

ताळगांव पठार, गोंय - ४०३ २०६

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Date: 18.11.2025

(Accredited by NAAC with Grade A+)

GU/Acad -PG/BoS -NEP/2025-26/603

CIRCULAR

In supersession to the Circular No. GU/Acad –PG/BoS -NEP/2025-26/556 dated 18.11.2025, the syllabus of Semester II of the **Master of Science in Inorganic Chemistry** Programme approved by the Academic Council in its meeting held on 13th September 2025 is attached. The syllabus of Semester I approved earlier by the Academic Council in its meeting held on 13th & 14th June 2025 is also attached.

The Dean & Vice-Dean (Academic) of the School of Chemical Sciences and the Principals of affiliated Colleges offering the **Master of Science in Inorganic Chemistry** Programme are requested to take note of the above and bring the contents of the Circular to the notice of all concerned.

(Ashwin V. Lawande) Deputy Registrar – Academic

To,

- 1. The Dean, School of Chemical Sciences, Goa University.
- 2. The Vice-Dean (Academic), School of Chemical Sciences, Goa University.
- 3. The Principals of affiliated Colleges offering the Master of Science in Inorganic Chemistry Programme.

Copy to:

- 1. Chairperson, BoS in Chemistry, Goa University.
- 2. Programme Director, M.Sc. Inorganic Chemistry, Goa University.
- 3. Controller of Examinations, Goa University.
- 4. Assistant Registrar Examinations (PG), Goa University.
- 5. Director, Directorate of Internal Quality Assurance, Goa University for uploading the Syllabus on the University website.



MASTER OF SCIENCE IN INORGANIC CHEMISTRY

(Effective from the Academic Year 2025-26)

ABOUT THE PROGRAMME

This program is designed by integrating academics with research and industrial needs. Students with this degree will be ready for careers in the pharmaceutical, chemical, healthcare, environmental, material science and related industries. Students are equipped with hands-on research experience and skills through projects and dissertations to pursue advanced degrees like Ph.D. programs and contribute to research in the field. Students with this knowledge would excel in competitive exams like NET, GATE, and others.

OBJECTIVES OF THE PROGRAMME

- 1. To provide a deep understanding of the fundamental principles and concepts of inorganic chemistry, including bonding theories, structure, and reactivity.
- 2. To impart systematic understanding of the chemistry of different groups of elements and their compounds.
- 3. To provide the principles and applications of coordination compounds, including their structure, bonding, and reactivity.
- 4. To expose students to advanced concepts like nanotechnology, materials science, and their applications in various fields like catalysis, energy, and environment.

INORGA	NIC CHEMISTRY (CHI)
PROGRA	MME SPECIFIC OUTCOMES (PSO)
PSO 1	Understand the properties of elements

PSO 1.	Understand the properties of elements and compounds and use concepts like
	molecular symmetry and tools such as spectroscopy, diffraction, thermal
	techniques and others, to study chemical structures and solve both theoretical
	and practical problems in inorganic chemistry.

PSO 2.	Apply inorganic chemistry principles to explain and	model biological,
CONTINU	environmental, and industrial processes.	

PSO 3. Analyse environmental and industrial samples, including pollutants, ores, and alloys that will prepare students for careers in science and industry.

PSO 4. Design experiments, interpret results, and propose effective solutions to chemical challenges that will help create and develop materials for use in areas like catalysis, energy, environment, electronics, and healthcare using ecofriendly and sustainable methods.

ANALYTICAL CHEMISTRY (CHA) PROGRAMME SPECIFIC OUTCOMES (PSO)

PSO 1.	Understand different chemical and instrumental methods of analysis and apply
	appropriate methods for qualitative and quantitative analysis.
	(7), (1))

- **PSO 2.** Select technique for synthesis, separation, structural characterization and microscopic analysis.
- **PSO 3.** Interpret data pertaining to optical techniques, diffraction techniques and spectral techniques such as IR, UV, NMR, Mass, X-Ray, and others.
- **PSO 4.** Develop expertise through hands on training for qualitative and quantitative estimation using chemical and instrumental methods.

	CAL CHEMISTRY (CHP) AMME SPECIFIC OUTCOMES (PSO)
PSO1	Understand the fundamental principles and core concepts of Quantum chemistry, Electrochemistry, Spectroscopy, Thermodynamics & Reaction Kinetics, and the scientific theories cum models that govern them.
PSO 2	Demonstrate a proficient understanding of the principles of Group Theory and their applications in chemistry, i.e. molecular symmetry, hybridization, and electronic structure, facilitating the interpretation of spectroscopic data and chemical phenomena.
PSO 3	Understand and interpret spectroscopic data of industrially important compounds using microwave, IR, Raman, NMR, and ESR spectroscopy and elucidate their chemical structure and properties.
PSO 4	Demonstrate hands-on expertise in handling instruments like conductometer, potentiometer, pH meter, colorimeter, linear sweep and cyclic voltammeter, and bomb calorimeter, and use them to monitor the kinetic rates and thermodynamic properties of chemical reactions.
PSO 5	Design, synthesize, and characterize nano-catalysts and use them to address societal problems of wastewater pollution, using adsorption and photocatalytic technology.
PSO 6	Acquire the ability to fabricate efficient electrodes and test their efficiency in electrocatalytic and spectro-electrochemical reactions such as HER and CO ₂ reduction, electrochemical energy generation and storage systems such as batteries, fuel cells, photovoltaics, and supercapacitors.
PSO 7	Determine the fundamental physical properties such as density, viscosity, specific gravity, etc., and use them to construct phase diagrams.
PSO 8	Acquire the ability to write computer programs. Ab-initio programs like Gaussian are used to calculate the molecular and spectroscopic properties of chemical compounds.

