3, 4	Evaluating
CO-5	Discuss the photochemical reactions of supra molecules.	1, 2, 3	Creating

Relationship Matrix

Semester	Course Code			Title of the Course			Hours			Credits
I	21PECH11A			Photochemistry			60			4
Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓	✓	✓	✓		✓		
CO-2	✓	✓	✓			✓		✓		
CO-3	✓	✓	✓	✓	✓	✓		✓		✓
CO-4	✓	✓	✓	✓	✓	✓		✓	✓	
CO-5	✓	✓	✓	✓	✓	✓	✓	✓		
	Number of matches (✓) = 35 Relationship = High									

Semester I

Course Title	Medicinal Chemistry
Total hrs	60
Hrs/Week	4
Sub. Code	**21PECH11B**
Course Type	DSE-IB
Credits	4
Marks	100

General Objective:

This Course focuses on the functions of General Anesthetics, Muscle Relaxants, Antipyretic, Analgesics, molecular modeling and drug design.

Course Objectives:

CO No.	The learners will be able to
CO - 1	Understand the role of analogues and lead compounds in drug design.
CO - 2	Outline the basis of molecular modeling and its action.
CO - 3	Acquire the knowledge about anesthetics.
CO - 4	Explain the mode of action of in muscular relaxants.
CO - 5	Comprehend the effects of antipyretic analgesics.

UNIT I DRUG DESIGN

Analogues - Prodrugs - Lead compounds - Narcotic analgesics - Antipyretic analgesics - Antirheumatic drugs - Drug design- Factors, Rational, Method of variation, Disjunction - Revolution - Molecular hybridization - Rigidity and flexibility- Tailoring - Structurally specific drug - Non-specific drug - Thermodynamic activity - Meyer-Overton and Meyer-Hemmi Theory - Ferguson's theory - Vander vaals constant - The cut-off point - Steric factor - Taft's steric factor - Verloop steric parameter - Molar refractivity.

UNIT II MOLECULAR MODELLING AND DRUG DESIGNING

Molecular modeling - Molecular mechanics - Quantum mechanics - Charge and electrostatics - Chemical reactions modeling - Transition inhibitor - 3D structure of macromolecular targets - Structure based drug design - Major steps - Ligand receptor recognition - Active site - Electrostatic and hydrophobic fields- Design of ligands - Visually Assisted Design - Databases - Divide and Rule - Methodologies of Docking.

UNIT III GENERAL ANESTHETICS

Classification - Inhalation anesthetic - Ether, Ethyl chloride, Vinyl ether, Cyclopropane, Chloroform - Intravenous - Thiopental sodium, Ketamine hydrochloride, Thiamylal sodium - Basal anesthetics - Fentanyl Citrate, Tribromo ethanol, Paraldehyde - Mode of action - Stereochemical effects - Ion channel and protein Receptor hypothesis - Mechanism.

UNIT IV MUSCLE RELAXANTS

Classification - Neuromuscular Blocking Drugs - Centrally Acting Muscle Relaxants - Depolarizing Neuromuscular Blocking Drugs - Centrally acting muscle relazant - Substituted Alkanediols and Analogues - Imidazoline analogue - Mechanism of action - Mode of action.

UNIT V ANTIPYRETIC ANALGESICS

Classification - Aniline and p-aminophenol analogue - Paracetamol, Phenacetin, Acetanilide - Salicylic acid analogue - Aspirin, Salol, Salsalate, Sodium salicylate, Salicylamide - Quinoline derivatives - Cincophen, Neocinchophen - Pyrazolones and Pyrazolodiones - Phenazone, Aminophenazone - N-Arylanthranilic acid - Mechanism.

REFERENCES:

1. Medicinal Chemistry, Ashutosh Kar, New Age International Publishers, 2007.
2. The Organic Chemistry of Drug Design and Drug action R. Silverman, (Ed) Academic Press, 2004.
3. Organic Chemistry, I.L. Finar, Vol II, ELBS, 1975.
4. Burger's Medicinal Chemistry and Drug Discovery Vol. - I, 5thEdn. John Wiley & Sons, New York, 1995.
5. Chemistry of organic drugs, V.Vaidhyalingam. I Edn. (Thailambigai Publications), 2000.
6. An introduction to Medicinal Chemistry, Graham L.Patrick, Oxford University press, New York, 1995.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Understand the concepts of drug design.	1, 2	Understanding
CO-2	Apply the molecular modeling to design new drugs.	1, 2, 3, 4, 5	Applying
CO-3	Classify anesthetics based on their administration.	1, 2	Analyzing
CO-4	Explain the actions of muscle relaxants.	1, 2	Evaluating
CO-5	Design the mechanism of analgesics.	2, 3, 5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
I	21PECH11B	Medicinal Chemistry	60	4

Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓			✓	✓			
CO-2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO-3	✓	✓	✓			✓	✓			
CO-4	✓	✓	✓			✓	✓			
CO-5		✓	✓	✓	✓		✓	✓		✓
	Number of matches (✓) = 32 Relationship = Medium									

Semester I

Course Title	Chemistry of Corrosion
Total hrs	60
Hrs/Week	4
Sub. Code	**21PECH11C**
Course Type	DSE-IC
Credits	4
Marks	100

General Objective:

To grasp the ideas about mechanism and prevention of corrosion.

Course Objectives:

CO No.	The learners will be able to
CO - 1	Understand the concept of corrosion.
CO - 2	Outline the mechanism of corrosion.
CO - 3	Acquire the knowledge about passivity.
CO - 4	Explain the factors affecting atmospheric and soil corrosion.
CO - 5	Comprehend the preventive measures of corrosion.

UNIT I CORROSION

Definition - Importance - Risk management - Causes – Pilling-Bed worth Ratio - Dry cell analogy - Cathode and Anode - Types of cells - Corrosion damage - Change in Gibbs free energy - Measurement of EMF, pH and Half cell potential - Hydrogen electrode - Oxygen electrode - Galvanic series - Liquid Junction Potential - Reference electrodes - Calomel, Silver-Silver chloride, Saturated Copper-Copper sulphate electrodes.

UNIT II THERMODYNAMICS AND KINETICS OF CORROSION

Pourbaix Diagrams - Water, Iron, Aluminium, Magnesium - Limitations - Polarization - Polarized cell - Measurement - Causes - Hydrogen overpotential - Polarization diagram - Corrosion rate - Calculation - Anode-Cathode area ratio - Electrochemical Impedence Spectroscopy - Cathodic protection.

UNIT III PASSIVITY

Definition - Characteristics - Flade potential - Passivators - Iron and Nitric acid - Anodic protection and transpassivity - Theories -Passive films - Passive-Active cells - Critical Pitting potential - Critical Pitting temperature - Alloys - Nickel-Copper alloys - Cathodic polarization and catalysis.

UNIT IV ATMOSPHERIC AND SOIL CORROSION

Atmospheric corrosion: Types of atmospheres - Corrosion-product films - Factors - Particulate matter - Gases - Moisture - Remedial measures.

Soil corrosion: Factors - Bureau of standard tests - Pitting characteristics - Stress-corrosion cracking - Remedial measures.

UNIT V PREVENTION OF CORROSION

Metallic coatings - Methods of application - Classification - Nickel, Lead, Zinc, Cadmium, Tin, Chromium, Aluminium - Inorganic coatings - Vitreous enamel, Portland cement, Chemical conversion - Organic coatings - Paints, Wash primer, Aluminium and zinc coating, Plastic lining.

REFERENCES:

1. Corrosion and corrosion control: An introduction to Corrosion science and engineering (4th ed.), H. H. Uhlig and R. W. Revie, John Wiley & Sons, 2008.
2. Corrosion science and Technology, Third Edition, DavidE.J.Talbot James D.R. Talbot, CRC, Taylor and Francis group, 2018.
3. Corrosion Inhibitors: Principles and Applications, V.S, Sastri, John Wiley & Sons, 1998.
4. Handbook of corrosion engineering, SIecond edition, PierreR.Roberge, McGraw- Hill Education, 2012.
5. Michael Dornbusch, Corrosion analysis, CRC Press, 2019.
6. Coatings Technology Handbook, Arthur A. Tracton, CRC Press 2005.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Understand the importance and causes of corrosion.	1, 2	Understanding
CO-2	Apply the theories of thermodynamics and kinetics to corrosion of metals.	1, 2, 3, 4, 5	Applying
CO-3	List out the characteristics of passivation.	1, 2	Analyzing
CO-4	Explain the remedial measures to prevent atmospheric and soil corrosion.	1, 2	Evaluating
CO-5	Discuss the different methods of corrosion.	2, 3, 5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
I	21PECH11C	Chemistry of Corrosion	60	4

Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓			✓	✓			
CO-2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO-3	✓	✓	✓			✓	✓			
CO-4	✓	✓	✓			✓	✓			
CO-5		✓	✓	✓	✓		✓	✓		✓
	Number of matches (✓) = 32 Relationship = Medium									

Semester I

Course Title	Inorganic Chemistry Practical - I
Total hrs	60
Hrs/Week	4
Sub. Code	**21PCCH1P1**
Course Type	Practical-I
Credits	2
Marks	100/2

General Objective:

To acquire practical skills in semi micro analysis and complexometric titration in inorganic chemistry

Course Objectives:

CO No.	The learners will be able to
CO - 1	Obtain practical skills in semi micro qualitative analysis of familiar and less familiar metal ions.
CO - 2	Understand the principles of qualitative analysis.
CO - 3	Demonstrate the laboratory techniques applied for the estimation of metals.
CO - 4	Apply the precipitation and filtration techniques in complexometric titrations.
CO - 5	Comprehend the chemistry behind the formation of Inorganic complexes.

I. Inorganic semi-micro qualitative analysis

Analysis of mixture containing two familiar and two less familiar cations

Group I less familiar Cations: W and Tl

Group II less familiar Cations: Se and Mo

Group III less familiar Cations: Zr, Ce and V

Group VI less familiar Cations: Li

Minimum 8 mixtures of inorganic compounds should have been analyzed.

II. Complexometric Titrations (A minimum of four)

1. Estimation of Copper in the presence of Lead
2. Estimation of Copper in the presence of Nickel
3. Estimation of Copper in the presence of Zinc

4. Estimation of Copper in the presence of Iron
5. Estimation of Zinc in the presence of Barium

REFERENCES:

1. Vogel's Qualitative Inorganic Analysis, 7th edition, Pearson, 2006.
2. College Practical Chemistry, V.K. Alhuvalia, Sunita Dingra, 1- Edition, University Press, 2005.
3. A Collection of Interesting General Chemistry Experiments, A. J. Elias, University Press, 2002.
4. Inorganic Chemistry Practical, Deepak Pant, e-book, Book-Rix edition, 2004.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Outline the methodology of semi micro analysis.	1, 2, 4	Understanding
CO-2	Make use of complexometric titrations to estimate the amount of ions.	1, 2, 3	Applying
CO-3	Analyze the methodology of complex preparation.	1, 2	Analyzing
CO-4	Classify the familiar and less familiar cations.	1, 5	Analyzing
CO-5	Predict the group of cations.	1, 2	Creating

Relationship Matrix

Semester	Course Code	Title of the Course					Hours			Credits
I	21PCCH1P1	Inorganic Chemistry Practical - I					60			2
Course Outcomes (COS)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓	✓	✓	✓	✓		✓	
CO-2	✓	✓	✓	✓	✓	✓	✓	✓		
CO-3	✓	✓	✓			✓	✓			
CO-4	✓	✓	✓	✓	✓	✓				✓
CO-5	✓	✓	✓			✓	✓			
	Number of matches (✓) = 33 Relationship = Medium									

Semester I

Course Title	Physical Chemistry Practical - I
Total hrs	60
Hrs/Week	4
Sub. Code	**21PCCH1P2**
Course Type	Practical-II
Credits	2
Marks	100/2

General Objective:

To experiment with the principles of kinetic, surface reactions and interpret the results.

Course Objectives:

CO No.	The learners will be able to
CO - 1	Acquire the skill of handling the instruments.
CO - 2	Explain the kinetics of reaction.
CO - 3	Analyze the surface reactions of adsorption.
CO - 4	Define the solubility of salts.
CO - 5	Develop the skill of using software.

1. Estimation of acetic acid and sodium acetate in the buffer conductometrically.
2. Estimation of strengths of strong and weak acid in a mixture conductometrically.
3. Precipitation titration of Barium chloride against Magnesium sulphate by conductometry.
4. Estimation of strengths of strong and weak acid in a mixture by potentiometric method.
5. Determination of dissociation constant of a weak acid by potentiometric method.
6. Verification of Ostwald's dilution law.
7. Study of distribution of benzoic acid.
8. Comparison of acid strength by ester hydrolysis.
9. Adsorption of acetic acid on activated charcoal - verification of Freundlich and Langmuir isotherms, determination of unknown concentration.
10. Kinetics of persulphate - iodide reaction in solution.
11. To study the effect of ionic strength on the solubility of $CaSO_4$ and to determine its thermodynamic solubility product and mean ionic activity.

12. Avogadro software (Course work). Draw simple molecules using Avogadro software- H_2O, CO_2, Acetaldehyde, Formaldehyde, methane, acetone.

REFERENCES:

1. Advanced Physical Chemistry Experiments, Dr. J. N. Gurtu, Pragati Prakashan, 2008.
2. College Practical Chemistry, H.N. Patel, S. P. Turakhia, S. S. Kelkar, N. S. Israney, S. R. Puniyani, Himalaya Publishing House, 2010.
3. Practical Physical Chemistry, Alexander Findlay, Longmans Green and co, London, 7th edition, 2012.
4. Physical Chemistry Laboratory, L. Peter Gold, McGraw-Hill PVT Ltd., 1997
5. Experimental Physical Chemistry: A Laboratory Textbook, Arthur Halpern, George McBane, 2006.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Explain the principles of conductometric and potentiometric titrations.	1, 3	Understanding
CO-2	Apply the concept of adsorption to determine unknown concentrations.	1, 2	Applying
CO-3	Analyze the dissociation constants of weak acids.	1, 3, 4, 5	Analyzing
CO-4	Evaluate the solubility of salts on the basis of ionic strengths.	1, 3	Evaluating
CO-5	Design the structure of molecules using software.	1, 3, 5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours		Credits		
I	21PCCH1P2	Physical Chemistry Practical- I				60		2		
Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓	✓	✓	✓		✓		
CO-2	✓	✓	✓			✓	✓			
CO-3	✓	✓	✓	✓	✓	✓		✓	✓	✓
CO-4	✓	✓	✓	✓	✓	✓		✓		
CO-5	✓	✓	✓	✓	✓	✓		✓		✓
	Number of matches (✓) = 36 Relationship = High									

Semester - I

Course Title	**Analytical Biochemistry**
Total hrs	30
Hrs/Week	2
Sub. Code	**21PICH11**
Course Type	IDC-I
Credits	2
Marks	100/2

General Objective:

To inquire knowledge about spectroscopic, separation and electroanalytical methods of biomolecules.

Course Objectives:

CO No.	**The learners will be able to**
CO - 1	Understand the principles of analytical biochemistry
CO - 2	Apply the principle of spectroscopy.
CO - 3	Analyze the carbohydrates.
CO - 4	Explain the amino acid,its properties and analysis.
CO - 5	Discuss the detection and analysis of isotopes.

UNIT I: PRINCIPLES OF ANALYTICAL BIOCHEMISTRY

Selection of methods - Instrumental methods - Physiological methods, Assay kits. Quality of data - errors - Random and systematic errors - Assessment - Quality assurance - Calibration - Graphical representation.

UNIT II: SPECTROSCOPY

Principle and applications of Colorimetry, Spectrophotometry and Flame Photometry.

UNIT III: SEPARATION METHODS

Rf values, Factors affecting R_f values, Experimental procedures of Thin layer Chromatography and Paper Chromatography - Choice of paper - Choice of adsorbents - solvent systems - Preparation of plates - developments of chromatogram - Detection of the spots- Applications of TLC and Paper in separation of carbohydrates and amino acids.

UNIT IV: ELECTROANALYTICAL METHODS

Principle and applications - Conductometry, Coulometry, voltammetry.

UNIT V: RADIOISOTOPES

Types of radioisotopes - detection and measurement - Geiger, scintillation - Autoradiography - biochemical uses- Traces, isotope dilution analysis, radio activation analysis.

REFERENCES:

1. Analytical biochemistry, Third Edition, David, J. Holme and Hazel Peck, Pearson education, 1998.
2. Introduction to practical biochemistry, Gyorgy Hegyl Et.al., 2013.
3. Principles and techniques of biochemistry and molecular biology, 7th Edition, Keith Wilson, John Walker, Cambridge University press, 2010.
4. Bioanalytical Techniques" by Abhilasha Shourie and Shilpa S Chapadgaonkar, The Energy and Resources Institute, TERI, 25 March 2015.
5. Bioanalytical Techniques" by M L Srivastava, Alpha Science International Ltd; 1st edition, 30 January 2008.
6. Immunoassay and Other Bioanalytical Techniques" by Jeanette M van Emon, CRC Press; 1st edition, 19 December 2006.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Understand the analytical methods of biomolecules analysis.	1, 2	Understanding
CO-2	Apply the spectroscopic methods to analyze biomolecules.	1, 2	Applying
CO-3	Distinguish between the compounds using chromatography.	1, 3, 5	Analyzing
CO-4	Explain the principles of electroanalytical methods.	1, 4, 5	Evaluating
CO-5	Predict the radioisotopes present in the sample.	1, 2, 5	Creating

Relationship Matrix

Semester	Course Code			Title of the Course			Hours			Credit
I	21PICH11			Analytical Biochemistry			30			2
Course Outcomes (COS)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓			✓	✓			
CO-2	✓	✓	✓			✓	✓			
CO-3	✓	✓	✓	✓	✓	✓		✓		✓
CO-4	✓	✓	✓	✓	✓	✓			✓	✓
CO-5	✓	✓	✓	✓	✓	✓	✓			✓
	Number of matches (✓) = 34 Relationship = High									

Semester II

Course Title	Inorganic Chemistry - II
Total hrs	75
Hrs/Week	5
Sub. Code	**21PCCH21**
Course Type	DSC-IV
Credits	4
Marks	100

General Objective:

To expose themselves to coordination complexes, its structure, reactions and mechanisms.