ORGANIC CHEMISTRY (CHO) PROGRAMME SPECIFIC OUTCOMES (PSO)

- **PSO 1.** Demonstrate understanding of Organic Chemistry principles, apply them to scientific theories, communicate effectively with critical reasoning, and follow safe practices in handling chemical reagents, laboratory equipment, and glassware
- PSO 2. Utilize knowledge of synthetic organic chemistry, stereochemistry, pericyclic reactions, and photochemistry to synthesize organic molecules and elucidate their structures using various spectroscopic techniques
- PSO 3. Undertake synthetic methodologies towards organic compounds of commercial and scientific interest and also apply the concepts in chemistry of pharmaceuticals, natural products, polymers, synthetic intermediates, petroleum products, etc.
- PSO 4. Develop interdisciplinary approach of the subject of organic chemistry and related fields and augment the new progresses in the arena of Bioorganic Chemistry, Green Chemistry, Pharmaceutical Chemistry, Agrochemicals and relevant fields.

PROGRAMME STRUCTURE

Master of Science in Inorganic Chemistry Effective from the Academic Year 2025-2026

Bridge Course				
Sr. Course No. Code Title of the Course Cree				
1	CHC-1000	Bridge Course in mathematical concepts for chemistry		
2 CHC-1001 Bridge Course in organic chemistry		1		
AND AND AND				

	There	SEMESTER I		AR		
6/6	Discipline Specific Core (DSC) Courses (16 credits)					
Sr. No.	Course Code			Level		
1	CHO-5000	Fundamental Concepts in Organic Chemistry	4	400		
2	CHI-5000	Concise Inorganic Chemistry	4	400		
3	CHP-5000	Fundamentals of Physical Chemistry	4	400		
4	CHA-5000	Analytical Chemistry Techniques	4	400		
		Total Credits for DSC Courses in Semester I	16	·)		
	Disc	ipline Specific Elective (DSE) Course (4 credit	s)			
Sr. No.	Course Code	Title of the Course	Credits	Level		
1	CHO-5201	Organic Chemistry Practical - I	2	400		
2	CHO-5202	Organic Chemistry Practical - II	2	400		
3	CHI-5201	Inorganic Chemistry Practical - I	2	400		
4	CHI-5202	Inorganic Chemistry Practical - II	2	400		
5	CHP-5201	Physical Chemistry Practical - I	2	400		
6	CHP-5202	Physical Chemistry Practical - II	2	400		
7	CHA-5201	Analytical Chemistry Practical - I	2	400		
8	CHA-5202	Analytical Chemistry Practical - II	2	400		
		Total Credits for DSE Courses in Semester I	4			
		Total Credits in Semester I	20)		

	Semester II					
	Discipline Specific Core (DSC) Courses					
Sr. No.	Course Code	Title of the Course	Credits	Level		
1	CHI-5001	Coordination and Organometallic Compounds: Bonding to Reactivity	4	500		
2	CHI-5002	Solid State Chemistry	4	500		
3	CHI-5003	Molecular Symmetry and Spectroscopy	4	500		
4	CHI-5004	Concepts and Applications in Inorganic Chemistry	4	500		
	To	otal Credits for DSC Courses in Semester II	Bla	16		
Zala 8	Dis	scipline Specific Elective (DSE) Courses (4 ca	redits)			
Sr. No.	Course Code	Title of the Course	Credits	Level		
1	CHO-5201	Organic Chemistry Practical - I	2	400		
2	CHO-5202	Organic Chemistry Practical - II	2	400		
3	CHI-5201	Inorganic Chemistry Practical - I	2	400		
4	CHI-5202	Inorganic Chemistry Practical - II	2	400		
5	CHP-5201	Physical Chemistry Practical - I	2	400		
6	CHP-5202	Physical Chemistry Practical - II	2	400		
7	CHA-5201	Analytical Chemistry Practical - I	2	400		
8	CHA-5202	Analytical Chemistry Practical - II	2	400		
	To	otal Credits for DSE Courses in Semester II		4		
		Total Credits in Semester II		20		

Blooms Taxonomy Cognitive Levels			
Cognitive Level Notations			
K1 Remembering			
K2 Understanding			
K3 Applying			
K4 Analyzing K5 Evaluating K6 Create			



Title of the Course	Bridge Course in Mathematical Concepts for Chemistry
Course Code	CHC-1000
Number of Credits	1 Transperson
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	No No
Bridge Course/ Value added Course	Yes
Course for advanced learners	No Service Control of the Control of

Pre-requisites for the Course:	NIL			
Course Objectives:	To introduce mathematical concepts to the students of MSc Part-I (Chemistry).			
	Students will be able to solve problems based on:		Mapped to PSO	
	CO 1. Matrices in M.Sc. Chemistry		PSO1	
Course Outcomes:	CO 2. Determinants in M.Sc. Chemistry		PSO1	
	CO 3. Differential calculus in M.Sc. Chemistry		PSO1	
	CO 4. Integral calculus in M.Sc. Chemistry		PSO1	
Content:		No of	Mapped	Cognitive

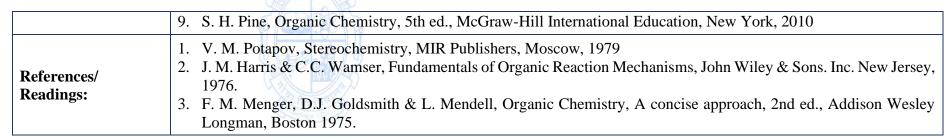
		hours	to CO	Level	
Module 1:	 Calculus for thermodynamics and kinetics Introduction to Differentiation: Notation, Differentiating various f functions, Differentiating a Sum, Product Rule, Quotient Rule, Chain Rule, Partial Differentiation: exact and inexact differentials. Introduction to Integration: Notation, Rules for Integrals, Integrating various functions, Definite and indefinite Integrals. 	8	CO3, CO4	K5	
Module 2:	 2. Matrices, Determinants and vector algebra: a. Types of Matrices: Identity, reflection, rotation, inversion, distance matrix, Matrix Algebra, Matrix similarity transformation. b. The Determinant, Minors and Cofactors, Inverse of a Matrix, Character of a matrix, Linear algebra. c. Vectors and molecular structure. 	7	CO1, CO2	K5	
Pedagogy:	Mainly lectures and tutorials. Seminars/assignments/presentations/self-study or a corused. ICT mode should be preferred. Sessions can preferably be interactive to enable			hese can be	
Texts:	Robert G. Mortimer, Mathematics for Physical Chemistry, Elsevier, New York. 4th ed., 2013				
References/ Readings:	James R. Barrante, Applied Mathematics for Physical Chemistry, 3rd ed., Prentice-H	Iall, New .	Jersey, 1998		



Title of the Course	Bridge Course in Organic Chemistry
Course Code	CHC-1001
Number of Credits	
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	No No
Bridge Course/ Value added Course	Yes
Course for advanced learners	No O

Pre-requisites for the Course:	NILO 15					
Course Objectives:	 To understand various principles of organic chemistry. To apply the importance of chirality in organic syntheses. To analyse stereoselective reactions. To interpret oxidation and reduction reactions. 					
	Students will be able to:	N				
	CO 1. understand knowledge of basic reaction mechanisms in organic transformation.		PSO2			
Course Outcomes:	CO 2. apply chirality in organic synthesis.		PSO2			
	CO 3. compare configurations/ conformations of organic molecules.		PSO2			
	CO 4. assess oxidizing and reducing reagents in organic synthesis.	assess oxidizing and reducing reagents in organic synthesis.				
Content:		No of	Mapped	Cognitive		

		hours	to CO	Level
Module 1:	1. Fundamentals of organic chemistry: Electron movement with arrows, half and double headed arrows (Cleavage of bonds: homolysis and heterolysis) in organic reaction mechanisms; inductive effect, electromeric effect, resonance and hyperconjugation, steric hindrance, hydrogen bonding; reactivity of organic molecules: nucleophiles and electrophiles; reactive intermediates: carbocations, carbanions and free radicals; strength of organic acids and bases, aromaticity, benzenoids and Huckel's rule.	8	CO1	K1, K2
Module 2:	2. Stereochemistry: Conformations with respect to butane and cyclohexane; interconversion of wedge formula, Newmann, Sawhorse and Fischer representations; CIP Rules: R/S configurations.	3	CO2, CO3	K2, K3, K4
Module 3:	3. Substitution, elimination and addition reactions: Substitution and elimination reactions (SN1, SN2, E1 and E2), addition of different groups on olefins.	2	CO1	K2, K3
Module 4:	4. Oxidation and reduction reactions: Basic concepts, oxidizing and reducing reagents and some examples.	2	CO4	K3, K4
Pedagogy:	Mainly lectures and tutorials. Seminars/assignments/presentations/self-study or a comused. ICT mode should be preferred. Sessions can preferably be interactive to enable preferred.			these can be
Texts:	 D. Nassipuri, Stereochemistry of Organic compounds - Principles and Application, 4th ed., Wiley Eastern Limited New Academic Science Limited, Lucknow, India, 2013 E. L. Eliel, Stereochemistry of carbon compounds, Tata MacGraw Hill Publishing Company Ltd., New Delhi, 1990 J. March, Advanced Organic Chemistry: Reaction, Mechanism and Structure, 4th ed., Wiley, USA, 2010. J. Clayden, N. Greeves, S. Warren & Wothers, Organic Chemistry, 2nd ed., Oxford University Press, Oxford, 2012 I. L. Finar Stereochemistry and Chemistry of Natural products, Vol. 2, 3rd ed., Longmans, ELBS London, 1963 F. A. Carey and R.J. Sundberg, Advanced Organic Chemistry, Vol. I & II. Plenum Press, New York, 1977 E. S. Gould et al., Mechanism and structure in Organic Chemistry, Holt, Rinehart And Winston, New York, 1965 F. A. Carey, Organic Chemistry, 4th ed., McGraw-Hill Higher Education, USA, 2000 			











SEMESTER I



Discipline Specific Core Courses

Title of the Course	Fundamental Concepts in Organic Chemistry
Course Code	CHO-5000
Number of Credits	4
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No la
Course for advanced learners	No Conseque to the second seco

Pre-requisites for the Course:	NIL (1)			
Course Objectives:	 To study the various concepts based on molecular orbital theory, Aromaticity, Acids and bases. To understand the concepts of stereochemistry and their significance in determining the structure, reactivity, and properties of organic molecules To understand the mechanistic aspects of various type of reactions in organic synthesis and the use of selective reagents in organic transformations. 			
Course Outcomes:	Students will be able to:	Mapped to PSO		