Course Objectives:

CO No.	The learners will be able to
CO - 1	Comprehend the structure of coordination complexes.
CO - 2	Explain the kinetics of the reactions in coordination complexes.
CO - 3	Sketch the structure and reactions of square planar and octahedral complexes.
CO - 4	Illustrate the stability constant of coordination complexes using various methods.
CO - 5	Evaluate the nucleophile reaction in coordination chemistry.

UNIT I: COORDINATION CHEMISTRY-I

Geometrical structure - Different coordination numbers - Coordination number 2 - Linear - $(CuCl_2]^{2-}$, coordination number 3 - Trigonal planar - $[HgI_3]^-$

Coordination number 4 - Tetrahedral - $[BeF_4]^{2-}$, $Cu[SP(Me_3)_3]^+$, $[Cu(SP(CH_3)_3)Cl]_3$, $[(CH_3CN)CuN_2C_{12}H_6(CH_3)_2]PF_6$, square planar complexes - $[Ni(CN)_4]^{2-}$N, $[Pt(Cl)_4]^{2-}$. Coordination number 5 - Tirgonal bipyramid - $Fe(CO)_5$, $[MoCl_5]^-$, Square pyramid complexes - $[SbF_5]^{2-}$, $[Ni\{(C_6H_5)_3P\}_2Br_3]^-$. Coordination number 6 - Octahedral - $[FeF_6]^{3-}$, $[SbF_6]^-$, $[PtF_6]^-$.

Coordination number 7 - Pentagonal bipyramidal - $[UO_2F_5]^{3-}$ - Distorted octahedral - $[NbOF_6]^{3-}$ - Trigonal prism - $[TaF_7]^{2-}$. Coordination number 8 - cubic - $[UF_8]^{3-}$ - square antiprism - $[TaF_8]^{3-}$ - Dodecahedral - $[Mo(CN)_8]^{4-}$

UNIT II: COORDINATION CHEMISTRY-II

Crystal Field theory (CFT) - Important features - Effects - atomic radii - lattice energy - Geometry of coordination complexes - Crystal field Splitting of d - orbitals in octahedral, tetragonal, square planar and tetrahedral complexes - Crystal field splitting energy (CFSE) values - factors affecting the value of Δ - Application - colour, spectral and magnetic properties.

Jahn Teller Effect distortion - Effect - Electronic spectra of complexes - $[CuL_6]^{2+}$

Isomerism - Structural isomerism - $Co(NH_3)_5BrSO_4$ - Hydrate isomerism - $CrCl_3.6H_2O$ - Coordination isomerism - $[Cu(NH_3)_4][PtCl_4]$ and $[Pt(NH_3)_4][CuCl_4]$ - Linkage isomerism - $[Co(NO_2)(NH_3)_5]Cl_2$ and $[Co(ONO)(NH_3)_5]$ - Coordination position isomerism - Di-Cobalt bridged complexes.

UNIT III: COORDINATION CHEMISTRY-III

Stereo isomerism - Geometrical isomerism - Coordination number 4 - Ma_2b_2 type (cis and trans form of $[PtCl_2(NH_3)_2]$), Ma_2bc type (cis and trans form of [Pt(py)2NH3Cl]), Mabcd type ($[Pt(NO_2)(C_2H_5N)(NH_3)(NH_2OH)]^+$), $[M(ab)_2]$ type - Cis and trans form of $[Pt(gly)_2]$. Coordination number 6 - $Ma_4b_2/Ma_2b_4/Ma_4bc$ type - cis and trans form of $[CrCl_2(NH_3)_4]^+$, Ma_3b_3 type (cis and trans form of $[RhCl_3(Py)_3]$), $[M(aa)_2b]$ type (cis and trans form of $[Co(en)_2Cl_2]^+$ ion.

Substitution reactions in octahedral and square planar complexes - S_N1, S_N2, S_N1CB reaction - Labile and inert complexes - Interpretation of lability and inertness of transition metal complexes by CFT - Crystal field activation energy (CFAE) with SN1 and S_N2 reaction - Acid and base hydrolysis of octahedral complexes - Substitution reaction in square planar complexes.

UNIT IV: COORDINATION CHEMISTRY - IV

Trans effect - π bonding theory - Electron transfer reaction - Outer sphere and inner sphere mechanism.

Thermodynamic stability - Stepwise stability constant and overall stability constant. Factors affecting stability of complexes in solution - Irving-Williams series- Determination of stability constant by Bjerrum method, spectrometric method and Job's method - Comparison of thermodynamic and kinetic stability. Molecular Orbital Approach - σ and π bonding in octahedral, tetrahedral and square planar complexes -Electronic and steric effect of complexes, Symbiosis.

UNIT V: COORDINATION CHEMISTRY - V

Russell Saunders states - jj coupling, Spin-spin coupling, Orbit-orbit coupling, Spin-orbit coupling - Term symbols- Selection rule for electronic transitions - Spin selection, Laporte selection- Width of spectra- Correlation diagram - Orgel diagram - Racah parameters - Tanabe-Sugano (TS) diagram - Evaluation Δ of β and values for d^2 and d^3 systems - Electronic spectrum of d^2, d^3, d^4, d^5, d^6, d^7, d^8 and d^9 complexes- Charge transfer spectra - Ligand to Metal Charge Transfer (LMCT) - Electronic spectra of lanthanides and actinides - Magnetic properties of complexes.

REFERENCES:

1. Advanced Inorganic Chemistry, F. A. Cotton, R. G. Wilkinson, 6thEdn., Wiley, 1996.
2. Inorganic Chemistry - Principles, structure and reactivity, IV edition, James E. Huheey, Ellen A Keitier, Richard LKeiter Pearson Publication (2012).
3. Solid State Chemistry and its Applications, A.R. West, Wiley, 1984.
4. Concise Inorganic Chemistry, J. D. Lee, Elbs with Chapman and Hall, London.
5. Principles of Inorganic Chemistry, Puri, Sharma and Kalia, 31st edition, Milestone Publishers.
6. Modern Inorganic Chemistry, Willam L. Jooly, Magraw-Hill, 1991.
7. Principles of Inorganic Chemistry, Puri, Sharma, Kalia, 33rd edition, Vishal publishing, 2016.
8. Selected Topics in inorganic Chemistry, Wahid U. Malik, G.D. Tuli, R.D. Madan, S. Chand, 8th edition, 2018.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Outline the nomenclature and isomerism of complexes.	1	Understanding
CO-2	Identify the crystal field splitting in different geometries.	2, 3, 5	Applying
CO-3	Compare the substitution reactions of complexes.	1, 2, 3, 4	Analyzing
CO-4	Assess the stability of complexes.	1, 3, 4	Evaluating
CO-5	Predict the structure of coordination complexes.	1, 3	Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
II	21PCCH21	Inorganic Chemistry - II	75	4

Course Outcomes (COS)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓			✓				
CO-2		✓	✓	✓	✓		✓	✓		✓
CO-3	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO-4	✓	✓	✓	✓	✓	✓		✓	✓	
CO-5	✓	✓	✓	✓	✓	✓		✓		
	Number of matches (✓) = 35 Relationship = High									

Semester - II

Course Title	Organic Chemistry - II
Total hrs	75
Hrs/Week	5
Sub. Code	**21PCCH22**
Course Type	DSC-V
Credits	4
Marks	100

General Objective:

This Course teaches the basic concepts in pericyclic reactions and newer methodologies in organic reactions using various organic reagents.

Course Objectives:

CO No.	The learners will be able to
CO - 1	Understand the stereochemistry of organic molecules.
CO - 2	Classify the types of reactions and the reagents employed in the oxidation and reduction reactions.
CO - 3	Acquire knowledge of synthons and synthetic methodologies.
CO - 4	Illustrate the mechanisms of rearrangement reactions.
CO - 5	Explain the pericyclic reactions.

UNIT I: STEREOCHEMISTRY II

Compounds containing two asymmetric centres - *Erythro* and *threo* isomers - Conversion of Fischer projection into perspective forms - *Erythro* and *Threo*-Inter conversion of Fischer to Sawhorse and Newman projections - Zig-Zag representation of glucose-Interpretation of homotopic, enantiotopic and diastereotopic atoms and faces - Prochiral chiral carbon - R & S nomenclature of simple compounds, allenes, spiranes and biphenyls - Stereospecific and Stereoselective reactions - Asymmetric Synthesis-Crams rule - Conformational analysis of cyclohexane - Conformational analysis of di-substituted cyclohexanes.

UNIT II: OXIDATION AND REDUCTION REAGENTS

OXIDATION REAGENTS

Oxidation with Cr and Mn reagents - Oxidation with LTA, DDQ and SeO_2 - Oxidation uses DMSO either with DCC or Ac_2O or Oxalyl chloride - Oxidation using Dess Martin reagent - Hydroxylation of olefinic double bonds (OsO_4, $KmnO_4$) - Woodward and Prevost oxidation - Epoxidation using peracids including Sharpless epoxidation, Ozonolysis.

Reduction Reagents

Reduction with $NaBH_4$, $LiAlH_4$, $Li(tBuO)_3AlH$, DIBAL-H, Red-Al, Et_3SiH and Bu_3SnH- Reduction using selectrides - Birch reduction - Hydrogenation (homogenous and heterogeneous) - hydration of carbon-carbon double and triple bonds. Asymmetric reduction of carbonyl functions (Corey's procedure).

UNIT III: NOVEL REAGENTS IN ORGANIC REACTIONS

Application of following d & p block elements in organic synthesis: Synthetic utility of Samarium iodide, Ruthenium (Ring Closing Metathesis-RCM) Zirconium (Schwartz's reagent) and Cobalt (Pauson-Khand reaction and Nicholas reaction) in organic synthesis - Asymmetric Reformatsky reaction using Samarium - Homogeneous hydrogenation - Application of Titanium in organic synthesis - Mc Murry coupling - Tin in organic synthesis - Use of Bu_3SnH and Tin mediated carbon-carbon bond formation in the synthesis of cyclic and acyclic molecules.

UNIT IV MOLECULAR REARRANGEMENTS:

Mechanism of the following rearrangements: Beckmann, Curtius, Hoffmann, Schmidt, Lossen, Wolff, Pinacol, Wagner Meerwin, Demyanov, Dienone-Phenol, Favorski, Benzidine, Claisen, Cope, Sommlet-Hauser, Pummerer rearrangements.

UNIT V PERICYCLIC REACTIONS

Electrocyclic reactions: Conrotatory and disotatory motions in (4n) and (4n+2) - allyl systems and secondary effects - Cycloadditions: Antarafacial and Suprafacial additions - Notation of cycloaddition of (4n) and (4n+2) systems - Secondary effects of substituents on the rates of cycloaddition reaction and chelotropic reactions - Sigmatropic reactions: Suprafacial and antarafacial shifts - Retention and inversion of configurations - Claisen and Cope rearrangements.

REFERENCES:

1) Advanced Organic Chemistry Reaction, Mechanism and Structure, Jerry March, 4th Edn., Wiley, 2006.
2) Heterocyclic Chemistry, Raj K. Bansal, 5th Edition, New Age International (Pvt.Ltd), 2006.
3) Reaction Mechanism in organic Chemistry, S. M. Mukherjee and S. P. Singh, Macmillan India Limited, 2009.
4) Carruthers, W., Some Modern Methods of Organic Synthesis, Cambridge University Press, 1987.
5) Sanyal, S. N., Reactions, Rearrangements & Reagents, Bharati Bhavan, 2004.
6) A Guide Book to mechanism in Organic Chemistry, P. Sykes, Orient Londman, 1989.
7) Advanced Organic Chemistry Reaction, Mechanism and Structure, Jerry March, 4th Edn., Wiley, 2006.
8) Advanced Organic Chemistry, F. A. Carey and R. J. Sunberg, Plerum, 5th edition, Springer Publication, 2007.
9) Structure and Mechanism in Organic Chemistry, C. K. Ingold, Correll University Press, 1953.
10) Organic Chemistry, J. Clayden, N. Greeves, S. Warren, P. Wothers, Oxford University Press, 2004.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Outline the basic idea about stereochemistry.	1, 2, 3, 5	Understanding
CO-2	Choose different reagents for oxidation and reduction.	1, 2	Applying
CO-3	List out the uses of reagents in organic synthesis.	3, 4, 5	Analyzing
CO-4	Explain the mechanisms of molecular rearrangements reactions.	1, 2, 5	Evaluating
CO-5	Construct the pathways of pericyclic reactions.	3, 4, 5	Creating

Relationship Matrix

Semester	Course Code			Title of the Course				Hours		Credits
II	21PCCH22			Organic Chemistry II				75		4
Course Outcomes (COS)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓	✓	✓	✓	✓	✓		✓
CO-2	✓	✓	✓			✓	✓			
CO-3			✓	✓	✓			✓	✓	✓
CO-4	✓	✓	✓	✓	✓	✓	✓			✓
CO-5			✓	✓	✓			✓	✓	✓
	Number of matches (✓) = 34 Relationship = High									

Semester - II

Course Title	Physical Chemistry – II
Total hrs	75
Hrs/Week	5
Sub. Code	**21PCCH23**
Course Type	DSC-VI
Credits	4
Marks	75

General Objective:

To explore the concepts of Electrochemistry, Statistical Thermodynamics and applications of Quantum Theory.

Course Objectives:

Co. No	The learners will be able to
CO - 1	Explain the theory of strong electrolytes.
CO - 2	Outline the application of electro chemistry.
CO - 3	Understand the electrode processes.
CO - 4	Analyze the relation between partition functions and thermodynamic properties.
CO - 5	Interpret the wave function and operators in Quantum Chemistry.

UNIT I ELECTROCHEMISTRY I

Debye-Huckel theory of strong electrolytes - derivation and verification - Activity coefficient of electrolytes - activity coefficient - ionic strength - Debye Huckel Limiting Law - derivation and verification - Determination of solute activities from solvent activities - Bjerrum's theory of ion association in electrolyte solution - Electrified interfaces - thermodynamic treatment - electrical capacitance. Determination of the surface excess - Structure of the electric field - Helmholtz - Perrin Model, Gouy - Chapmann diffusion model and Stern Model.

UNIT II ELECTROCHEMISTRY II

Kinetics of electrode reaction - Buttler Volmer equation - Tafel equation - Diffusion over potential. Irreversible electrode process - Overvoltage - Applications - electro deposition - corrosion - Polarography - Concentration potential - DME assembly - Advantages - Ilkovic equation - Derivation - Half-wave potential - Amperometric and coloumetric titration - Electrolyte concentration cells- with and

without transference - EMF measurements - Activity coefficients of electrolytes, transport number, solubility product.

UNIT III STATISTICAL THERMODYNAMICS I

Partition functions - Translational, Rotational, Vibrational and Electronic- Relation between thermodynamic functions and partition functions - Internal energy, heat capacity, entropy, work function, enthalpy, Gibbs free energy and chemical potential - Phase space - stirlings approximation - Micro and macro states - Statistical weight factor- Configuration - Ensemble - Types - Ensemble average and time average of property.

UNIT IV STATISTICAL THERMODYNAMICS II

Boltzmann distribution law - Kinetic theory of gases - Translational kinetic energy- Translational entropy - Equipartition of energy - Statistical theory of specific heat, Diatomic molecules - Rotational heat capacity for hydrogen molecule - Heat capacity of solid - Types of statistics - Maxwell-Boltzmann, Bose-Einstein, Fermi- Dirac.

UNIT V QUANTUM CHEMISTRY II

Operators – Vector - Laplacian - Hermitian - Unity - Projection parity - Ladder operator and density operator.

Postulates of Quantum mechanics - Applications of quantum mechanics - 1D, 3D box - degeneracy - Tunneling - Simple Harmonic Oscillator, Rigid rotor.

Radial and Angular part of wave function - Electron spin - Wave function for hydrogen atom - Slater determinants - Angular momentum in many electron system.