	CO 1. Understand the effect of delocalization of electrons & presence or absence of aromaticity in organic compounds.CO 2. Apply various concepts in stereochemistry to understand stereochemical outcome in a reaction.		PSO1, PSO 2 PSO1, PSO 2		
	CO 3. Evaluate plausible mechanisms of organic reactions.		PSO1, PSO2, PSO3		
	CO 4. Apply various reagents for desired organic transformations.	CO 4. Apply various reagents for desired organic transformations.		PSO1, PSO2, PSO3, PSO4	
Content:	TO A UNIVERS	No of hours	Mapped to CO	Cognitive Level	
Module 1:	 1.1 Molecular orbitals and delocalized chemical bonding a. Qualitative description of molecular orbitals of simple acyclic and monocyclic systems, frontier molecular orbitals. b. Conjugation, cross conjugation, hyperconjugation and tautomerism (types and examples). c. Aromaticity: Origin of Huckel's rule, examples of aromatic, non-aromatic and antiaromatic compounds; concept of Mobius aromaticity. 1.2 Structure & Reactivity a. Acidity, basicity and pKa of organic compounds; Acid and base strengths; HSAB concept & Factors affecting it, effect of structure & medium on acid and base strength. b. Concept of superacids and superbases. c. Electrophilicity & nucleophilicity, examples of ambident nucleophiles & electrophiles. (Including revision of aromatic electrophilic and nucleophilic substitution) 	15	CO1	K1, K2, K3, K4,K5	
Module 2:	 2. Stereochemistry a. Brief revision of configurational nomenclature: R & S; D & L; E & Z; cis & trans and syn & anti nomenclature. Chirality in molecules with two and more chiral centers. b. Conformational analysis of open chain compounds (Butane, 2, 3-butane) 	15	CO2, CO3	K1, K2, K3, K4, K5	

	diol, 2,3-dibromobutane etc.). Erythro and threo nomenclature.			
	c. Topicity and Prostereoisomerism: Topicity of ligands and faceshomotopic, enantiotopic and diastereotopic, ligands and faces.			
	d. Chemoselective, regioselective and stereoselective reactions with examples.			
	e. Conformation and reactivity of cyclohexane and substituted cyclohexanes, cyclohexene / cyclohexanone. Conformational isomerism and analysis in acyclic and simple cyclic systems substituted ethane, cyclopentane, cyclohexane.			
COAUNIVE	f. Optical isomerism - optical activity - molecular dissymmetry and chirality - elements of symmetry. optical isomerism in biphenyls, allenes and spirans - optical isomerism of nitrogenous compounds racemisation and resolution.			
6/28/8/10	3.1 Reaction Mechanism		CO2, CO3	K1, K2,
	a. Structure, stability and reactivity of reactive intermediates (carbocations, carbanions, free radicals, carbenes, arynes and nitrenes)			K3, K4, K5
Togy Carl	b. Types of mechanisms, types of reactions, thermodynamic and kinetic control.			
	c. Methods of determining reaction mechanisms:			
	i. Identification of products.			
Module 3:	ii. Determination of the presence of intermediates (isolation, detection, trapping and addition of suspected intermediate.	15		
	iii. Isotopic labelling.			
	iv. Stereochemical evidence.			
	v. Kinetic evidence and Isotope effect.			
	(at least two examples to be covered for above methods)			
	3.2 Selective reagents for Organic transformation			
	a. Oxidation of organic compounds: PCC, PDC and MnO2, ozonolysis,			

Module 4:	 peracids. b. Reduction of organic compounds: NaBH4, LAH, DIBAL reduction and reduction with borane and dialkylboranes. Clemmensen reduction, Birch reduction and Wolff-Kishner reduction 4.1 Aliphatic Nucleophilic substitution a. Nucleophilic substitutions with respect to mechanism and various factors affecting such reactions. b. The Neighbouring Group Participation (NGP)/ Anchimeric assistance: General approach to various NGP processes; NGP by unshared/lone pair of electrons; NGP by π-electrons; NGP by aromatic rings (formation of phenonium ion intermediate); NGP by sigma bonds with special reference to bornyl and nor- bornyl system (formation of nonclassical carbocation) 4.2 Elimination reactions a. The E2, E1 and E1cB mechanisms. Orientation of the double bond, Saytzeff and Hofmann rule. b. Effects of substrate, base, leaving group and medium on: i. Overall reactivity ii. E1 vs. E2 vs. E1cB iii. Elimination vs substitution, mechanism and orientation in pyrolytic syn elimination (various examples involving cyclic and acyclic substrates to 	15	CO3. CO4	K1, K2, K3, K4, K5
Pedagogy:	be studied). Mainly lectures and tutorials. Seminars / term papers /assignments / presentation of these can also be used. ICT mode should be preferred. Sessions should be int learning.		•	
Texts:	 R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, Organic Chemistry, 7th ed D. Nassipuri, Stereochemistry of Organic Compounds: Principles and Applic New Delhi, 2020 J. Clayden, N. Greeves, S. Warren, P. Wothers, Organic Chemistry, 2nd ed. 	cations, 4	th ed. New Age	International,

	4. J. March, Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 4th ed. Wiley Student Edition, New York, 2003.
	5. P. S. Kalsi, Stereochemistry: Conformation and Mechanism, 11th ed. New Age International, New Delhi, 2022
	6. E. L. Eliel, S. H. Wilen, Stereochemistry of Organic Compounds, 1st ed. John Wiley and Sons, New York, 1994
	7. H. O. House, Modern Synthetic Reactions, 2nd ed. W. A. Benjamin, New York, 1965
	8. F. A. Carey, R. J. Sundberg, Advanced Organic Chemistry, 5th ed. Springer India Private Limited, New Delhi, 2007
References/	1. R. Bruckner, Advanced Organic Chemistry: Reaction Mechanisms, 1st ed. Harcourt/Academic Press, San Diego, 2002.
Readings:	2. P. Y. Bruice, Organic Chemistry, 8th ed, Pearson, New Delhi, 2020







Title of the Course	Concise Inorganic Chemistry
Course Code	CHI-5000
Number of Credits	4
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No Company of the Com
Course for advanced learners	No O O O O O O O O O O O O O O O O O O O

Pre-requisites for the Course:	NIL CONTRACTOR OF THE PARTY OF	
Course Objectives:	 To explain fundamentals of solid state, coordination, organometallic, bioinorganic, and envir To describe atomic structure, molecular structure, bonding, and symmetry in molecules. To know fundamental aspects of elements & their compounds. To comprehend the effects of pollution, and its treatments. 	onmental chemistry.
	Students will be able to:	Mapped to PSO
Course Outcomes:	CO 1. explain basic concepts in solid state, coordination, organometallic, bioinorganic, and environmental chemistry.	PSO1, PSO2
	CO 2. illustrate characteristic of inorganic compounds related to biology and environment.	PSO2, PSO3
	CO 3. analyze molecular structure and their properties.	PSO1, PSO3

	CO 4. design compounds for various applications.		PSO4	
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	 Atomic structure, molecular structure and bonding Atomic Structure: Structures of hydrogenic atoms: some principles of quantum mechanics, atomic orbitals. Many electron atoms: penetration & shielding, building up principle, classification of elements. Spectroscopic terms. Atomic properties: atomic radii, ionic radii, ionization energy, electron affinity, electronegativity, polarizability. Molecular Structure & bonding: Lewis structures: octet rule, resonance. VSEPR model: basic shapes, modification of the basic shapes. Valence bond theory: hydrogen molecule, homonuclear diatomic molecules, polyatomic molecules, promotion, hypervalence, hybridization. Molecular orbital theory: approximation, boding & antibonding orbitals. Homonuclear diatomic molecules & heteronuclear diatomic molecules. 	10	CO1, CO2, CO3, CO4	K2, K3, K4, K5
Module 2:	 2. Solid state chemistry a. Structures of solids: crystal structures, lattices and unit cells, fractional atomic coordinates and projections, close packing of spheres, holes in closed-packed structures. b. Structures of metals & alloys: polytypism, nonclosed-packed structures, polymorphism of metals, atomic radii of metals, alloys, substitutional and interstitial solid solutions, intermetallic compounds. c. Ionic solids: characteristic structures of ionic solids, binary phases, ternary phases, rationalization of structures, ionic radii, radius ratio, structure maps, energetics of ionic bonding, lattice energy and Born Haber cycle, calculation of lattice enthalpies (numerical expected). 	10	CO1, CO2, CO3, CO4	K2, K3, K4, K5
Module 3:	3. Molecular Symmetry and chemistry of <i>d</i> - and <i>f</i> - block elements a. Symmetry elements and symmetry operations, equivalent symmetry elements and equivalent atoms, symmetry point groups and molecular symmetry. Systematic	15	CO1, CO2, CO3,	K2, K3, K4, K5

	procedure for symmetry classification of molecules. Dipole moment, optical activity and point groups. b. <i>d</i> -block elements: Zinc, cadmium and mercury: occurrence and properties. Transition element: IUPAC definition, occurrence and physical properties, chemical properties, metal halides, metal oxides & oxido compounds, metal sulfides and sulfide compounds, metal-metal bonded compound and clusters, magnetic properties. c. <i>f</i> -block elements: Lanthanides; occurrence and physical properties, lanthanide contraction, oxidation states, compounds of lanthanides, electronic, optical and magnetic properties. Actinoid; occurrence and properties, oxidation states, general trends, electronic		CO4	
OA UNIVERSITY	spectra, thorium and uranium.			
Module 4:	 4. Coordination, Organometallic and Bioinorganic Chemistry a. Coordination chemistry: Introduction, representative ligands, nomenclature. Constitution and geometry, isomerism & chirality in square planar and octahedral complexes, ligand chirality. Electronic properties of metal complexes: CFT applied to octahedral and tetrahedral complexes, magnetic moments, CFSE. Electronic spectroscopy: basic concepts, Orgel diagram for octahedral and tetrahedral complexes of d¹ & d9 ions. b. Organometallic Chemistry: Introduction to organometallic chemistry, nomenclature, stability and inert gas rules (neutral atom, and donor pair electron count methods). Homoleptic metal carbonyls - synthesis, properties, and spectroscopic studies. 	15	CO1, CO2, CO3, CO4	K2, K3, K4, K5
	c. Bioinorganic Chemistry: Macronutrients/micronutrients. Role of elements in biology. Metallobiomolecules, metalloporphyrins, structure of porphin and heme group, iron porphyrins (Haemoglobin and myoglobin), examples of metalloenzymes of Cu and Zn.			
Module 5:	5. Environmental Chemistry Directive of the Supreme Court in 1993 to introduce environmental education at all levels.	10	CO1, CO2, CO3,	K2, K3, K4, K5