REFERENCES:

1. Physical Chemistry, P. W. Atkins, Oxford University press, 7th Edition, 2002.
2. Physical Chemistry, G. M. Barrow, Tata-McGraw Hill, 5th Edition, 2003.
3. Advanced Physical Chemistry, D. N. Bajpai, S. Chand and Company Pvt Ltd., 2018.
4. Principles of Physical Chemistry, Puri, Sharma and Pathania, Vishal Publications, 2008.
5. Principles and Applications of Electrochemistry, Crow, D.R., Chapman and Hall, 1988.
6. Electrochemistry, Reiger, P.H., Chapman and Hall, 2nd Edn., 1983.
7. Quantum Chemistry, Donald A. Mcquire, Viva Books, 2011.
8. Quantum Chemistry, A.B. Samigrahi, Books and Allied Pvt. Ltd, 2010.
9. Introductory Quantum Chemistry, A.K. Chandra, 4th Edn., Tata McGraw Hill, 2001.
10. Quantum Chemistry, Ira N. Levin, Edition VI, PHI Learning PVT Ltd., New Delhi, 2009.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Explain theories of electrolytes.	1, 2	Understanding
CO-2	Apply the knowledge of reduction potential to prevent corrosion.	1, 3, 4	Applying
CO-3	Analyze the relations between partition functions and thermodynamic properties.	1, 2	Analyzing
CO-4	Assess the population of states using Boltzmann distribution law.	1, 3, 5	Evaluating
CO-5	Discuss the applications of quantum mechanics.	1, 3, 5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
II	21PCCH23	Physical Chemistry II	75	4

Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓			✓	✓			
CO-2	✓	✓	✓	✓	✓	✓		✓	✓	
CO-3	✓	✓	✓			✓	✓			
CO-4	✓	✓	✓	✓	✓	✓		✓		✓
CO-5	✓	✓	✓	✓	✓	✓		✓		✓
	Number of matches (✓) = 34 Relationship = High									

Semester - II

Course Title	**Analytical Chemistry**
Total hrs	60
Hrs/Week	4
Sub. Code	**21PECH21A**
Course Type	DSE-IIA
Credits	4
Marks	100

General Objective:

To classify the different types of chromatographic techniques, ~~learn~~ the principle and applications of Turbidimetry, Nephelometry, Fluorometry and Spectrophotometry techniques.

Course Objectives:

CO No.	**The learners will be able to**
CO - 1	Acquire the knowledge about thermal behavior of materials.
CO - 2	Obtain the knowledge about surface morphological characterization and poloarography.
CO - 3	Apply the knowledge of the separation of compounds by HPLC and Ion exchange chromatography in industrial applications.
CO - 4	Classify the types of errors in statistical analysis.
CO - 5	Discuss the principles and applications of atomic spectroscopy, Nephelometry and Fluorometry.

UNIT I: SEPARATION TECHNIQUES

Separation techniques – Types, Principle, application - Precipitation method - separation of sulphides, hydroxides - Fractional precipitation - organic precipitation - Dimethyglyoxime, Cupferron - pH range for metal oxinates - volatilization - Determination of carbondioxide, pure silica; Electrolytic separation - metal - Controlled cathode potential - Distillation, Filtration. Solvent extraction - synergistic extraction.

UNIT II: **THIN LAYER CHROMATOGRAPHY**

TLC - Principle - factors affecting Rf values - Experimental Procedures -

Choice of adsorbents and solvents - Preparation of plates - Development of the Chromatogram - Detection of the spots - Advantages of thin Layer Chromatography - Applications - Determination of aspirin, phenacetin, caffeine mixture.

UNIT III: **PAPER CHROMATOGRAPHY**

Paper chromatography - Types of paper, Rf values, Factors affecting Rf values, Experimental procedures, solvent systems, developments of chromatogram - Detection of the spots. Ascending, Descending and Radial Paper Chromatography, Two-Dimensional Chromatography -Applications.

UNIT IV: THERMAL ANALYSIS

Principle, instrumentation, application - Thermo Gravimetric Analysis (TGA) - Factors affecting TGA - TGA of Calcium oxalate monohydrate

Differential Thermal Analysis (DTA) - DTA analysis of Calcium oxalate monohydrate, sulphur, polymer - Comparison of DTA and TGA curves. Differential scanning calorimetry (DSC).

UNIT V: TUBIDIMETRY, FLUOROMETRY, SPECTROPHOTOMETRY

Principle, instrumentation, applications - Turbidimetry, nephelometry, fluorometry, UV-visible spectrophotometry - single beam, double beam spectrophotometers.

REFERENCES:

1) Vogel's textbook of Quantitive chemical analysis, G.H.Jeffery, J. Bassett, J. Mendham, R.C. Denney, Longman Scientific & Technical, John wiley & Sons, New York, 1989.
2) Principles of Instrumental Analysis, Douglas A. Skoog, F. James Holler, Stanley R. Crouch, 2006.
3) Instrumental Methods of Analysis - B. K. Sharma, 2003; Goel publishing House, Meerut.
4) Contemporary Chemical Analysis - Judith F. Rubinson, Prentice Hall (India).
5) Instrumental Methods of Analysis Hobart H. Willard, Lynne L. Merritt Jr, John Dean, Wadsworth Publishing Co Inc; 7th Edn., 1988.
6) Thin Layer Chromatography- A laboratory Handbook, Ashworth, Stahl. E., 1st Edn., Springer-Verlag, 1969.
7) Dynamics of Chromatography - Principles and Theory, J. Calvin Giddings, CRC Press, 2002.
8) Chromatographic methods, Braithwaite. A, Smith F.J, Springer, 1999.
9) Particles size distribution, Assessment and characterization, Theodore Provder, Editor, ACS, Washington, 1990.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Outline the separation methods.	1, 3	Understanding
CO-2	Experiment with the working of TEM and SEM.	1, 2, 4	Applying
CO-3	Analyze the theory behind Atomic Absorption Spectroscopy, Nephelometry, Fluorometry and Flame photometry.	1, 2, 4, 5	Analyzing
CO-4	Explain the DTA curves.	2, 4	Evaluating
CO-5	Choose the appropriate resin for effective separation.	1, 2, 4	Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
II	21PECH21A	Analytical Chemistry	60	4

Course Outcomes (COS)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓	✓	✓	✓		✓		
CO-2	✓	✓	✓	✓	✓	✓	✓		✓	
CO-3	✓	✓	✓	✓	✓	✓	✓		✓	✓
CO-4		✓	✓	✓	✓		✓		✓	
CO-5	✓	✓	✓	✓	✓	✓	✓		✓	
	Number of matches (✓) = 38 Relationship = High									

Semester - II

Course Title	**Material Chemistry**
Total hrs	60
Hrs/Week	4
Sub. Code	**21PECH21B**
Course Type	DSE-IIB
Credits	4
Marks	100

General Objective:

This Course focuses on the crystal structure of solids, its types of semiconductor, properties of polymeric materials, zero-dimensional nanomaterial and its characterization.

Course Objectives:

CO No.	**The learners will be able to**
CO - 1	Classify the crystal structure of solids.
CO - 2	Acquire the knowledge about the types of semiconductor.
CO - 3	Explain the properties of polymeric materials.
CO - 4	Interpret the zero-dimensional nanomaterial.
CO - 5	Elaborate the characterization of materials using different techniques.

UNIT I: CRYSTALLINE SOLIDS

Crystalline state - Crystal growth techniques- Crystal structure - archetypical industrial crystal lattice - Metalloxide lattice - Super conductivity of pervoskite - Crystal symmetric of space group - X-ray diffraction - Crystal imperfection.

UNIT II: SEMICONDUCTOR

Semiconductors - Electronic band diagram - Silicon - Properties and types of semiconductors - direct and indirect gaps - carrier statistics (intrinsic and extrinsic) - Hall effect - Silicon wafer production - Silicon based applications- Superconductivity - critical parameters - Anomalous characteristics - Isotope effect, Meissner effect - Type I and II superconductors - Bardeen-Cooper- Schrieffer

(BCS) theory - Josephson junctions and tunneling - SQUID - High temperature superconductors.

UNIT III: POLYMERIC MATERIALS

Self-assembly, self-assembled monolayers (SAMs). Langmuir-Blodgett (LB) films, clusters, colloids, zeolites, organic block copolymers, emulsion polymerization, templated synthesis, and confined nucleation and/or growth. Hyper branched polymer - A_2 + B_2 hb polymer structure - Dendritic Polymers - poly(amidoamine) - polymer matrix isolation, surface-templated nucleation.

UNIT IV: NANOMATERIALS

Nanotoxicity - Zero-dimensional nanomaterials - Nanoclusters ($Os_5(CO)_{16}$)- Nanoparticles - Nanopowder - Influence of size and shape on the light-scattering- Preparation - Gold, silver, nanooxides (TiO_2, ZnO), bimetallic nanoparticles- Nanotube and nanwire.

Graphene – preparation, properties and applications.

UNIT V: MATERIAL CHARACTERIZATION

Principle, Theory, Working and Application - Optical microscopy - Electron microscopy - X-Ray Reflectivity - High Resolution Transmission Electron Microscopy- Field Emission Scanning Electron Microscopy - Photoluminescence Spectroscopy - Electrochemical Impedance Spectroscopy - X-ray absorption fine structure (XAFS).

REFERENCES:

1. Materials Chemistry, Second Edition, Springer, Bradley D. Fahlman, USA, Springer, 2011.
2. Solid State Chemistry and its Applications" by A R West, 2nd edition, Wiley Publishers, 2014.
3. Solid State Chemistry - An Introduction" by L Smart and E Moore, 5th edition, CRC Press, 2020.
4. Material Science and Engineering" by V Raghavan, Prentice Hall India Learning, 2015.
5. Nanostructured Materials: Processing, Properties and Potential Applications" by C C Koch, 2nd edition, Science Direct, 2007.
6. Handbook of Nanostructured Materials and Nanotechnology" by H Singh Nalwa, Elsevier Inc., 2000.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Outline the various crystal growth techniques.	1, 2, 3	Understanding
CO-2	Identify the type of superconductors.	2	Applying
CO-3	Classify the different types of polymers.	2, 3, 5	Analyzing
CO-4	Explain the applications of nanomeric materials.	2, 3, 4	Evaluating
CO-5	Discuss the characterization of materials using different methods.	1, 2, 3	Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
II	21PECH21B	Material Chemistry	60	4

Course Outcomes (COS)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓	✓	✓	✓	✓	✓		
CO-2		✓	✓				✓			
CO-3		✓	✓	✓	✓		✓	✓		✓
CO-4		✓	✓	✓	✓		✓	✓	✓	
CO-5	✓	✓	✓	✓	✓	✓	✓	✓		
	Number of matches (✓) = 33 Relationship = Medium									

Semester II

Course Title	Forensic Chemistry
Total hrs	60
Hrs/Week	4
Sub. Code	**21PECH21C**
Course Type	DSE-IIC
Credits	4
Marks	100

General Objective:

To explore the ideas about forensic analysis.

Course Objectives:

CO No.	The learners will be able to
CO - 1	Understand the analysis of textile and paints in forensic chemistry.
CO - 2	Outline the types of explosives.
CO - 3	Compare the soil and geological microtraces.
CO - 4	Explain the process of fingerprint detection.
CO - 5	Discuss the methods of data analysis.

UNIT I TEXTILE AND PAINT EXAMINATION

Textile examination: Morphology - Natural, Animal, Plant, Manufactured fibers - Fiber types - Acetate, Acrylic, Aramids, Modacrylic - Instrumental analysis- Raman Spectroscopy.

Paint examination: Binders - Dyes and pigments - Additives - Forensic analysis - Microscopy, Vibrational spectrometry, SEM, EDX and XRF.

UNIT II FIRE DEBRIS AND EXPLOSIVES

Fire Debris: Sample collection - Classification - Ignitable liquids, Petroleum based liquids, Non-petroleum based liquids - sample preparation - Analysis and interpretation.

Explosives: Types - Effects - Low explosives - High explosives - Portable technology and on-screen analysis - Lab analysis - Chemical tests - X-ray analysis - SEM, EDS, Fluorescence - Spectroscopic analysis - FTIR, Raman - Chromatographic analysis - TLC, Ion and Gas, Liquid chromatography.

UNIT III SOIL AND GEOLOGIC MICROTRACES

Trace evidence - Genesis - Soil and geologic microtraces - Sample collection - Comparison - Origin, Color, Texture, Mineral - Modal analysis - Automated Instrumental Modal analysis - Ecological constituents - Anthropogenic constituents - Results.

UNIT IV FINGERMARK DETECTION

Sources - Aqueous components - Liquid components - Chemical processing - Reagents - Amino acid, Ninydrin, 1,8-Diazafluoren-9-one, 1,2-indanedione, p-Dimethylamino cinnamaldehyde - Physical developer - Lipid sensitive reagents - Oil red O, Nile red - Powder techniques - Cyanoacrylate fuming - Vacuum metal deposition.

UNIT V CHEMOMETRICS

Chromatograms and spectra - Baseline correction - Smoothing - Retention-time alignment - Normalization and Scaling - Pattern recognition - Hierarchical cluster analysis - Principle Component Analysis - k-Nearest Neighbors - Discriminant Analysis- Linear, Partial Least Squares - Soft Independent Modeling - Model Validation - Applications.

REFERENCES:

1. Forensic Chemistry, Fundamentals and applications, Jay A. Siegel, John Wiley & Sons, Ltd, 2016.
2. Forensic Examination of Fibres, 2nd edn., Robertson, J., Roux, C., and Wiggins, K. CRC Press, Boca Raton, FL, 2002.
3. Transfer, in Encyclopedia of Forensic Sciences, Roux, C. and Robertson, J., 2nd edn (eds J. Siegel and P. Saukko), Elsevier, Amsterdam, 2013.
4. Explosives, Meyer, R., Kohler, J., and Homburg, A., 5th edn. Berlage GmgH/WileyBHS, Weinheim, 2002.
5. Encyclopedia of Forensic Sciences, Seigel, J.A. and Suakko, P.J., 2nd edn. Elsevier/Academic Press, Boston, MA, 2013.
6. Evidence from the Earth: Forensic Geology and Criminal Investigation, Murray, R.C., 2nd edn. Mountain Press, Missoula, MT, 2011.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Understand the morphology of fibers.	1, 2	Understanding
CO-2	Apply suitable technology to analyze the explosives.	1, 2, 3, 4, 5	Applying
CO-3	Analyze the samples for soil and geological traces.	1, 2	Analyzing
CO-4	Explain the different reagents used for fingerprint detection.	1, 2	Evaluating
CO-5	Discuss the methods of data modeling.	2, 3, 5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
II	21PECH21C	Forensic Chemistry	60	4

Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓			✓	✓			
CO-2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO-3	✓	✓	✓			✓	✓			
CO-4	✓	✓	✓			✓	✓			
CO-5		✓	✓	✓	✓		✓	✓		✓
	Number of matches (✓) = 32 Relationship = Medium									

Semester - II

Course Title	**Organic Chemistry Practical - I**
Total hrs	60
Hrs/Week	4
Sub. Code	**21PCCH2P1**
Course Type	Practical-III
Credits	2
Marks	100/2

General Objective:

To teach the learners the basic organic concepts for designing a synthesis, apply the various methodologies to purify and analyze the products using different chromatography techniques.

Course Objectives:

CO No.	**The learners will be able to**
CO - 1	Explain the quantity of organic compounds.
CO - 2	Apply the basic organic concepts for designing a synthesis of organic compounds.
CO - 3	Analyze the formation of products with chromatography techniques.
CO - 4	Illustrate the methodology to purify the compounds.
CO - 5	Examine the spectra using different analytical techniques.

Qualitative Analysis and Organic Preparations

I. Separation and organic qualitative analysis of the mixture containing one or two functional group. The students are expected to determine the physical constants for both the components and their derivatives.

Minimum 8 mixtures of organic compounds should have been analyzed.

II. Single step synthesis of organic compounds - isolation and purification by recrystallization of the products

1) Synthesis of 2-phenylindole from phenyl hydrazine (Fischer indole synthesis)
2) Preparation of benzpinacol from benzophenone
3) Nitro salicylic acid from salicylic acid (nitration)
4) Phenyl-azo-2-napthol from aniline (diazotization)
5) Cannizaro reaction: Benzoic acid and Benzyl alcohol from benzaldehyde
6) Mannich Reaction: Preparation of 3-amino-1,2-diphenylpropan-1-one

REFERENCES:

1. Practical Organic Chemistry Floyd George Mann, Frederick George Mann, Bernard Charles Saunders, Longmans, 1962.
2. Comprehensive Practical Organic Chemistry, V K Ahluwalia and Sunita Dhingra, Universities Press (India) Private Limited, 2000.
3. Vogels Text book of Practical Organic Chemistry, B.S. Furniss, A.J. Hannaford, V, Rogers, R.W.G. Smith, and A.R. Tatchell, ELBS, 2003.
4. Understanding the Principles of Organic Chemistry: A Laboratory course: Peterson Myres, Cengage Learning, 2010.
5. Laboratory Manual of Organic Chemistry, Raj K Bansal, New Age International, 2009.
6. A Manual of Organic Chemistry Practical, Practical and Theoretical, Huge Clement, W.G. Blackie and Co Printers, 1879.
7. Practical Organic Chemistry, 4th Edn., F G Mann , S C Saunders, 1978.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Outline the isolation and purification of organic compounds.	1, 2	Understanding
CO-2	Apply the methodology to determine physical constants.	3, 4, 5	Applying
CO-3	Analyze the separation of compounds using chromatography.	3, 4, 5	Analyzing
CO-4	Interpret the spectral data to identify the molecules.	1, 2, 3, 5	Evaluating
CO-5	Discuss the mechanisms involved in organic compound preparation.	1, 3, 5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
II	21PCCH2P1	Organic Chemistry Practical - I	60	2

Course Outcomes (COS)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓			✓	✓			
CO-2			✓	✓	✓			✓	✓	✓
CO-3			✓	✓	✓			✓	✓	✓
CO-4	✓	✓	✓	✓	✓	✓	✓	✓		✓
CO-5	✓	✓	✓	✓	✓	✓		✓		✓
	Number of matches (✓) = 34 Relationship = High									

Semester - II

Course Title	Analytical Chemistry Practical
Total hrs	60
Hrs/Week	4
Sub. Code	**21PCCH2P2**
Course Type	Practical-IV
Credits	2
Marks	100/2

General Objective:

To make the students to understand the skills in handling UV-Visible spectrometer and chromatographic techniques

Course Objectives:

CO No.	The learners will be able to
CO - 1	Acquire the skills of handling the instruments.
CO - 2	Determine the concentrations of compounds using the Flame photometer.
CO - 3	Experiment with the spectrophotometric titrations of inorganic metals.
CO - 4	Find the concentration of anion using the turbidimetry.
CO - 5	Distinguish the compounds using the chromatographic techniques.