 a. Air Pollution: Classification of air pollutants and photochemical reactions in the atmosphere. Common air pollutants (e.g. CO, NOx, SO₂, hydrocarbons and particulates) i. sources ii. physiological and environmental effect iii. monitoring, iv. various remedial & technological measures to curb pollution. Air quality standards. b. Water pollution: Importance of buffer & buffer index in waste water treatments. Chemical, physical & biological characteristics of water pollution, specific & non-specific characterization of water. DO, BOD, COD, and chlorine demand, typical water treatment & waste water treatment (Municipal). Impact of plastic pollution and its effect. 	CO4	
 Oxford University Press, Oxford, 2009. F. A. Cotton, G. Wilkinson, P. L. Gauss, Basic Inorganic Chemistry, 3rd Ed., Wiley (reprint). F. A. Cotton, Chemical applications of group theory, 3rd Ed., Wiley India, New Delhi, 2044. A. K. De, Environmental Chemistry, 3rd Ed., New Age Intl. Publishers, New Delhi, 2005. J. E. Huheey, E. A. Kieter, R. L. Kieter, O. K. Medhi, Inorganic Chemistry: Principles of 4th Ed., Pearson, New Delhi, 2011. J. D. Lee, Concise Inorganic Chemistry, 5th Ed., Wiley India, New Delhi, 2008. H. V. Keer, Principles of Solid State Chemistry, 1st Ed., New Age Intl. Ltd, New Delhi, A. R. West, Solid State Chemistry and Its Applications, 1st Ed., Wiley India, New Delhi, D. K. Chakrabarty, Solid State Chemistry, 2ed Ed., New Age Intl. Publishers, New Delhi, R. S. Drago, Physical Methods in Inorganic Chemistry, Affiliated East West Press Pvt. L. 	India, New of the structure & 1993, (reprint 1984 (reprint 2010. td., New Dell	delhi, 2008 Reactivity, 2008). t 2007). ni, 2017.
	atmosphere. Common air pollutants (e.g. CO, NOx, SO ₂ , hydrocarbons and particulates) i. sources ii. physiological and environmental effect iiii. monitoring, iv. various remedial & technological measures to curb pollution. Air quality standards. b. Water pollution: Importance of buffer & buffer index in waste water treatments. Chemical, physical & biological characteristics of water pollution, specific & non-specific characterization of water. DO, BOD, COD, and chlorine demand, typical water treatment & waste water treatment (Municipal). Impact of plastic pollution and its effect. Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study of these can also be used. ICT mode should be preferred. Sessions should be interactive in na learning. 1. P. W. Atkins, T. Overton, J. Rourke, M. Weller, F. Armstrong, Shriver & Atkins Inorga Oxford University Press, Oxford, 2009. 2. F. A. Cotton, G. Wilkinson, P. L. Gauss, Basic Inorganic Chemistry, 3rd Ed., Wiley (reprint). 3. F. A. Cotton, Chemical applications of group theory, 3rd Ed., Wiley India, New Delhi, 204. 4. A. K. De, Environmental Chemistry, 3rd Ed., New Age Intl. Publishers, New Delhi, 205. 5. J. E. Huheey, E. A. Kieter, R. L. Kieter, O. K. Medhi, Inorganic Chemistry: Principles of 4th Ed., Pearson, New Delhi, 2011. 6. J. D. Lee, Concise Inorganic Chemistry, 5th Ed., Wiley India, New Delhi, 2008. 7. H. V. Keer, Principles of Solid State Chemistry, 1st Ed., New Age Intl. Ltd, New Delhi, 10 R. S. Drago, Physical Methods in Inorganic Chemistry, Affiliated East West Press Pvt. Ltd. 10. R. S. Drago, Physical Methods in Inorganic Chemistry, Affiliated East West Press Pvt. Ltd.	atmosphere. Common air pollutants (e.g. CO, NOx, SO ₂ , hydrocarbons and particulates) i. sources ii. physiological and environmental effect iii. monitoring, iv. various remedial & technological measures to curb pollution. Air quality standards. b. Water pollution: Importance of buffer & buffer index in waste water treatments. Chemical, physical & biological characteristics of water pollution, specific & non-specific characterization of water. DO, BOD, COD, and chlorine demand, typical water treatment & waste water treatment (Municipal). Impact of plastic pollution and its effect. Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combinat of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature toenable learning. 1. P. W. Atkins, T. Overton, J. Rourke, M. Weller, F. Armstrong, Shriver & Atkins Inorganic Chemist Oxford University Press, Oxford, 2009. 2. F. A. Cotton, G. Wilkinson, P. L. Gauss, Basic Inorganic Chemistry, 3rd Ed., Wiley India, New (reprint). 3. F. A. Cotton, Chemical applications of group theory, 3rd Ed., Wiley India, New Delhi, 2012 (reprint). 4. A. K. De, Environmental Chemistry, 3rd Ed., New Age Intl. Publishers, New Delhi, 2012 (reprint). 5. J. E. Huheey, E. A. Kieter, R. L. Kieter, O. K. Medhi, Inorganic Chemistry: Principles of Structure & 4th Ed., Pearson, New Delhi, 2011. 6. J. D. Lee, Concise Inorganic Chemistry, 5th Ed., Wiley India, New Delhi, 1993, (reprint B. A. R. West, Solid State Chemistry and Its Applications, 1st Ed., Wiley India, New Delhi, 1984 (reprint).

	Delhi, 2017.
References/	1. F. A. Cotton, G. Wilkinson, Advanced Inorganic Chemistry, 6rd Ed., Wiley India, New Delhi, 2003 (reprint 2012).
Readings:	2. G. C. Miessler, D. A. Tarr, Inorganic Chemistry, 3rd Ed., Pearson, New Delhi, 2004.









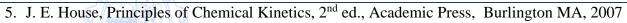
Title of the Course	Fundamentals of Physical Chemistry
Course Code	CHP-5000
Number of Credits	04
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No Service Ser
Course for advanced learners	No O Company of the C

Pre-requisites for the Course:	NILO SE LO		
Course Objectives:	 To introduce various mathematical and computational concepts of chemistry To gain knowledge of core concepts of physical chemistry i.e. thermodynamics, kinetics, quantum chemistry and electrochemistry To inculcate critical thinking and apply the knowledge of physical chemistry concepts in problem solving To understand and apply physical chemistry principles to other areas of chemistry 		
	Students will be able to:	Mapped to PSO	
	CO 1. Explain various concepts in physical chemistry.	PSO1, PSO2	
Course Outcomes:	CO 2. Utilise concepts of electrochemistry and their applications in renewable energy generation and storage.	PSO1, PSO6	
	CO 3. Demonstrate the concepts during the lab course in physical chemistry.	PSO3, PSO4, PSO5	