I. Spectrophotometric techniques

1. Determination of the concentration of unknown sodium solution by flame photometer
2. Determination of the concentration of unknown potassium solution by flame photometer
3. Determination of the concentration of unknown copper sulphate solution by UV-Visible spectrometer
4. Spectrophotometric titrations for the determination of Cu(II) with EDTA
5. Spectrophotometric titrations for the determination of Fe(III) with EDTA
6. Determination of sulphate by turbidimetry.

II. Separation of mixtures (A minimum of 5 experiments)

1. Identification of amino acids (glycine, alanine, tyrosine) with the help of Paper chromatography. Calculation of R_f value of individual amino acid.
2. Identification of carbohydrates (glucose, fructose, sucrose) with the help of

Thin layer chromatography. Calculation of Rf value.

3. Benzophenone and benzoic acid and checking their Rf values by TLC
4. Paper chromatographic separation of red and blue inks. Determination of Rf values.
5. Thin layer chromatographic separation of Mn and Zn. Determination of Rf values.
6. Paper chromatographic separation of Cadmium and Zinc. Determination of Rf values.

REFERENCES:

1. Vogel's Qualitative Inorganic Analysis, 7th edition, Pearson, 2006.
2. College Practical Chemistry, V K Alhuvalia, Sunita Dingra, 1- Edition, University Press, 2005
3. A collection of interesting general chemistry experiments, A. J. Elias, University Press, 2002
4. Inorganic Chemistry Practical, Deepak Pant, e-book, Book-Rix edition.
5. Lab Experiments in Organic Chemistry, Arunsethi, New Age International Publishers, 2010.
6. The Systematic Identification of Organic Compounds R.L. Shriner, C.K.F. Hermann, T.C. Morrill, D.Y. Curtin & R.C. Fuson John Wiley & Sons, Inc., 1997.
7. Identification of organic compounds. By N. D. Cheronis and J. B. Entrikin. Interscience Publishers, New York, 1963.
8. Organic Cum Practical Handbook Of Organic Chemistry, B J Hassard
9. Organic Experiments, Louis F. Fisser, Kenneth Williamson, D.C. Heath and company, 1992.
10. A Hand Book Of Organic Analysis: Qualitative and Quantitative, Hans Thacher Clarke,1916.
11. Experimental Organic Chemistry, H Dubont Durst And George W Gokal, 2nd Edn., New York: McGraw-Hill, 1987.
12. Practical Organic Chemistry, F G Mann and B C Saunders, 4th Edn., Pearson Education Ltd., 2009.
13. Systematic Organic Chemistry, Modern Methods of Preparation and Estimation. By W.M. Cumming, I. Vance Hopper, and T. Sherlock Wheeler, London, 1923.
14. Thin layer chromatography of carbohydrates, Journal of Chromatography A, Evgency V Evtushenko, Vlasdivoslok, 1967

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Outline the various crystal growth techniques.	1, 2	Understanding
CO-2	Identify the type of superconductors.	1, 3	Applying
CO-3	Classify the different types of polymers.	2, 3, 5	Analyzing
CO-4	Explain the applications of nanomeric materials.	2, 3, 4	Evaluating
CO-5	Discuss the characterization of materials using different methods.	1, 2, 3	Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
II	21PCCH2P2	Analytical Chemistry Practical	60	4

Course Outcomes (COS)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓	✓	✓	✓	✓			
CO-2		✓	✓	✓	✓	✓		✓		
CO-3		✓	✓	✓	✓		✓	✓		✓
CO-4		✓	✓	✓	✓		✓	✓	✓	
CO-5	✓	✓	✓	✓	✓	✓	✓	✓		
	Number of matches (✓) = 35 Relationship = High									

SEMESTER - II

Course Title	SWAYAM-NPTEL ONLINE CERTIFICATION COURSE
Total hrs	30
Hrs/Week	2
Sub. Code	**21PSCH21**
Course Type	SEC
Credits	2
Marks	100/2

SWAYAM-NPTEL ONLINE CERTIFICATION COURSES

GUIDELINES AND INSTRUCTIONS

1. National Programme on Technology Enhanced Learning (NPTEL) provides e-learning through online web and video courses in Engineering, Science and Humanities streams through its portal https://swayam.gov.in/ncdetails/NPTEL.
2. Enrollment to all the courses is FREE.
3. Enrollment to courses and Examination Registration can be done ONLINE only. The link is available on NPTEL Website http://nptel.ac.in/
4. SWAYAM– NPTEL Online Certification Courses are mandated for the students in the PG Programmes from the Academic year 2021-2022.
5. Candidates must have completed Examination Registration successfully within the prescribed time to receive hall tickets and to write examinations.
6. Any Eight – Week, Two-Credit Course in any discipline to offer for two hours a week be chosen by the respective Departments in the second semester of the Postgraduate Programmes.
7. The SWAYAM–NPTEL Online Certification Courses offered during the December – April Semester be chosen by the Departments. The

courses may be handled by the Department Mentor or by any teacher in the respective Departments.

8. The allocation of marks for the online examination conducted by the respective IITs is 25:75 for each course.
9. A candidate should obtain a minimum of 40 marks on 100 marks (a minimum of 10 marks for Assignment and 30 marks in the final examination) to pass the Online Courses.
10. If a student fails in the Online Examination conducted by the respective IITs he/she would be permitted to write a Supplementary Examination for 75 marks by the Controller of Examinations of our College.
11. Those who registered for the Online Courses, obtained Assignment marks, appeared for the Online Examination and failed in the courses alone are eligible to apply for the Supplementary Examinations conducted by the College.
12. If a candidate fails in the Supplemenary Examinations conducted by the College, the norms followed for taking an Arrear Examination will be adopted.
13. A provision is given to candidates to reappear for Supplementary/Arrear Examinations in the same semester to facilitate them to receive their Degrees.
14. The Question paper in Multiple Choice Question Pattern for 75 marks shall be framed by the respective faculty/ by an External Examiner for conducting the Supplementary Examinations.
15. The Supplementary Examinations would be conducted for three hours.
16. Course Completion Certificate will not be issued by the respective IITs for the candidates who clear the Online Courses through the Supplementary Examinations conducted by the College. The two credits the candidate earns, if passed, would be added in the Consolidated Statement of Marks issued by the Controller of Examinations.

SEMESTER - III

Course Title	**Organic Chemistry - III**
Total hrs	75
Hrs/Week	5
Sub. Code	**21PCCH31**
Course Type	DSC-VII
Credits	4
Marks	100

General Objective:

To master the basic concepts of aromatic, anti-aromatic properties, various heterocyclic ring systems and the structural elucidation of natural products

Course Objectives:

CO No.	The learners will be able to
CO - 1	Outline the aromatic and anti-aromatic characters of organic compounds.
CO - 2	Apply the knowledge of bicyclic, three and five membered heterocyclic ring systems.
CO - 3	Analyze the structure and reactions of carbohydrates.
CO - 4	Explain alkaloids and terpenoides.
CO - 5	Elaborate the structural elucidation of Vitamins.

UNIT I: AROMATICITY AND NOVEL RING SYSTEMS

Aromaticity

Aromaticity - Huckel's rule - Five, Six, Seven and Eight membered rings, Other systems containing aromatic sexlet, Systems of two, four, six, eight, ten and more than ten electrons, Homoaromatic compounds, Syndroes and Fullerenes.

Novel rings -Nomenclature of bicyclic system - Adamantane and tricyclic systems - Cubane

Molecular machines - Catenanes, Rotaxanes, Cucurbit[n]uril - Based Gyroscane structure

UNIT II: HETEROCYCLIC CHEMISTRY

Structure synthesis and reactions of following heterocyclic compounds

Bicyclic ring systems: Indoles - Isoindoles - Benzofurans - Dibenzofurans - Quinolines - Isoquinolines - Acridines .

Five membered heterocyclic compounds with two hetero atoms:

Pyrazoles - Imidazoles - Oxazoles - Thiazoles - coumarins - flavones.

Three membered heterocyclic compounds:

Aziridine and oxirane ring systems

UNIT III: ALKALOIDS AND TERPENOIDS

Occurrence - Hoffmann, Emde and von Braun degradations - Structure elucidation of quinine, atropine and reserpine.

Classification of terpenoids with examples - isoprene rules - structural elucidations of α-pinene, Zingiberene and abitic acid.

UNIT IV STEROIDS

Total Synthesis of Steroids: Androsterone, Testosterone, Estrone, Estradiol, 2-Methoxyestradiol and Progesterone (Racemic as well as Chiral Synthesis) - Conversion of Cholesterol into steroids- Chiral as well as Racemic synthesis of Prostaglandins PGE1, PGE2 and PGE3

UNIT V: VITAMINS

Classification, Sources, Structure and Deficiency of Vitamins - structural elucidation of Vitamins A, H, and E, Biosynthesis of Anthocyanin.

REFERENCES:

1) Advanced Organic Chemistry Reaction, Mechanism and Structure, Jerry March, 4th Edn., Wiley, 2006.
2) Reaction Mechanism in organic Chemistry, S. M. Mukherjee and S. P. Singh, Macmillan India Limited, 2009.
3) Heterocyclic Chemistry, Raj K. Bansal, 5th Edition, New Age International (Pvt.Ltd), 2006.
4) Pericyclic reaction, S. M. Mukherjee, Macmilan India Limited, 2009.
5) Heterocyclic Chemistry, Raj K. Bansal, 5th Edition, New Age International (Pvt.Ltd), 2006.
6) Medicinal Chemistry, Ashutosh Kar, 2nd Edn. New Age International (Pvt) publishers, 2007.
7) Chemistry of Natural Products, S. V. Bhat, B. A. Nagasampagi, N. Sivakumar, Narosa publishing House, New Delhi, 2010.
8) Advanced Organic Chemistry Reaction, Mechanism and Structure, Jerry March, 4th Edn., Wiley, 2006.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Understand Huckel's rule of aromaticity.	1,2	Understanding
CO-2	Identify the structures of heterocyclic ring systems.	1, 2, 3	Applying
CO-3	Classify the terpenoids.	3,4, 5	Analyzing
CO-4	Explain the structure of steroids.	1, 2, 3, 5	Evaluating
CO-5	Discuss the vitamins' structures.	3, 4, 5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
III	21PCCH31	Organic Chemistry III	75	4

Course Outcomes (COS)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓			✓	✓			
CO-2	✓	✓	✓	✓	✓	✓	✓	✓		
CO-3			✓	✓	✓			✓	✓	✓
CO-4	✓	✓	✓	✓	✓	✓	✓	✓		✓
CO-5			✓	✓	✓			✓	✓	✓
	Number of matches (✓) = 34 Relationship = High									

Semester - III

Course Title	**Physical Chemistry - III**
Total hrs	75
Hrs/Week	5
Sub. Code	**21PCCH32**
Course Type	DSC-VIII
Credits	4
Marks	100

General Objective:

To familiarize with the group theory, theories related to quantum chemistry, phase rule and rotational, vibrational spectroscopic behavior of molecules.

Course Objectives:

CO No.	**The learners will be able to**
CO – 1	Understand the phase diagrams of different systems.
CO – 2	Explain the energy states involved in transitions.
CO – 3	Apply the theories of quantum chemistry to higher molecules.
CO – 4	Explain the point group of molecules.
CO – 5	Analyze the rotational and vibrational spectroscopy of molecules.

UNIT I: Group Theory I

Symmetry elements - Symmetry operations- product of symmetry operations - Symmetry point group - Determination of point group with examples - Representation of group - Matrix Notation - Great Orthogonality Theorem (GOT) - Illustration - Construction of character tables - C_{2v}, C_{3v}, C_{2h}, D_{3h}.

UNIT II: Group Theory II

Reducible representation into its irreducible representation - Rules for determining the irreducible representation of vibrational modes - normal modes of vibration of polyatomic molecules - H_2O, NH_3, BF_3 - Direct product of irreducible representation - selection rule for n-π^* and π-π^* transition in HCHO construction of Hybrid orbitals - CH_4, $[PtCl_4]^{2-}$ - secular equation in MO theory - trans 1,3-butadiene, Benzene.

UNIT III: Quantum Chemistry III

Time independent Perturbation theory - Applications to hydrogen and Helium atoms - Variation theorem - Application to hydrogen and helium atoms - Time dependent perturbation theory - Born-Oppenheimer approximation - MO theory - LCAO approximation - MO method for H_2^+ and H_2 - VB treatment of H_2 molecule - Excited state of Hydrogen molecule - Comparison of MO and VB theories.

UNIT IV: Phase rule and Colloids

Phase rule: Three component liquid systems - one, two and three pairs of partially miscible liquids - Ternary solution with common ions - Hydrate formation - Compound formation - Method of wet residue - Variation of temperature with composition - Representative point - three component system with solid phase - salting out effect.

Colloids: Preparation of lyophobic colloids - Mechanical dispersion, Electrical dispersion, Peptization - Charge on colloids - Electrical Double layer theory - DLVO theory - Applications.

UNIT V: Rotational and Vibrational Spectroscopy

Rotational Spectroscopy: Molecular rotation - Rotational spectra - Rigid diatomic molecules - Spectral line intensities - Effect of isotopic substitution - Non-rigid rotator - Spectrum of non-rigid molecules - Polyatomic molecules - linear, Symmetric top molecules - Asymmetric top molecules - Instrumentation - Stark effect - Application.

Vibrational Spectroscopy: Diatomic molecules- Energy - Simple Harmonic Ocsillator - Anharmonic oscillator - Selection rule- Spectrum of Carbon monoxide - Vibrational-rotational interactions - Polyatomic molecules - Overtone and vibrational frequencies - Selection rule for linear molecules - Influence of nuclear spin.

REFERENCES:

1. Chemical Applications of Group theory, F. Albert Cotton, 3rd edition, Wiley-Interscience Publication, 1990.
2. Principles of Physical Chemistry, Puri, Sharma and Pathania, Vishal Publications, 2008.
3. Group Theory in Chemistry, Gopinathan, M.S., and V. Ramakrishnan, Vishal Publications, Jalandhar (India), 1986.
4. Quantum Chemistry, Donald A. Mcquire, Viva Books, 2011.
5. Quantum Chemistry Including Spectroscopy, B. K. Sen, 4th edition, Kalyani Publishers, 2011.
6. Introductory Quantum Chemistry, A.K. Chandra, 4th Edn., Tata McGraw Hill, 2001.
7. Quantum Chemistry, Ira N. Levin, Edition VI, PHI Learning PVT Ltd., New Delhi, 2009.
8. Advanced Physical Chemistry, D. N. Bajpai, S. Chand and Company Pvt Ltd., 2018.

9. Fundamentals of Molecular Spectroscopy, C. N. Banwell, 4th edition, McGraw- Hill Book Company, 2017.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Understand the Great Orthogonality Theorem.	1, 3	Understanding
CO-2	Construct molecular orbital diagrams using direct product representation.	1, 3	Applying
CO-3	List out the theories of approximations to solve Schrodinger equations.	1, 2, 3	Analyzing
CO-4	Compare the phase diagrams of different systems.	1, 4	Evaluating
CO-5	Discuss the rotational and vibrational spectrum of molecules.	1, 3, 5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
III	21PCCH32	Physical Chemistry III	75	4

Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓	✓	✓	✓		✓		
CO-2	✓	✓	✓	✓	✓	✓		✓		
CO-3	✓	✓	✓	✓	✓	✓	✓	✓		
CO-4	✓	✓	✓			✓			✓	
CO-5	✓	✓	✓	✓	✓	✓		✓		✓
	Number of matches (✓) = 35 Relationship = High									

Semester - III

Course Title	Research Methodology
Total hrs	75
Hrs/Week	5
Sub. Code	**21PCCH33**
Course Type	DSC-IX
Credits	4
Marks	100

General Objective:

To apply the knowledge of the fundamentals of research, the processes of citation, referencing and intellectual property rights

Course Objectives:

CO No.	The learners will be able to
CO - 1	Understand the fundamentals of research, sampling and ethics.
CO - 2	Acquire the skill of writing research papers.
CO - 3	Outline the processes of citation and referencing.
CO - 4	Analyze different methods of factor analysis.
CO - 5	Explain the intellectual property rights.

UNIT: I RESEARCH FUNDAMENTALS

Objective - Criteria for good research - Choosing a research problem - Selecting, Defining - Literature survey - Primary and Secondary – Working - Experimental design Sampling, Types - problems faced - Measurement- Scaling, Tests, Techniques- Research ethics - Plagiarism - Complete Plagiarism, Source-based Plagiarism, Direct Plagiarism, Self or Auto Plagiarism, Paraphrasing plagiarism, Inaccurate Authorship, Mosaic Plagiarism, Accidental Plagiarism, Plagiarism software.

UNIT: II RESEARCH WRITING AND PRESENTATION

Report writing - Types of research reports - Research paper, Short communication, Chapters in book, Review and Conference report, Project report- Research writing tools - Toggl, Phrase bank, Zotero, Trello.