	CO 4. Apply fundamentals of chemical kinetics and thermodynamics for under reaction processes and mechanisms	rstanding	PSO3, PSo	07
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	 Mathematical Preparations Introduction to various functions and function plotting (exponential, logarithmic, trigonometric etc.), functions of many variables. complex numbers and complex functions. Linear equations, vectors, matrices and determinants. Basic rules of differentiation and integration, Partial differentiation, location and characterization of critical points of a function, Regression methods, curve fitting. Introduction to series, convergence and divergence, power series, Fourier series e. Probability (permutations and combinations). 	10	CO1, CO3	K1, K2, K3
Module 2:	 2. Quantum Chemistry a. Operators, Functions, Eigen value equations, Postulates. b. Schrödinger equation, application to simple system viz. free particle, particle in one dimensional, two dimensional and three-dimensional box (quantization, separation of variables, degenerate wave functions). c. Hydrogen like atoms, Schrödinger equation and its solutions, atomic orbital wave functions and interpretation. d. Hückel MO theory, Secular equations, Secular determinant, delocalization energy, charge density, π-bond order, free valence, applications to C₂H₄, C₃H₅ (radical), C₄H₆, C₄H₄, C₆H₆, C₆H₈. 	20	CO1, CO3	K1, K2, K5
Module 3:	3. Thermodynamics a. Thermodynamic properties: Gas laws, real gases, Boyle temperature, critical temperature, state and path properties. Intensive and extensive properties. Exact and inexact differentials. Internal energy, enthalpy, entropy, free energy and	12	CO1, CO3, CO4	K1, K2, K3, K5

			1	
G CONTROL OF THE PARTY OF THE P	their relations and significances. Maxwell relations. Thermodynamic equations of state. b. Joule-Thomson effect. Joule-Thomson coefficient for van der Waals' gas. Joule-Thomson effect and production of low temperature, adiabatic demagnetization, Joule-Thomson coefficient, inversion temperature. c. The third law of thermodynamics. Need for the third law. Apparent exceptions to third law. Application of third law. Use of thermodynamic functions in predicting direction of chemical change. Entropy and third law of thermodynamics. d. Phase equilibria: Phase rule, Discussion of two component systems forming solid solutions with and without maximum or minimum in freezing point curve. Systems with partially miscible solid phases. e. Three component systems: Graphical representation. Three component liquid systems with one pair of partially miscible liquids. Influence of temperature. Systems with two pairs and three pairs of partially miscible liquids. The role of added salts.			
Module 4:	 4. Electrochemistry a. EMF series, cell potential: Nernst equation, Cells at equilibrium. Determination of thermodynamic functions. b. Decomposition potential and overvoltage, electronegativity, basic principles, completeness of deposition, separation with controlled potentials, constant current electrolysis, composition of electrolyte, potential buffers, physical characteristics of metal deposits. c. Electroplating and electroless plating, electrosynthesis. d. Concepts of acid-base aqueous and non-aqueous solvents, hard and soft acid-base concept and applications. 	9	CO1, CO2, CO3	K1, K2, K3, K5, K6
Module 5:	5. Chemical Kinetics a. General introduction to various types of order of reaction including fractional order, molecularity of the reaction.	9	CO1, CO3, CO4	K1, K2, K3, K4, K5

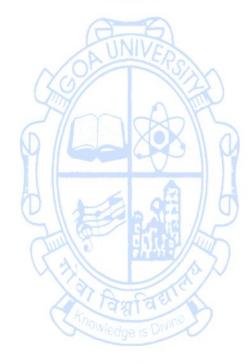
OP UNIVERSIA	 b. Introduction to reversible and irreversible reactions and reactions leading to equilibrium. van't Hoffs equation and analysis of Gibbs free energy of equilibrium reactions. c. Collision theory and Maxwell Boltzmann distribution of energies of colliding molecules. The concept of collisional cross section and reactive cross section and its significance. d. Comparative study of transition state and collision state theory. e. Reaction Mechanisms: elementary reactions, consecutive elementary reactions, steady state approximation, the rate determining step and pre-equilibria. f. Free radical reactions, complex reactions such as acetaldehyde decomposition and reaction between H₂ and Br₂. Homogeneous reactions and acid-base catalysis. g. Elementary enzyme reactions. Lineweaver-Burk plot and its analysis.
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.
Texts:	 P. W. Atkins and J. D. Paula, Physical Chemistry, 8th ed., Oxford University Press, New Delhi. 2007 G. M. Barrow, Physical Chemistry, 5th ed., Tata McGraw Hill, New Delhi. 2016 J. E. House, Principles of Chemical Kinetics, 2nd ed., Academic Press, Elsevier Burlington, USA, 2007 I. N. Levine, Quantum Chemistry, 7th ed., Prentice-Hall, New Delhi. 1999. S. Glasstone, Text Book of Physical Chemistry, D. Van Nostrand Company, New York, Reprint 1942.
References/ Readings:	 B. R. Puri, L. R. Sharma and M. S. Pathania, Principles of Physical Chemistry, 49th ed., Vishal Publishing Co., New Delhi, 2020 A. Saggion, R. Faraldo, M. Pierno, Thermodynamics - Fundamental Principles and Applications, Springer, Switzerland, 2019 J. Bockris, A. K.N. Reddy, M. E. Gamboa-Aldeco, Modern Electrochemistry: Fundamentals of Electrodics, Vol. 2A, 2nd ed., Kluwer Academic Publishers, New York, 2002 J. Bockris, A. Reddy, Modern Electrochemistry: Ionics, Vol. 1, 2nd ed., , 2nd Ed., Kluwer Academic Publishers, New York, 2002