Oral presentation - Power point slide preparation, Poster preparation - Writing research paper - Title, Abstract, Key words, Introduction, Methodology, Results and Discussion, Acknowledgement, Statement of conflict of interest, Cover letter, Referencing- Bibliography - Online submission of manuscripts to journals.

Pictorial tools - Mind map, Plotvar, online chart tool, Rapid tables, Chemdraw, Chemsketch.

UNIT: III DATABASE

Literature database - Scifinder, STN and Raxys - Crystallographic database - Protein databank, Cambridge Structural database - Spectral databases - NIST web book, Spectral Data Base System (SDBS), KnowItAll, Chemspider - Reactions database - chemistry. Stack exchange, Organic Synthesis, Inorganic Synthesis - Thermophysical database - NIST, Dortmund Data Bank (DDB) - Conformational database - Frog, click2drug, OMEGA, MS-DOCK - Substructure database - Molsoft, Molcart, Giga Search.

UNIT: IV STATISTICAL TOOLS

Classification of errors - Accuracy – Precision - Minimization of errors - Reliability of results - Q-test, Student's T-test, F-test, Chi-square test - Correlation coefficient - Regression - Random samples - Sampling Distribution - Confidence Intervals - T-Distribution - ANOVA in excel - Wilcoxon Signed-Rank Test - Single and Paired data - Linear Least square Analysis - ToolPak regression tool - Plotting graph for least square fit - Multiple linear regression – Origin - Data analysis, curve and surface fitting, peak analysis, statistics - Impact factor - h-index - i_{10} index.

UNIT: V IPR

Introduction - Types - Need - Protection - Copyrights, Trademarks, Designs, Utility Models, Trade Secrets, Geographical Indications - Patent and Non-patentable inventions - Patent application process - Writing document - Drafting - Filing - Legal requirements - Patent Agent - Qualification, Registration procedure - Patent offices in India - Patent databases.

REFERENCES:

1. Handbook of Research Methodology, A Compendium for Scholars and Researchers, Dr. Shanti Bhushan Mishra Dr. Shashi Alok, Educreation Publishing, 2011.
2. Research Methodology, Methods and Techniques, C. R. Kothari, 2nd Revised edition, New Age International Publishers, 1990.
3. Research Methodology, a step-by-step guide for beginners, Ranjit Kumar, 3rd edition, Sage Publications, 2011.
4. J. Anderson, B.H. Durstan and M. Poole, Thesis and assignment writing, Wiley Eastern, New Delhi, 1977.

5. R.O. Butlet, Preparing thesis and other manuscript.
6. Rajammal P. Devadas, A Handbook of Methodology of Research, S.R.K. Vidyalaya Press, Chennai, 1976.
7. Physical Methods for Chemists, Russell S. Drago, 2nd edition, Scientific Publishers, 1992.
8. Cyber Crime Law and Practice, CS Mamta Binani, The Institute of Company Secretaries of India, 2016.
9. Intellectual Property Law in India, Nishith Desai, Nishith Desai Associates Legal and Tax Counseling, 2015.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Understand the ethics of research.	3, 4, 5	Understanding
CO-2	Develop presentation and writing skills.	3, 4, 5	Applying
CO-3	Analyze the process of referencing.	3, 4, 5	Analyzing
CO-4	Interpret the statistical analysis of samples.	1, 3, 5	Evaluating
CO-5	Elaborate the process of patenting.	1, 2, 3, 5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
III	21PCCH33	Research Methodology	75	4

Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1			✓	✓	✓			✓	✓	✓
CO-2			✓	✓	✓			✓	✓	✓
CO-3			✓	✓	✓			✓	✓	✓
CO-4	✓	✓	✓	✓	✓	✓		✓		✓
CO-5	✓	✓	✓	✓	✓	✓	✓	✓		✓
	Number of matches (✓) = 35 Relationship = High									

Semester - III

Course Title	Spectroscopy
Total hrs	60
Hrs/Week	4
Sub. Code	**21PECH31A**
Course Type	DSE-IIIA
Credits	4
Marks	100

General Objective:

To be trained about the principle and interpretation of electronic, vibrational, NMR and Mass spectrometry.

Course Objectives:

CO No.	The learners will be able to
CO – 1	Understand the principle of electronic spectra.
CO – 2	Know about the vibrational frequencies for different functional groups.
CO – 3	Comprehend the spinning of molecules under the magnetic field.
CO – 4	Explain the basic concept of ESI-MS.
CO – 5	Interpret the different spectral concepts.

UNIT I: ELECTRONIC SPECTRA

Principles - selection rule **-** types of electron transition - chromofore - auxochrome - shifts - The Beer-Lambert Law - Rotational structure of electronic and vibrational spectra - Franck Condon principle - types of electronic transitions - solvent effect - blue and red shift - calculation of λ_{max} by Woodward Fieser rule and Scott rule - Applications of UV spectroscopy - calculate λ_{max} value of dienes, polyenes, carbonyl compounds and α, β-unsaturated carbonyl compounds using Woodward Fieser rule.

UNIT II: VIBRATIONAL SPECTRA

Theoretical principle - Selection rule - Harmonic oscillator- anharmonicity

determination of force constant - Rotational - Vibrational spectra of diatomic molecules - P, Q, R branches - Vibrational spectra of polyatomic molecules - normal modes of vibration of CO_2, H_2O. Vibrational frequencies - Factors affecting vibrational frequencies - Finger print region - Fermi-resonance - vibrational frequencies of alkanes, alkenes, aromatic compounds, alcohols, phenols, aldehydes, ketones, carboxylic acids, esters, amines, amides, nitro, nitriles, anhydrides, lactones and lactams.

UNIT III: NMR SPECTROSCOPY - I

^{1}H NMR: Chemical shift, Spin-spin interaction, shielding and deshielding (aliphatic, olefinic, aldehyde and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides and mercapto) - Factors affecting chemical shift - Deuterium exchange - Spin-spin coupling - factors affecting coupling constant - Complex spin-spin interaction between two and three nuclei - Simplification of complex spectra, nuclear magnetic double resonance, contact shift reagents, solvent effects - Fourier transform technique - Nuclear Over-Hauser effect (NOE). Resonance of other nuclei, Introduction and applications of ^{19}F and ^{31}P. Multidimensional NMR spectroscopy: 2D to n-D - homonuclear coherence transfer and mixing: COSY, NOESY and TOCSY

UNIT IV: MASS SPECTROMETRY

Theory - instrumentation- Unit mass and molecular ions- singly and doubly charged ions, metastable peak, base peak, isotropic mass peaks, relative intensity and FTMS - Recognition of M+ ion peak - General fragmentation rules - Fragmentation of organic molecules- compounds containing oxygen, sulphur, nitrogen and halogens - α, β, allylic and benzylic cleavage - McLafferty rearrangement.

Various types of Mass Spectrometry: FABMS, EIMS, MALDI, ICPMS and HRMS.

UNIT V: SPECTRAL PROBLEMS

Combined problems on UV, IR, NMR and Mass spectral data for structure determination.

Elucidation of structure of organic molecules using spectra (IR & NMR).

REFERENCES:

1. Fundamentals of Analytical Chemistry - D.A.Skoog, D.M. West, F.J. Holler and S.R. Crouch - 2004; Thompson Asia Private Ltd., Bangalore.
2. Spectroscopy of Organic Compounds, P S Kalsi, New Age International, 2007.

3. Organic Spectroscopy by William Kemp, Third edition, 2019.
4. Instrumental Methods of Analysis - B. K. Sharma, Goel publishing House, Meerut, 2003.
5. Contemporary Chemical Analysis - Judith F. Rubinson, Prentice Hall (India), 1998.
6. Instrumental Methods of Analysis Hobart H. Willard, Lynne L. Merritt Jr, John Dean, Wadsworth Publishing Co Inc; 7th Edn., 1988.
7. Thin Layer Chromatography- A laboratory Handbook, Ashworth, Stahl. E., 1st Edn., Springer-Verlag, 1969.
8. Dynamics of Chromatography - Principles and Theory, J. Calvin Giddings, CRC Press, 2002.
9. Spectroscopy of organic compounds, Kalsi, P.S., New Age Publishers New Delhi, 2007.
10. Principles of Instrumental Analysis, Douglas A. Skoog, F. James Holler, Stanley R. Crouch, 2006.
11. Fundamentals of Medical Imaging, Paul Suetens, 2nd Edition, Cambridge University Press, 2002.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Understand the types of electronic transitions.	1, 3	Understanding
CO-2	Identify the finger print regions in the spectrum.	3, 5	Applying
CO-3	Analyze the NMR spectra of organic molecules.	1, 3, 5	Analyzing
CO-4	Explain the fragmentation of organic molecules.	3, 4, 5	Evaluating
CO-5	Predict the structure of molecules using the spectral data.	1, 3, 5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
III	21PECH31A	Spectroscopy	60	4

Course Outcomes (COS)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓	✓	✓	✓		✓		
CO-2	✓	✓	✓	✓	✓			✓		✓
CO-3	✓	✓	✓	✓	✓	✓		✓		✓
CO-4			✓	✓	✓			✓	✓	✓
CO-5	✓	✓	✓	✓	✓	✓		✓		✓
	Number of matches (✓) = 36 Relationship = High									

Semester - III

Course Title	Chemistry of Milk
Total hrs	60
Hrs/Week	4
Sub. Code	**21PECH31B**
Course Type	DSE-IIIB
Credits	4
Marks	100

General Objective:

To grasp knowledge on enzymes, various components of milk products and its applications

Course Objectives:

CO No.	The learners will be able to
CO – 1	Understand the lactose and lipid content of milk.
CO – 2	Identify the enzymes present in milk.
CO – 3	Explain the colloidal nature of milk.
CO – 4	Interpret the composition of different milk products.
CO – 5	Summarize the components of milk.

UNIT I: LACTOSE AND LIPIDS

Lactose - physical and chemical properties - Physio chemical aspects - crystallization - lactic acid fermentation - solubility - uses - Nutritional value.

Milk lipids - compositions - properties - tryglycirides - free fatty acid - compound lipids - unsaponifible matter - auto oxidation - crystallization - nucleation - crystal growth - polymorphism - compound crystal - rheological aspects.

UNIT II: PROTEINS AND ENZYMES

Chemistry of proteins definition - Casein - Precipitation of casein - Enzyme in milk - Enzyme activity - Antibacterial enzymes - Oxidoreductases - Phosphatases - Lipoytic enzymes - Proteinases - Amylases - Inactivation - Salts in milk - Composition and distribution of salt among the phases - Trace elements - Properties of salt solution - Colligative properties - Colloidal calcium phosphate - Natural components of milk - Contaminants.

UNIT III: COLLOIDAL PARTICLES OF MILK

Fat globules - Properties - Emulsion stability - Types of Instability - Coalescence - Interaction with air bubbles - High pressure milk - Raw milk - Cream and Skim milk - Lipolysis - Casein micelles - Classification of whey - Whey proteins - Heat liable - Heat stable

protein - Milk as a substrate for bacteria - Pathogenic microorganisms - Spoilage microorganisms - Pathogenic organism in milk - Hygienic measure - Protection of the consumer against pathogen - Hazard analysis and critical control points (HACCP) - Quality assurance of raw milk - Milk Transport and storage - Milk chilling and storage - Membrane filtration process.

UNIT IV: CONCENTRATED MILK

Evaporated milk - Manufacture - organoleptic properties - heat stability - creamy - age thickening and gelation

Sweet and Condensed milk - Manufacture - homogenization - cooling and seeding - microbial soilage - remedies - chemical deterioration - lactose crystals.

UNIT V: TESTING OF MILK AND MILK PRODUCTS

Platform testing - organoleptic test - sediment test - clot-on boiling (COB) - alcohol test - fat test - lactometer test - total solids - acidity - methylene blue reduction test (MBRT) - Phosphate - Sharer method - freezing point - microbiological test.

REFERENCES:

1. Webb Johnson and Alfond, Fundamentals of Dairy Chemistry, 2nd edition, C.B.S. Publishers and Distributers Delhi, 2005.
2. Rangappa, K.S. and Achaya, K.T., Indian Dairy products, Asia Publishing House, Bombay, 1974.
3. Webb, B.H. and Whittier, E.O., By-products from Milks, the A.V.I. Publ. Co. Inc., Westport, Connecticut, 1970.
4. Srinivasan, M. R. and Anantakrishnan, C.P., Milk Products of India, ICAR Animal Husbandry Series No. 4, New Delhi, 1957.
5. Murray, R.K.,Granner, D.K., Mayes, P.A. and Rodwell, V.W.Harper'sBiochemisry, (21stEdn). McGraw-Hil, 1990.
6. Sukumar De., Outlines of Dairy Technology, (1st Edn.), Oxford University Press, 1991.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Explain the lactose and lipid contents of milk.	1, 2, 3, 5	Understanding
CO-2	Identify the enzymes present in the milk.	1, 2	Applying
CO-3	Examine the colloidal nature of milk.	3, 4, 5	Analyzing
CO-4	Evaluate the composition of different milk products.	1,2, 3	Evaluating
CO-5	Discuss the components of milk.	3, 4, 5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
III	21PECH31B	Chemistry of Milk	60	4

Course Outcomes (COS)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓	✓	✓	✓	✓	✓		✓
CO-2	✓	✓	✓			✓	✓			
CO-3			✓	✓	✓			✓	✓	✓
CO-4	✓	✓	✓	✓	✓	✓	✓	✓		
CO-5			✓	✓	✓			✓	✓	✓
	Number of matches (✓) = 34 Relationship = High									

Semester III

Course Title	**Agricultural Chemistry**
Total hrs	60
Hrs/Week	4
Sub. Code	**21PECH31C**
Course Type	DSE-IIIC
Credits	4
Marks	100

General Objective:

To get in-depth knowledge about agricultural chemistry.

Course Objectives:

CO No.	**The learners will be able to**
CO – 1	Understand the nutrients essential for plant growth.
CO – 2	Outline the structure of soil.
CO – 3	Identify the hormones necessary for plant growth.
CO – 4	Explain the responses and stress in the growth of plants.
CO – 5	Discuss the water and energy balances required for plants.

UNIT I PLANT NUTRITION

Biochemical functions of major nutrients - Nitrogen - Assimilation of sulphur - Deficiency - Phosphorus - Potassium - Calcium - Magnesium - Toxic effects - Carbon and nitrogen metabolism - Carbon assimilation - Nitrogen assimilation - Senescence and nutrient cycling.

UNIT II SOIL STRUCTURE

Dynamics - Soil aggregation - Clusters - Microaggregates - Macroaggregates - Clods - Applications of Hierarchical model - Factors affecting soil aggregation - Root penetration - Moisture dynamics - Root exudates - Carbon inputs - Inorganic binding agents - Wetting and drying cycles - Clay swelling and shrinkage - Capillary forces - Soil fragmentation - Characterization of soil structure - Morphological and hydrologic properties - Stability - Imaging techniques.

UNIT III PLANT HORMONES

Auxins, Gibberellins, Cytokinins, Ascorbic acid - Biochemistry - Synthesis and transport - Physiological activities - Applications.

UNIT IV PLANT GROWTH AND DEVELOPMENT

Responses to light, Effects on photosynthesis, Phytochrome mediated responses, Temperature response, Vernalization - Atmospheric stress - Temperature, Water and Salt stress - Plant growth regulators - Morphactins - Maleic hydrazide - Glyphosine.

UNIT V WATER AND ENERGY BALANCES

Energy balance equation - Net radiation - Solar irradiance - Latent heat flux - Eddy covariance - Brown ratio - Fetch requirements - Field surface energy balance and remote sensing - Penman-Monteith estimates - Limitations - Recursive estimates - Bare soil evaporation estimates - Transpiration - Soil heat flux.

REFERENCES:

1. An Introduction to Agricultural Biochemsitry, Chesworth JM, Stuchbury T and Scaife JR, 1st edition, Chapman & Hall, UK, 1998.
2. Handbook of soil sciences, Properties and Processes, Pan Ming Huang Yuncong Li Malcolm E. Sumner, 2nd edition, CRC Press, New York, 2012.
3. Elements of Agricultural Chemistry, Thomas Anderson, Abhishek Publications, 2019.
4. Science in Farming. a Textbook on the Principles of Agriculture, Including a Treatise on Agricultural Chemistry, Ralph Seymour Thompson, Franklin Classics Trade Press, 2018.
5. Basics of Agricultural Chemistry, Choudhary Dewasish, Anmol Publications Pvt Ltd, 2008.
6. Textbook of Agro-Chemistry, H. Parameshwar Hegde, Discovery Publishing Pvt.Ltd, 2009.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Understand the biochemical functions of nutrients.	1, 2	Understanding
CO-2	Apply the knowledge of soil structure for growing plants.	1, 2, 3, 4, 5	Applying
CO-3	Classify the hormones based on their functions.	1, 2	Analyzing
CO-4	Explain the stress factors affecting the plant growth.	1, 2	Evaluating
CO-5	Estimate the latent heat flux using different methods.	2, 3, 5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
III	21PECH31C	Agricultural Chemistry	60	4

Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓			✓	✓			
CO-2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO-3	✓	✓	✓			✓	✓			
CO-4	✓	✓	✓			✓	✓			
CO-5		✓	✓	✓	✓		✓	✓		✓
	Number of matches (✓) = 32 Relationship = Medium									

Semester - III

Course Title	Organic Chemistry Practical - II
Total hrs	60
Hrs/Week	4
Sub. Code	**21PCCH3P1**
Course Type	Practical-V
Credits	2
Marks	100/2

General Objective:

To get knowledge about extraction, purification of natural compounds and estimation of organic compounds

Course Objectives:

CO No.	The learners will be able to
CO - 1	Understand the estimation of organic compounds.
CO - 2	Explain the extraction and purification of natural compounds.
CO - 3	Summarize the iodine value method to test the quality of oils.
CO - 4	Experiment with different stages of the preparation of organic compounds.
CO - 5	Outline the concept of chromatography to verify the formation of products.

I. Estimation of Organic Compounds

1. Estimation of Glucose by Bertrand's method
2. Estimation of Ascorbic acid by titration method
3. Organic estimation of citric acid
4. Estimation of Ethyl methyl ketone

II. Extraction and Recrystallization Techniques (Course Work)

1) Extraction of caffeine
2) Extraction of pigments/terpenoids-Soxhlet method
3) Recrystallization technique - Slow evaporation method

III. Organic Synthesis (Double Stage)

Exp 1: Synthesis of ethyl p-aminobenzoate (benzocaine) from p-nitro benzoic acid

Exp 2: Synthesis of Anthranilic acid from phthalic acid

Exp 3: Synthesis of m-nitro aniline from nitro benzene

Exp 4: Synthesis of m-Chloro-nitrobenzene from m-nitro aniline

Exp 5: Synthesis of Benzanilide from Benzophenone

Exp 6: Synthesis of p-bromobenzanilide from benzanilide

All the students must submit the TLC for preparation and a photo copy must be pasted in records.

REFERENCES:

1. Lab Experiments in Organic Chemistry, Arunsethi, New Age International Publishers, 2010.
2. The Systematic Identification of Organic Compounds R.L. Shriner, C.K.F. Hermann, T.C. Morrill, D.Y. Curtin & R.C. Fuson John Wiley & Sons, Inc., 1997.
3. College Practical Chemistry, V. K. Ahluwalia, Sunita Dhingra and Adarsh Gulati, by University Press, Hyderabad, 2012.
4. Identification of Organic Compounds. By N. D. Cheronis and J. B. Entrikin. Interscience Publishers, New York, 1963.
5. Organic Experiments, Louis F. Fisser, Kenneth Williamson, D.C. Heath and company, 1992.
6. Experimental Organic Chemistry, H Dubont Durst and George W Gokal, 2nd Edn., New York: McGraw-Hill, 1987.
7. Practical Organic Chemistry, F G Mann and B C Saunders, 4th Edn., Pearson Education Ltd., 2009.
8. Textbook Of Practical Organic Chemistry, A I Vogel, Prentice Hall; 5th Edn., 1989.
9. Systematic Organic Chemistry, Modern Methods of Preparation and Estimation. By W.M. Cumming, I. Vance Hopper, and T. Sherlock Wheeler, London, 1923.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Understand the purification methods for organic compounds.	1, 2, 4, 5	Understanding
CO-2	Apply different methods to estimate the organic compounds.	1, 2	Applying
CO-3	Analyze the methodologies for the extraction of natural products.	1, 2, 3, 5	Analyzing
CO-4	Explain the different stages of preparing organic compounds.	1, 2, 4, 5	Evaluating
CO-5	Elaborate the methods for the separation of compounds.	2, 5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
III	21PCCH3P1	Organic Chemistry Practical - II	60	2

Course Outcomes (COS)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓	✓	✓	✓	✓		✓	✓
CO-2	✓	✓	✓			✓	✓			
CO-3	✓	✓	✓	✓	✓	✓	✓	✓		✓
CO-4	✓	✓	✓	✓	✓	✓	✓		✓	✓
CO-5		✓	✓	✓	✓		✓			✓
	Number of matches (✓) = 38 Relationship = High									

Semester - III

Course Title	Physical Chemistry Practical - II
Total hrs	60
Hrs/Week	4
Sub. Code	**21PCCH3P2**
Course Type	Practical-VI
Credits	2
Marks	100/2

General Objective:

To examine the principles of conductometric, potentiometric experiments and statistical analysis.

Course Objectives:

CO No.	The learners will be able to
CO – 1	Familiarize in handling the instruments.
CO – 2	Compile the reactions involved in ester hydrolysis and surface phenomenon.
CO – 3	Understand the heat of solutions of mixtures.
CO – 4	Explain the principles of electrical experiments.
CO – 5	Summarize the concepts of statistical analysis.

1. Estimation of the strengths of HCl and NH_4Cl in the mixture by conductometric method.
2. Determination of dissociation constant of a weak acid conductometric method.
3. Determination of equivalent conductance of strong electrolytes at infinite dilution by conductometric method.
4. Determination of order of the saponification of an ester by half-life method.
5. Estimation of FAS by potentiometric titration.
6. Estimation of $KMnO_4$ by potentiometric titration.
7. Determination of heat of solution of naphthalene - toluene system.
8. Determination of heat of solution of oxalic acid - water system.
9. Determination of heat of solution of ammonium oxalate - water system.
10. Primary salt effect (Course Work).
11. Determination of Solubility product of Ca $(OH)_2$ at room temperature.
12. Statistical Analysis- Chi test, F-test, t-test, Regression analysis.

REFERENCES:

1. Advanced Physical Chemistry Experiments, Dr. J. N. Gurtu, Pragati Prakashan, 2008.
2. College Practical Chemistry, H.N. Patel, S. P. Turakhia, S. S. Kelkar, N. S. Israney, S. R. Puniyani, Himalaya Publishing House, 2010.
3. Practical Physical Chemistry, Alexander Findlay, Longmans Green and co, London, 7th edition, 2012.
4. Physical Chemistry Laboratory, L. Peter Gold, McGraw-Hill PVT Ltd., 1997.
5. Experimental Physical Chemistry: A Laboratory Textbook, Arthur Halpern, George McBane, 2006.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Outline the principles of conductometric and potentiometric titrations.	1, 2	Understanding
CO-2	Apply the knowledge of phase rule to different systems.	1, 3	Applying
CO-3	Inspect the distribution of salts in various solvents.	1, 3	Analyzing
CO-4	Determine the solubility products of salts.	1, 3, 5	Evaluating
CO-5	Test the statistical analysis for different sets of data.	1, 3,4, 5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
III	21PCCH3P2	Physical Chemistry Practical- II	60	2

Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓			✓	✓			
CO-2	✓	✓	✓	✓	✓	✓		✓		
CO-3	✓	✓	✓	✓	✓	✓		✓		
CO-4	✓	✓	✓	✓	✓	✓		✓		✓
CO-5	✓	✓	✓	✓	✓	✓		✓	✓	✓
	Number of matches (✓) = 36 Relationship = High									

Semester - III

Course Title	Industrial Chemistry
Total hrs	30
Hrs/Week	2
Sub. Code	**21PICH31**
Course Type	IDC-II
Credits	2
Marks	100/2

General Objective:

To learn about the petrochemical processes, fertilizers, pesticides and food adulteration

Course Objectives:

CO No.	The learners will be able to
CO - 1	Understand the composition and uses of petrochemical products.
CO - 2	Summarize the processes in petrochemical industries.
CO - 3	Analyze the importance of fertilizers.
CO - 4	Explain the harmful effects of pesticide pollution.
CO - 5	Discuss the food adulterants.

UNIT I: PETROCHEMICALS - I

Refining of petroleum crude - Composition and uses of main petroleum fractions - Heavy oil, lubricating oil, Diesel, kerosene, Petrol, Naphtha, gases - LPG, CNG. Synthetic petrol - Bergius process. Cracking - Thermal Cracking, Catalytic cracking - Advantages - Spark Ignition (SI) engine for petrol vehicles - Octane number - Quality of petrol - Antiknock agents - Unleaded petrol.

UNIT II: PETROCHEMICALS - II

Manufacture - Amination -Pyrolysis - Esterification- Compression ignition (CI) engine - Cetane number - Quality of diesel - Anti diesel knock agents - Flash point.

UNIT III: FERTILIZERS

Fertilizer - Nutrient function - Micro nutrient - Fertilizer type - Need - Classification - Ammonium nitrate - Ammonium Sulphate - Phosphate fertilizer - Phosphate rock - Normal superphosphate - Effects.

UNIT IV: PESTICIDES

Pesticides - DDT, BHC, Gammexane, fumigants, Rodenticides, Fungicides,

Herbicides, Synthetic insecticides, Pesticides pollution, Persistent pesticides, Biodegradation of pesticides.

UNIT V: FOOD ADULTERATION

Definition – Types - Common food adulterants - Causes, Effects, Prevention and Detection.

REFERENCES:

1. Industrial Chemistry - B.K.Sharma, 2003, Goel Publishing House, Meerut.
2. Industrial Chemicals - Faith etal, Wiley Interscience, New York.
3. Chemical Process Industries - R.N. Shreve, 2000; Tata McGraw Hill Publishing Company, Mumbai.
4. James A. K., Reigel's Handbook of Industrial Chemistry 9th Edition, CBS Publication 1997.
5. Principles of Industrial Chemistry, C. A. Clausen and G. Matts.
6. Chakrabarty B.N. (1981): Industrial chemistry, Oxford & IBH publishing Co., New Delhi.
7. Food adulteration and its detection, Jesse Park Battershall, Published by Book on Demand, Miami, 2015.
8. Environmental handbook for fertilizers and agrochemicals by J.Harold Parker
9. Manures fertilizers & Agrochemicals, TNAU, 2017.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Understand the composition of petrochemical products.	1, 2,	Understanding
CO-2	Experiment with the quality of diesel.	2, 4, 5	Applying
CO-3	Classify the fertilizers based on nutrients present.	1, 2, 4, 5	Analyzing
CO-4	Explain the effects of pesticides.	2, 3, 4, 5	Evaluating
CO-5	Test the quality of food.	1, 3	Creating

Relationship Matrix

Semester	Course Code			Title of the Course			Hours		Credits
III	21PICH31			Industrial Chemistry			60		4
Course Outcomes (COS)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO3	PLO4	PLO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓			✓	✓			
CO-2		✓	✓	✓	✓		✓		✓	✓
CO-3	✓	✓	✓	✓	✓	✓	✓		✓	✓
CO-4		✓	✓	✓	✓		✓	✓	✓	✓
CO-5	✓	✓	✓	✓	✓	✓		✓		
	Number of matches (✓) = 36 Relationship = High									

SEMESTER - IV

Course Title	Inorganic Chemistry - III
Total hrs	75
Hrs/Week	5
Sub. Code	**21PCCH41**
Course Type	DSC-X
Credits	4
Marks	100

General Objective:

To aquire knowledge about the structure, bonding, molecular orbital diagrams of organometallic complexes, metalloproteins and enzymes.

Course Objectives:

CO No.	The learners will be able to
CO – 1	Explain the basic concepts of organometallic compounds.
CO – 2	Construct the bonding and molecular orbital diagrams of organometallic complexes.
CO – 3	Analyze the reactions and applications of organometallic compounds.
CO – 4	Illustrate the role of Fe, Cu, Zn, Mn and Co in biological functions.
CO – 5	Rephrase the structures and functions of metals in metalloproteins.

UNIT I: ORGANOMETALLIC CHEMISTRY-I

Organometallic compounds - Classification - metal alkyls, metal carbonyls - Group 2 elements (Be, Mg) - preparation - $(CH_3)_2BeN(CH_3)_3$, Grignard reagent, Group 12 elements (Zn, Hg, Cd) - preparation - $Zn(C_2H_5)_2$ - Group 13 elements (B) - Preparation - $(CH_3\text{-}CH_2)_3B$, - Structure - $[(CH_3)_3AlF]_4$, $[(CH_3)_3In]_4$ - Group 14 elements (Sn, Ge) - Preparation - $(C_2H_5)_3Ge\text{-}Ge(C_6H_4CH_3)_3$ - structure - $(C_2H_5)_2SnF_2$ - Group 15 elements (P) - preparation - $(CH_3)_3P{=}CH_2$ - Classification of ligands - ligand for metal-carbon bond based different electron (e^-) numbers - $1e^-$ (CH_3-Mg-Br), $2e^-$ (para alkenyl organometallics), $3e^-$ (para allylicorganometallics), $4e^-$ (para butadiene organometallics), $5e^-$ (cyclopentadienyl organometallics), $6e^-$

(cyclooctatriene organometallics), $7e^-$ (Tropilium), $8e^-$ (cyclooctatetraene organometallics).

UNIT II: ORGANOMETALLIC CHEMISTRY-II

Hapticity of organic ligands - 18 electron rule - Electron count of metal carbonyls - $Fe(CO)_5$, $Fe(CO)_9$, $Mo(CO)_6$, $Mn_2(CO)_{10}$, $[\eta^5\text{-}C_2H_5\text{-}Re\text{-}(CO)_2\text{-}C_2H_5]$, $(\pi\text{-}C_7H_7)Co(CO)_3$.

Bonding - Multicentre bonds - $Li(CH_3)_4$, $[Al(CH_3)_2ph]_2$, Fluxionality - Ruthacene - Bonding in π-metal alkenyl complexes - Zeise's salt structure - $(K[PtCl_3(C_2H_4)]$ - Synergic effect - comparison of synergic effect in carbonyls - Binding in π-metal alkynyl complexes - $[C_2ph_2Pt(PPh_3)_2]$, $[C_2(C_6H_5)_2Co_2(CO)_6]$ - Bonding in ferrocene - MO diagram.

UNIT III: ORGANOMETALLIC CHEMISTRY-III

Metallocenes: Synthesis, properties, structure - Bessylocene, molybdenocene, ferrocene, magnocenes - Ferrocene aromaticity character - Nitration, Bromination, Friedel-crafts reaction, Vilsmeir reaction, Mannich Condensation.

Catalysis - hydrogenation of olefins (Wilkinson's catalyst), Hydroformylation of olefins using Cobalt or Rh catalyst (oxo process), Oxidation of olefins to -CHO or –CO - (Wacker process), Polymerization (Ziegler's Natta Catalyst), Cyclooligomerization of olefins and acetylenes using Ni catalyst (Reppe's catalyst).

UNIT IV: BIOINORGANIC CHEMISTRY-I

Bioinorganic compounds - metals; Fe, Cu, Zn, Mn, Co - Metabolism - storage and transport - metal containing protein - Heme protein, Ceruloplasmin, serum albumin, zinc finger protein, super oxide dismutase, vitamin B12 - Na and K metals - chlorophyll - Homeostasis of calcium - Role of Ca^{2+} and Mg^{2+} ions - Ca pump - Na/K pump - Role of Mg^{2+} ions in energy in blood clotting - Role of H^+-K^+ pump to maintain high acidity.

UNIT V: BIOINORGANIC CHEMISTRY-II

Structure and function - Metalloproteins, enzymes - Hemoglobin, myoglobin, cytochrome - O_2 binding mechanism - Heterotropic allosteric effect on O_2 - Hemerythin, hemocyanine - Oxygen uptake - Blue copper protein, superoxide dismutase (SOD) - oxygen transport mechanism - Bohr effect - Metal storage protein - Ferritin, transferrin.

Porphyrin and macrocycle rings - Aromaticity - Porphyrin, Chlorin, Baterochlorin, Corrin ring, Corphin - Flexibility of the ring.

REFERENCES:

1. Advanced Inorganic Chemistry, F. A. Cotton, R. G. Wilkinson, 6thEdn., Wiley, 1996.
2. Inorganic Chemistry - Principles, structure and reactivity, IV edition, James E. Huheey, Ellen A Keitier, Richard Lkeiter Pearson Publication (2012).
3. Solid State Chemistry and its Applications, A.R. West, Wiley, 1984.
4. Bio-inorganic chemistry, K. Hussain Reddy,1st Edn, Newage Publishers, 2003, Advanced Inorganic Chemistry, F. A. Cotton, R. G. Wilkinson, 6thEdn., Wiley, 1996.
5. Advanced Inorganic chemistry, Satyaprakash, G.D. Tuli and S.K. Basu, Volume. 1,S. Chand. Company, 2006.
6. Modern Inorganic Chemistry, William L. Jooly, Magraw-Hill, 1991.
7. Biophysical, Bioorganic & Bioinorganic chemistry, Asim. K. Das, Mahua Das, 2004.
8. Principles of Inorganic Chemistry, Puri, Sharma, Kalia, 33rd edition, Vishal publishing, 2016.
9. Selected Topics in inorganic Chemistry, Wahid U. Malik, G.D. Tuli, R.D. Madan, S. Chand, 8th edition, 2018.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Understand the organometallic compounds.	2, 3	Understanding
CO-2	Apply the valence bond and molecular orbital theories to determine the structure of complexes.	1, 2, 5	Applying
CO-3	Examine the reactions of metallocenes.	1, 2, 3, 4	Analyzing
CO-4	Compare the role of metals in biological processes.	2	Evaluating
CO-5	Discuss the structure and functions of metalloproteins.	1, 2, 3	Creating

Relationship Matrix

Semester	Course Code			Title of the Course		Hours			Credits
IV	21PCCH41			Inorganic Chemistry III		75			4
Course Outcomes (COS)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1		✓	✓	✓	✓		✓	✓		
CO-2	✓	✓	✓	✓	✓	✓	✓			✓
CO-3	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO-4		✓	✓				✓			
CO-5	✓	✓	✓	✓	✓	✓	✓	✓		
	Number of matches (✓) = 34 Relationship = High									

Semester - IV

Course Title	Advanced Organic Chemistry
Total hrs	75
Hrs/Week	5
Sub. Code	**21PCCH42**
Course Type	DSC-XI
Credits	4
Marks	100

General Objective:

To gain knowledge about disconnection approach of organic molecules on the basis of synthons and synthetic equivalents.

Course Objectives:

CO No.	The learners will be able to
CO - 1	Acquire knowledge about basic concepts of retrosynthetic analysis.
CO - 2	Explain the retrosynthesis based reactions.
CO - 3	Rephrase the steps involved in synthesis of ring and complex molecules.
CO - 4	Outline the role of metals in organic reactions.
CO - 5	Illustrate the olefination and metathesis reactions.

UNIT I: RETROSYNTHETIC ANALYSIS

Disconnection approach - Basic principles of Synthons and Reagents - Synthesis of Aromatic compounds - The order of events - One group disconnections - Chemo selectivity - Two group C-X disconnection - Reversal of polarity and cyclisations - Amine synthesis - Protecting groups - One group C-C disconnections for alcohols - General Strategy A: Choosing disconnection - Stereoselctivity.

UNIT II: RETROSYNTHETIC ANALYSIS BASED REACTIONS

Synthons (acceptor and donor) - Retrosynthetic analysis - Umpolung - antithesis - chiron - C-C bond forming reactions (alkylation as well as enamine

alkylation) - Aldol, directed aldol condensation - Michael Additions - Robinson annulations - Cycloaddition methodology in synthesis - Synthesis of cyclic structures.

UNIT III: RING SYNTHESIS AND COMPLEX MOLECULES

Ring Synthesis

Introduction to ring - saturated heterocycles - synthesis of 3,4,5 and 6 membered rings - rearrangements and photochemistry in synthesis - aromatic heterocycles.

Complex molecules

Synthetic routes based on retrosynthetic analysis for following molecules: Longifoline - Reserpine - Juvabione - Aphidicoline - Taxol.

UNIT IV: TRANSITION METAL COMPLEX IN ORGANIC REACTIONS

Transition metal complexes in organic synthesis; only Pd, Ni, Co, Fe (Metal mediated) C-C and C-X bond formation reactions: Heck - Stille - Fukuyama - Kumada - Hiyama - Negishi - Buchwald-Hartwig - Noyori - Reppe - and Oxo process.

C=C formation reactions: Horner-Wordworth-Emmons - Shapiro - Bamford Stevens - McMurry and Peterson olefination reactions.

UNIT V: REACTION AND APPLICATIONS OF FOLLOWING REAGENTS

Titanium-carbene mediated olefination: Tebbe - Petasis and Nysted reagent - Multi-component reactions: Ugi - Passerini - Biginelli and Mannich reactions - Ring formation reactions: Pausan-Khand - Bergman and Nazerov cyclization - Metathesis: Grubbs 1st and 2nd generation catalyst, Olefin cross coupling (OCM) - ring closing (RCM) and ring opening (ROM) metathesis and applications.

REFERENCES:

1. Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, J. March, M.B. Smith, 6th Edn., Wiley, 2007.
2. Advanced Organic Chemistry, Part B: Reactions and Synthesis, F.A. Carey, R.A. Sundberg, 5th Edn., Springer, 2007.
3. Advanced Organic Chemistry: Reaction Mechanism, R. Bruckner, Academic Press, 2002.
4. Modern Methods of Organic Synthesis, W. Carruthers, I. Coldham, Cambridge University Press, 2005.
5. Chemistry of Natural Products, S.V. Bhat, B.A. Nagasampagi, N. Sivakumar, Narosa Publishing House, New Delhi, 2010.

6. Organic Chemistry, I L Finar, Vol II ELBS, 5th Edn., 2000
7. Medicinal Chemsitry, Ashutosh Kar, 2nd Edn., New Age International (Pvt.) Publishers, 2007.
8. Organic Chemistry of Natural Products, Volume II, Chatwal Gurdeep R, Himalaya Publishing House, 2009.
9. S. Sankararaman, Pericyclic Reactions-A Text Book, Wiley VCH, 2005.
10. Organic Chemistry, J. Clayden, N. Greeves, S. Warren, P. Wothers, Oxford University Press, 2004.
11. Organic Chemistry, Volume II, Stereochemistry and the Chemistry of Natural Products, I.L. Finar, Longmans, 1964.
12. Organic Synthesis: The Disconnection Approach: Stuart Warren, Chichester, UK : John Wiley & Sons, 2008.
13. Organometallics in organic synthesis - J. M. Swan and D. C. Black (Chapman and Hall), 2004
14. Advanced organic chemistry, Part B - F. A Carey and R. J. Sundberg, 5th edition, 2007.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Understand the basics of retrosynthetic analysis	1,2, 3	Understanding
CO-2	Identify the synthons and synthetic equivalents.	3, 4, 5	Applying
CO-3	Analyze the synthetic routes of rings and complex molecules.	2,3, 5	Analyzing
CO-4	Explain the role of transition metal complex in organic synthesis.	1, 2	Evaluating
CO-5	Discuss the reaction and applications of various reagents	1, 3, 5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
IV	21PCCH42	Advanced Organic Chemistry	75	4

Course Outcomes (COS)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓	✓	✓	✓	✓	✓		
CO-2		✓	✓	✓	✓			✓	✓	✓
CO-3		✓	✓	✓	✓		✓	✓		✓
CO-4	✓	✓	✓			✓	✓			
CO-5	✓	✓	✓	✓	✓	✓		✓		✓
	Number of matches (✓) = 35 Relationship = High									

Semester - IV

Course Title	PROJECT
Total hrs	120
Hrs/Week	8
Sub. Code	21PPCH41
Course Type	PROJECT
Credits	4
Marks	150

The following are the guidelines to be adhered to by the Postgraduate students :

- Individual Projects should be taken.
- The Project should be written in English only.
- The Minimum number of pages should be 60.
- Project observations, suggestions and summation/conclusion shall form part of the Project Report.
- The Projects will be evaluated by the Internal Examiner and the External Examiner for 150 marks. The distribution of mark should be 90 marks for the Project Report and 60 marks for the Viva-Voce Examination. The Division of marks for the Project Report is as follows:

Particulars	Internal Examiner	External Examiner
Wording of Title	5	5
Objectives / Formulation including Hypothesis	10	10
Review of Literature	15	15
Relevance of the Project to Social Needs	10	10
Methodology / Technique / Procedure Adopted	30	30
Summary / Findings / Conclusion / Summation	10	10
Bibliography / Annexure / Foot notes / Works Cited / Works Consulted	10	10
Total	90	90

- The Internal Examiner and the External Examiner will award the marks for each candidate. The average mark obtained by the candidate is considered marks for the Project Report.

Semester - IV

Course Title	Advanced Topics in Chemistry
Total hrs	60
Hrs/Week	4
Sub. Code	**21PECH41A**
Course Type	DSE-IVA
Credits	4
Marks	100

General Objective:

To study Nano Chemistry, Green Chemistry, supra molecules and spectroscopic methods for material characterization

Course Objectives:

CO No.	The learners will be able to
CO - 1	Understand the basic concepts of Nano Chemistry.
CO - 2	the green Chemistry of synthesis
CO - 3	Analyze the interactions and applications of supramolecules.
CO - 4	Explain Illustrate the principles of microscopic and spectroscopic techniques.
CO - 5	Formulate the physical concepts and splitting in Mossbauer spectroscopy.

UNIT I: NANO CHEMISTRY

Background to Nanoscience - Scientific revolution - Atomic Structure and atomic size, emergence and challenges of nanoscience - Nanostructures - Carbon Nanotubes (CNT), Graphenes, Fullerenes, Quantum Dots and Semiconductor Nanoparticles - Metal based nanostructures (nanoparticles, nanowires, nanorod) - Polymer-based Nanostructures - Coreshell, dendrimers - Applications of nanomaterials (chemical synthesis, nanomedicine). Nanoscience and Interface: Intermolecular forces, Van der Waals forces (Kessorn, Debye, and London Interactions).

UNIT II: GREEN CHEMISTRY

Green chemistry - Atom efficiency - Catalysis- Solid acids and bases- Catalytic reduction - Microwave synthesis - Electro-organic methods - Biocatalysis - Advantages in industry – Challenges - Soil enrichment - Bioisosteric modification - Homogenous biocatalysis – Cyclodextrin - Green solvents - Ionic liquids - Super

critical carbon dioxide - Super critical water - Industry perception - Solar energy - updraft tower - Ocean waves- hydroelectricity - Geothermal energy – Biodiesel - Biofuel.

UNIT III: SUPRAMOLECULAR CHEMISTRY

Supramolecular interaction - Ion-Ion, Ion-dipole, Dipole-dipole interactions - Hydrogen bonding – Cation-π, Anion-π, π-π interactions, Vanderwaals forces, closed shell interactions - Hydrophobic and salvation effects – enzymes - characteristics - Mechanism - coenzyme, Biochemical self assembly chemistry - Cation binding host - Supramolecular cation coordination chemistry, Crown ether, Lariat ethers, Podanes, Cryptanes, Sphenads.

UNIT IV: MICROSCOPIC AND SPECTROSCOPIC CHARACTERIZATION

Microscopic techniques: Principle, Instrumentation and applications - Scanning electron microscope (SEM) - Tunneling electron microscope (TEM) - Atomic force microscope (AFM). Sample preparation for SEM, TEM, AFM analyses.

Spectroscopic techniques: Principle, Instrumentation and applications - Atomic absorption spectroscopy (AAS) - Photoelectron spectroscopy (PES). .

UNIT V: MOSSBAUER SPECTROSCOPY

Physical concepts, spectral line shape, isomer shift, quadrupole splitting, magnetic hyperfine interaction - Temperature shift - Nuclear Zeeman effect - Interpretation of Mossbauer parameters of ^{57}Fe and ^{119}Sn. Applications to Solid - state reactions, thermal decomposition, ligand exchange, electron transfer and isomerism- Antiferromagnetic transition in ferrous fluoride.

REFERENCES:

1. Green Chemistry, V. K. Ahluwalia, 2nd edition, Ane's book Pvt Ltd.
2. Chemistry of nanomaterials: Synthesis, properties and applications by CNR Rao et.al. 2.
3. Nanoparticles: From theory to applications - G. Schmidt, Wiley Weinheim 2004.
4. A.W. Adamson and A.P. Gast, Physical Chemistry of surfaces, Wiley Interscience, NY 2004.
5. P.C Hiemen and R.Rajgopalan, Principle of colloid and surface Chemistry, NY Marcel Dekker, 1997.
6. M. J. Rosen, Surfactant and Interfacial phenomena, Wiley Inter Science Publication, NY 2004.
7. Handbook of Molecular Descriptors, R. Mannhold, H. Kubinyi, H. Timmerman (Eds) VCH Verlag 2002.
8. Molecular Modeling, Principles and Applications, Andrew R. Leach, II Edition, 2001, Dorset Press, Dorchester, Dorset.
9. NMR, NQR, EPR and Mossbauer spectroscopy in inorganic chemistry, R.V. Parrish, Ellis Horwood Limited, UK, 1990.
10. Green chemistry and Engineering, Mukesh Doble and Anil Kumar, Elsevier, 2017.
11. Green chemistry and catalysis, Roger. A. Sheldon, Et.al. Wiley, Verleg, 2007.
12. Supramolecular chemistry, Jonathan. W. Steed and Jerry Atwood. 2nd edition, Wiley, 2009.
13. Scanning electron microscopy and X-ray microscopy, J.I. Goldstein, D.E. Newbury, P. Echlin, D. E. Joy, C. Fiori and E. Lifshin, Plenum Press, New York, Springer, 1981.

14. Transmission electron microscopy, D. B. Williams, C. B. Carter and C. Barry, Plenum press, Springer, 2009.
15. Scanning electron microscopy and X-ray microscopy, J.I. Goldstein, D.E. Springer, 2003.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Summarize the applications of nano particles.	2, 4, 5	Understanding
CO-2	Apply green principles to prepare compounds.	1, 2, 3, 5	Applying
CO-3	Analyze the guest-host interactions in supramolecules.	1, 5	Analyzing
CO-4	Interpret the morphological structure of molecules using microscopic techniques.	1, 3	Evaluating
CO-5	Discuss the applications of Mossbauer spectroscopy.	1, 3	Creating

Relationship Matrix

Semester	Course Code			Title of the Course		Hours			Credits
IV	21PECH41A			Advanced Topics in Chemistry		60			4
Course Outcomes (COS)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)			
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1		✓	✓	✓	✓		✓		✓	✓
CO-2	✓	✓	✓	✓	✓	✓	✓	✓		✓
CO-3	✓	✓	✓	✓	✓	✓				✓
CO-4	✓	✓	✓	✓	✓	✓		✓		
CO-5	✓	✓	✓	✓	✓	✓		✓		
	Number of matches (✓) = 37 Relationship = High									

Semester - IV

Course Title	Food Chemistry
Total hrs	60
Hrs/Week	4
Sub. Code	**21PECH41B**
Course Type	DSE-IVB
Credits	4
Marks	100

General Objective:

To know about food contaminants, separation techniques and role of mass spectroscopy in food analysis

Course Objectives:

CO No.	The learners will be able to
CO – 1	Understand the concepts of food additives and contaminants.
CO – 2	Acquire knowledge about separation techniques used in food analysis.
CO – 3	Explain pesticides residues in food
CO – 4	Illustrate the importance of food safety.
CO – 5	Discuss the importance of mass spectrometry in food analysis.

UNIT I: FOOD ADDITIVES AND CONTAMINANTS

Food additives - Vitamins, amino acids, minerals, Aroma substance flavour enhancers - monsodium glutamate, 5-nucleotides. Sugar substitutes, sorbital. Sweeteners-saccharin, cyclamate. Food colour. Anti-nutritional factors and food contaminant: Toxic-trace elements, radio nuclides.

UNIT II: FOOD ANALYSIS BY CHROMATOGRAPHY TECHNIQUE

Determination of water activity in foods, Determination of level of artificial sweeteners, Determination of crude fiber in food products, Determination of Antioxidant in fruits, vegetables, Determination of polyphenols in lemon juice, Determination of fat in grains; Determination of proteins in flour, Determination of tannins in coffee/tea, caffeine content in coffee, Determination of Vitamin C, Determination of Iron , calcium in foods, Determination of Ash content in flour; Determination of total soluble solids in fruit juice, determination of reducing and non reducing sugars in food.

UNIT III: PESTICIDE RESIDUES IN FOOD

Major contaminants in food - organic contaminants - dioxins, PCBs, PCNs, veterinary drug residues, agrochemicals residues, heat-generated toxicants, heavy metals and metalloids, microbiological contaminants, mycotoxins, phycotoxins plant-derived contaminants.

UNIT IV: PHYCOTOXIN

Food safety issues - origin of phycotoxin and mechanism of phycotoxin - ciguatoxin, pinnatoxin, ichthyotoxin, - food safety control of marine toxins, climate change and water toxins, and microalgae as a source of nutraceuticals.

UNIT V: MASS SPECTROMETRIC ANALYSIS

Matrix-assisted laser desorption/ionization mass spectrometry imaging (MALDI-MSI) - principle of MALDI-MSI. Detect the food compounds in a tissue section without extraction, purification, separation or Labeling. Application of MALDI-MSI.

REFERENCES:

1. Fennema, O.R. 1985. Food Chemistry, Marcer Dekker Inc., New York
2. H.D. and Grosch, W. 1987. Food Chemistry
3. Belitz Srinivas, D. and Alan Praf, 1997. Food Proteins and their Applications. Marcel Dekker Inc., New York.
4. Turker, G.A. and Woods, LFJ, 1995. Enzymes in Food Processing. Blackie Academic Professionals.
5. Williams, P.A. and Phillips, G.O. 2000. Gums and Stabilizers for the Food Industry. Royal Society of Chemistry
6. Robinson DS. 1987. Food Biochemistry and Nutritional Value. Longman.
7. Luis M. Botanan, Wiley, Phycotoxins chemistry and biochemistry
8. Y. Yoshimura, Significant advancement of mass spectrosmetry imaging for food chemistry, Food chemistry, 2016.
9.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Outline the contaminants and additives used in food.	1, 4, 5	Understanding
CO-2	Experiment with the techniques of analyzing food.	2, 3, 4, 5	Applying
CO-3	Analyze the pesticide residues present in food.	1, 2, 4, 5	Analyzing
CO-4	Appraise the food safety issues.	2, 4, 5	Evaluating
CO-5	Test the food using Mass spectrometry.	1, 3	Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
IV	21PECH41B	Food Chemistry	60	4

Course Outcomes (COS)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓	✓	✓	✓			✓	✓
CO-2		✓	✓	✓	✓		✓	✓	✓	✓
CO-3	✓	✓	✓	✓	✓	✓	✓		✓	✓
CO-4		✓	✓	✓	✓		✓		✓	✓
CO-5	✓	✓	✓	✓	✓	✓		✓		
	Number of matches (✓) = 39 Relationship = High									

Semester IV

Course Title	Polymer Science
Total hrs	60
Hrs/Week	4
Sub. Code	**21PECH41C**
Course Type	DSE-IVC
Credits	4
Marks	100

General Objective:

To explore the ideas about polymeric materials.

Course Objectives:

CO No.	The learners will be able to
CO - 1	Understand the processing of polymers.
CO - 2	Outline the microstructure of polymers using different techniques.
CO - 3	Determine the molecular weights of polymers.
CO - 4	Explain the mechanical properties of polymers.
CO - 5	Discuss the thermal properties of polymers.

UNIT I POLYMER PROCESSING

Rheology - Processing of thermoplastics - Injection moulding - Extrusion - Blown film - Cable coating - Cast film extrusion - Mesh extrusion - Profile extrusion - Fibre spinning - Strand pelletising - Pipe extrusion - Blow moulding - Thermoforming - Rotational moulding - Processing of thermosetting polymers - Compression moulding - Transfer moulding - Injection moulding - Expanded plastics - Coating systems.

UNIT II MICROSTRUCTURE OF POLYMERS

Stereoregularity - Semi-crystalline thermoplastics - Degree of crystallinity - Density method - X-ray method - Infra-red method - Thermal analysis method - Cross linking - Copolymer arrangements - Domain structures - Degree of molecular orientation - Briefrengence, Sonic technique, X-ray method, Infra-red method.

UNIT III POLYMER BEHAVIOR

Degradation - Viscoelasticity - Voigt model - Maxwell model - Shortcomings - Dynamic mechanical thermal behavior - Relaxation transitions - Molecular weight - End group analysis, Colligative property measurement, Light scattering,

Ultracentrifugation, Gel Permeation chromatography - Molecular chain - Side groups - Molecular polarity - Molecular symmetry - Second glass transitions.

UNIT IV MECHANICAL PROPERTIES

Tensile properties - Effects - Testing speed and time, water absorption, Long term loading - Flexural properties - Compressive properties - Shear properties - Hardness - Impact properties and fracture toughness - Charpy test - Izod test - Falling weight test - Fracture mechanics approach - Bearing strength - Environmental stress cracking - Fatigue and wear.

UNIT V THERMAL PROPERTIES

Differential Scanning Calorimetry - Degree of crystallinity - Specific heat capacity - Oxidative induction time/temperature - Thermogravimetric analysis - Thermomechanical analysis - Time-temperature superposition - Service temperature limits - Annealing and orientation - Polymer blends - Plasticizers and moisture effects - Softening temperature - Heat distortion temperature - Vicat softening temperature - Thermal conductivity.

REFERENCES:

1. Introduction to Polymer Science and Technology, Mustafa Akay, Bookboon, The eBook Company, 2015.
2. Textbook of Polymer Science, Fred W. Billmeyer Jr, 3rd edition, Wiley-Interscience Publications, New York, 1984.
3. Thermal characterization of polymeric materials, Turi EA, Volumes 1 & 2, 2nd edition, Academic Press, San Diego, 1997.
4. Material Science and Engineering, An Introduction, Callister WD, 7th edition, Wiley-Interscience Publications, New York, 2007.
5. Handbook of polymer testing, physical methods, Brown R, Marcel Dekker, New York, 1999.
6. Plastic materials and processing, Strong AB, Prentice Hall, New Jersey, 1996.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Understand the different processes of moulding.	1, 2	Understanding
CO-2	Apply suitable technology to analyze the microstructure of polymers.	1, 2, 3, 4, 5	Applying
CO-3	Analyze the behavior of polymers using different tests.	1, 2	Analyzing
CO-4	Explain the mechanical strength of polymers.	1, 2	Evaluating
CO-5	Discuss the thermal behavior of polymers using different techniques.	2, 3, 5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
IV	21PECH41C	Polymer Science	60	4

Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓			✓	✓			
CO-2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO-3	✓	✓	✓			✓	✓			
CO-4	✓	✓	✓			✓	✓			
CO-5		✓	✓	✓	✓		✓	✓		✓
	Number of matches (✓) = 32 Relationship = Medium									

Semester - IV

Course Title	**Inorganic Chemistry Practical - II**
Total hrs	60
Hrs/Week	4
Sub. Code	**21PCCH4P1**
Course Type	Practical-VII
Credits	2
Marks	100/2

General Objective:

To learn about inorganic concepts for qualitative analysis, gravimetric estimation of inorganic complexes and analytical techniques like UV spectrophotometer.

Course Objectives:

CO No.	**The learners will be able to**
CO - 1	Understand the qualitative analysis of inorganic complexes.
CO - 2	Demonstrate the gravimetric estimation of inorganic complexes.
CO - 3	Explain the preparation and characterization of inorganic complexes.
CO - 4	Acquire the knowledge on handling UV spectrophotometer.
CO - 5	Discuss the principle of UV spectrophotometer.

I. Gravimetric estimation and Qualitative analysis

1. Estimation of copper (V) and Nickel (G)
2. Estimation of Copper (V) and Zinc (G)
3. Estimation of Iron (V) and Nickel (G)
4. Estimation of Barium (G) and Calcium (V)

II. Complex preparation and characterization by UV-Visible spectroscopic techniques (include three)

1. Estimation of Cu(II) and Ni(II) -Spectrophotometric
2. Potassium ferrioxalate
3. Hexaammine cobalt(II) chloride
4. Hexaammine nickel(II) chloride
5. Cis-Chromiumdioxalatodihydrate
6. $[Ni(NH_3)_6]Cl_2$

REFERENCES:

1. Vogel's Qualitative Inorganic Analysis, 7th edition, Pearson, 2006.
2. College Practical Chemistry, V.K. Alhuvalia, Sunita Dingra, 1- Edition, University Press, 2005.
3. A collection of interesting general chemistry experiments, A. J. Elias, University Press, 2002.
4. Inorganic Chemistry Practical, Deepak Pant, e-book, Book-Six edition, University press, 1992.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Understand the gravimetric estimation of metal ions.	1, 2, 3, 5	Understanding
CO-2	Apply different methodologies to prepare complexes.	1, 2	Applying
CO-3	Analyze the spectra of complexes.	3, 4, 5	Analyzing
CO-4	Compare the spectra of complexes.	1, 2	Evaluating
CO-5	Discuss the structure of complexes.	2, 3, 4, 5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
IV	21PCCH4P1	Inorganic Chemistry Practical- II	60	2

Course Outcomes (COS)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓	✓	✓	✓	✓	✓		✓
CO-2	✓	✓	✓			✓	✓			
CO-3			✓	✓	✓			✓	✓	✓
CO-4	✓	✓	✓			✓	✓			
CO-5		✓	✓	✓	✓		✓	✓	✓	✓
	Number of matches (✓) = 33 Relationship = Medium									

Semester - IV

Course Title	Green and Nanochemistry Practical
Total hrs	60
Hrs/Week	4
Sub. Code	**21PCCH4P2**
Course Type	Practical-VIII
Credits	2
Marks	100/2

General Objective:

To understand about Green Chemistry concepts in organic compounds preparation using eco-friendly starting materials and solvents.

Course Objectives:

CO No.	The learners will be able to
CO - 1	Understand the use of green solvents for preparation.
CO - 2	Explain the green concepts in preparation of organic compounds.
CO - 3	Analyze the various methods adopted in the preparation of nano particle.
CO - 4	Explain ecofriendly starting materials and solvents.
CO - 5	Discuss the basic principle of nanoparticle synthesis.

I. Preparation of compounds using Green Chemistry

1. Synthesis of adipic acid
2. Synthesis of biodiesel
3. Preparation of benzopinacolone
4. Preparation of 1, 1-bis-2-naphthol
5. Preparation of 4-nitrosalicylic acid
6. Preparation of 1,5-Diphenyl-penta-1,4-dien-3-0ne

II. Preparation of compounds using Nanochemistry

1. Synthesis of Barium nanoparticles by precipitation method.
2. Synthesis of zinc nanoparticles by bioreduction method.
3. Synthesis of copper nanoparticles by bioreduction method.
4. Synthesis of Iron nanoparticles by bioreduction method.

REFERENCES:

1. Lab Experiments in Organic Chemistry, Arunsethi, New Age International Publishers, 2010.
2. The Systematic Identification of Organic Compounds R.L. Shriner, C.K.F. Hermann, T.C. Morrill, D.Y. Curtin & R.C. Fuson John Wiley & Sons, Inc., 1997.
3. Identification of organic compounds. By N. D. Cheronis and J. B. Entrikin. Interscience Publishers, New York, 1963.
4. Organic Cum Practical Hand Book Of Organic Chemistry, B J Hassard
5. Organic Experiments, Louis F. Fisser, Kenneth Williamson, D.C. Heath and Company, 1992.
6. A Hand Book Of Organic Analysis: Qualitative and Quantitative, Hans Thacher Clarke,1916.
7. Experimental Organic Chemistry, H Dubont Durst And George W Gokal, 2nd Edn., New York: McGraw-Hill, 1987.
8. Practical Organic Chemistry, F G Mann and B C Saunders, 4th Edn., Pearson Education Ltd., 2009.
9. Textbook Of Practical Organic Chemistry, A I Vogel, Prentice Hall; 5th Edn., 1989.
10. Systematic Organic Chemistry, Modern Methods of Preparation and Estimation. By W.M. Cumming, I. Vance Hopper, and T. Sherlock Wheeler, London, 1923.
11. Monograph on Green Chemistry Laboratory Experiments, Green Chemistry Task Force Committee, DST.
12. Green synthesis of metals and their oxide nanoparticles: application for environmental remediation, Journal of nanobiotechnology, Jagpreet Singh, Springer, 2018.
13. Synthesis of silver nanoparticles: Chemical, physical and biological methods, Research in pharmaceutical Sciences, S. Iravani, Res. Pharm Sci, 2014.
14. Practical Approach to green chemistry, Meena Bhandari, Seema Raj, International Journal of Pharmacy and Pharmaceutical Sciences, 2017.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Illustrate the green techniques to prepare organic compounds.	1, 3, 4, 5	Understanding
CO-2	Choose the solvents for green preparation of inorganic complexes.	1, 3	Applying
CO-3	Analyze the radicals using green reagents.	2, 3	Analyzing
CO-4	Explain the green chemistry involved in the analysis of organic compounds.	1, 3	Evaluating
CO-5	Adopt green methodology to prepare metal nano particles.	2, 3, 4, 5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
IV	21PCCH4P2	Green and Nano Chemistry Practical	60	4

Course Outcomes (COS)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓	✓	✓	✓		✓	✓	✓
CO-2	✓	✓	✓	✓	✓	✓		✓		
CO-3		✓	✓	✓	✓		✓	✓		
CO-4	✓	✓	✓	✓	✓	✓		✓		
CO-5		✓	✓	✓	✓		✓	✓	✓	✓
	Number of matches (✓) = 37 Relationship = High									

INTERDISCIPLINARY COURSES (2021 – 2024)							
SEM	TITLE OF THE COURSE	COURSE CODE	H/W	C	MARKS		
					I	E	T
DEPT. OF ENGLISH							
II	SOFT SKILLS	**21PIEN11**	**2**	**2**	**40**	**60**	**100/2**
III	ENGLISH FOR BUSINESS COMMUNICATION	**21PIEN31**	**2**	**2**	**40**	**60**	**100/2**
DEPT. OF HISTORY							
II	INDIAN HISTORY FOR COMPETITIVE EXAMINATIONS UPTO 1707A.D	**21PIHS11**	**2**	**2**	**40**	**60**	**100/2**
III	INDIAN HISTORY FOR COMPETITIVE EXAMINATIONS FROM (1707-1947 A.D)	**21PIHS31**	**2**	**2**	**40**	**60**	**100/2**
DEPT. OF COMMERCE							
II	ENTREPRENEURIAL DEVELOPMENT	**21PICO11**	**2**	**2**	**40**	**60**	**100/2**
III	HUMAN RESOURCE MANAGEMENT	**21PICO31**	**2**	**2**	**40**	**60**	**100/2**
DEPT. OF MATHEMATICS							
II	DISCRETE STRUCTURE – I	**21PIMA11**	**2**	**2**	**40**	**60**	**100/2**
III	DISCRETE STRUCTURE – II	**21PIMA31**	**2**	**2**	**40**	**60**	**100/2**
DEPT. OF CHEMISTRY							
II	ANALYTICAL BIOCHEMISTRY	**21PICH11**	**2**	**2**	**40**	**60**	**100/2**
III	INDUSTRIAL CHEMISTRY	**21PICH31**	**2**	**2**	**40**	**60**	**100/2**
DEPT. OF COMPUTER SCIENCE							
II	DIGITAL LITERACY	**21PICS11**	**2**	**2**	**40**	**60**	**100/2**
III	DIGITAL TECHNOLOGY	**21PICS31**	**2**	**2**	**40**	**60**	**100/2**
DEPT. OF MICROBIOLOGY							
II	MICROBIOLOGY AND HUMAN HEALTH	**21PIMB11**	**2**	**2**	**40**	**60**	**100/2**
III	ENTREPRENEURSHIP IN MICROBIOLOGY	**21PIMB31**	**2**	**2**	**40**	**60**	**100/2**
DEPT. OF PHYSICS							
II	THE BASICS OF DIGITAL ELECTRONICS	**21PIPH11**	**2**	**2**	**40**	**60**	**100/2**
III	ENERGY PHYSICS	**21PIPH31**	**2**	**2**	**40**	**60**	**100/2**
DEPT. OF ZOOLOGY							
II	ORNAMENTAL FISH CULTURE	**21PIZO11**	**2**	**2**	**40**	**60**	**100/2**
III	APPLIED ZOOLOGY	**21PIZO31**	**2**	**2**	**40**	**60**	**100/2**
DEPT. OF NUTRITION AND DIETETICS							
II	DIET THERAPY-I	**21PIND11**	**2**	**2**	**40**	**60**	**100/2**
III	DIET THERAPY-II	**21PIND31**	**2**	**2**	**40**	**60**	**100/2**

THE SCHEME OF EXAMINATIONS UNDER CHOICE BASED CREDIT SYSTEM

- The medium of instruction in all the UG and PG Programmes is English and Students shall write the CIA Tests and the Semester Examinations in English. Three CIA Tests for one hour each will be conducted. For the calculation of CIA Tests marks the average of the best two tests will be taken. The portion for each test can be 1.5 units of the unitized syllabi.
- Two assignments for the Undergraduate Programmes and one assignment and one seminar for the Postgraduate Programmes are compulsory.
- Two Practical Examinations will be conducted for CIA at the end of the semester and the average will be taken.

Distribution of Marks for the Students admitted into the UG and PG Programmes from the academic year 2021-2022

CIA Tests and Semester Examinations

Undergraduate, Certificate, Diploma and Advanced Diploma Programmes						
Course Type	TOTAL MARKS	CIA TESTS MAX.MARKS	SEMESTER EXAMINATION Max. Marks	PASSING MINIMUM		
				CIA	SEM. EXAM	OVERALL
Theory	100	25	75	Nil	30	40
Practical (2Hrs.)	50	20	30	Nil	12	20
Practical (4Hrs.)	100	40	60	Nil	24	40
Project	100	Nil	Report- 60 Marks Viva-Voce- 40 Marks	Nil	Nil	100

Postgraduate Programmes						
Course Type	TOTAL MARKS	CIA MARKS	SEMESTER EXAM	PASSING MINIMUM		
				CIA	SEM. EXAM	OVERALL
Theory	100	40	60	Nil	30	50
Practical	50	20	30	Nil	15	25
Practical (for PG Maths only)	100	40	60	Nil	30	50
Project Report	150	Nil	Project Report- 90 Marks Viva-Voce Examination - 60 Marks	Nil	Nill	150

CIA TESTS

Distribution of Marks

Components	Tests (A)			Assignment (B)	Seminar (C)	Record Note (D)	Total (A+B+C+D)
	I	II	III				
UG-Theory	20	20	20	5	-	-	25
	The Average of the Best Two Tests:20						
PG-Theory	30	30	30	5	5	-	40
	The Average of the Best Two Tests:30						
UG-Practical (2 hrs)	15	15		-	-	5	20
	The Average of the Tests: 15						
UG-Practical (4 hrs)	30	30		-	-	10	40
	The Average of the Tests: 30						
PG-Practical	15	15		-	-	5	20
	The Average of the Tests: 15						
PG-Practical (Maths only)	30	30		-	-	10	40
	The Average of the Tests: 30						

Question Pattern for CIA Test (Theory)

Programme	Question Paper Pattern			Total (A+B+C)
	Part-A	Part-B	Part-C	
UG	MCQs-8x0.5=4 marks	Internal Choice (Either or type). 2x4=8 marks Answer should not exceed 250 words	Internal Choice (Either or type) 1x8=8 marks Answer should not exceed 500 words	20
PG	MCQs-20x0.5=10 marks	Internal Choice (Either or type) 3x4=12 marks Answer should not exceed 250 words	Internal Choice (Either or type) 1x8=8 marks Answer should not exceed 500 words	30

End Semester Examination (ESE)

The students who have put in the required number of days of attendance are eligible to appear for the End Semester Examinations irrespective of whether they have passed in the CIA Tests or not. They have to pay the examination fees for all the current courses and the arrear courses, if any,

and submit the application form before the due date specified for the purpose. For any reason, the dates will not be extended. Hall tickets will be issued only for those who have paid the fees. The question papers for the End Semester Examinations for all the theory courses of the UG and the PG Programmes will be set for 75 marks.

Question Pattern for End Semester Examinations (Theory)

Programme	Question Paper Pattern			Total (A+B+C)
	Part-A	**Part-B**	**Part-C**	
UG	MCQs- 30x0.5=15 marks	Internal Choice (Either or type) 5x4=20 marks Answer should not exceed 250 words	Internal Choice (Either or type) 5x8=40 marks Answer should not exceed 500 words	**75**
PG	MCQs- 30x0.5=15 marks	Internal Choice (Either or type) 5x4=20 marks Answer should not exceed 250 words	Internal Choice (Either or type) 5x8=40 marks Answer should not exceed 500 words	$\left(\frac{x}{75} \times 60\right)$ **60**

The Question Paper Pattern for the End Semester Examinations (Practical)

The Question Paper Pattern is designed by the respective departments.