6. J. P. Lowe, K. Peterson, Quantum Chemistry, 3rd ed., Elsevier, Burlington MA, 2006

7. R. G. Mortimer, Physical Chemistry, 3rd ed., Elsevier, Burlington MA, 2008









Title of the Course	Analytical Chemistry Techniques
Course Code	CHA-5000
Number of Credits	4
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No Service Ser
Course for advanced learners	No O

Pre-requisites for the Course:	NIL SE	
Course Objectives:	 To learn various methods of data handling in analysis. To explain the significance of sampling and calibration techniques. To understand principles and applications of various types of techniques To train the students to deduce structures based on IR, NMR, MS combined data. 	
	Students will be able to	Mapped to PSO
Course Outcomes:	CO 1. explain the role of statistical tools for determination of error and organize data management for systematic interpretation.	PSO1
	CO 2. analyse the appropriate technique for thermoanalytical studies.	PSO1
	CO 3. explain basic principles and scope of different methods of separation and techniques of analysis	PSO1. PSO2

	CO 4. solve problems based on IR, NMR, MS combined spectral data.		PSO1, PS	SO2, PSO3
Content:		No of hours	Mapped to CO	Cognitive Level
	1.1. Analytical Objectives and Data Handling: Importance of analytical chemistry in research and industry; statistics and data handling in analytical chemistry, standard operating procedures, good laboratory practices: quality assurance, method validation and quality control.	5	CO1	K1, K2, K3, K4
Module 1: Module 2:	1.2. Sampling and Calibration Techniques: Sampling and sample preparation, general steps in chemical analysis, calibration of glassware. Finding the best straight line - least square regression, correlation coefficient; Calibration curves, standard addition, external standards and internal standards. Chemical concentrations. Classical methods of Analysis: Gravimetry and Titrimetric methods: Principle, methodology, advantages & disadvantages over instrumental methods.	5	CO1	K1, K2, K3, K4
	1.3. Thermoanalytical techniques: Principle, instrumentation and applications of Thermogravimetric Analysis (TGA), Differential Thermal Analysis (DTA), and Differential Scanning Calorimetry (DSC). Numericals based on TGA.	5	CO1, CO2	K1, K2, K3, K4, K5
	 2.1. Concepts in Chromatography Principles of chromatography, classification of chromatographic techniques based on mechanism of retention, configuration, mobile and stationary phase. Efficiency of separation- plate theory (theoretical plate concept) and rate theory (van Deemter equation). 	4	CO3	K1, K2, K3, K4, K5
	2.2. Chromatographic techniques Principles and applications of Paper chromatography, thin layer chromatography, HPTLC, Size exclusion and Ion exchange chromatography. Counter-current chromatography for isolation of natural products.	4	CO3	K1, K2, K3, K4, K5

	2.3. Gas and Liquid Chromatography Introduction; Instrumental Modules; Separation System; Choice of Conditions of Analysis; Sample Inlet Systems; Detectors; Practical Considerations in Qualitative and Quantitative Analysis; Coupled Systems-introduction to GCMS, GCIR, LCMS: Applicability, interpretation and numericals.	7	CO3		K2, K4,
Module 3:	3.1. Spectroscopic Techniques Interaction of Electromagnetic Radiation with Matter, Electromagnetic spectra, regions of spectrum, numericals. Ultraviolet and visible Spectroscopy: Electronic spectra and Molecular structure: types of electronic transition, Chromophore and auxochrome, absorption by isolated chromophore, conjugated chromophores, aromatic compounds, inorganic chelates. Choices and effect of solvents on UV-Vis. Quantitative Calculations: Beer-Lambert Law; Mixtures of absorbing species-laws of additivity of absorbance; calibration curve for calculation of unknown; Spectrometric errors in measurement; Deviation from Beer-Lambert Law - chemical deviation, instrumental deviation; Numericals for quantitative analysis using UV-Vis spectroscopy. Infrared Spectroscopy: Infrared absorption and molecular structures, molecular vibrations, types of vibrations, IR spectra, overtones and bands-basis of NIR absorption. Spectrometric instrumentation of UV-Vis and IR: Sources, monochromators, sample cells, detectors, instrumental wavelength and absorption calibration.	10	CO4	K1, K K3, K K5, K6	ζ4,
	 3.2. Applications of UV-Vis spectroscopy for qualitative analysis Calculating λmax for Conjugated Dienes, Trienes, polyenes, α,β-unsaturated carbonyl compounds, Numericals. Applications of IR spectroscopy for qualitative analysis: Spectra interpretation, Frequencies of functional group, Spectral Databases, Identification of unknown compounds. 	5	CO4	K3, K K5	(4,

Module 4:	4.1. Raman Spectroscopy Theory, Basic instrumentation and Structural analysis using Raman Spectra. Mass Spectrometry: Principle, Instrumentation and various fragmentation patterns.	5	CO4	K2, K3, K4	
	4.2. Proton and Carbon NMR Spectroscopy Theory of NMR, Instrumentation, Chemical shift, factors influencing chemical shift, solvents used in NMR, spin-spin splitting, coupling constant calculation, factors influencing coupling constant.	5	CO4	K1, K2, K3, K4, K5, K6	
	4.3. Conjoint spectrometry problems Structural elucidation of organic molecules using IR, UV, NMR and MS.	5	CO4	K3, K4, K5, K6	
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-s of these can also be used. ICT mode should be preferred. Sessions should be interactive learning.	•			
Texts:	 G. D. Christian, Analytical Chemistry, 6th Ed., Wiley, Singapore, 2004. G. W. Ewing, Instrumental Methods of Chemical Analysis, 5th Ed., McGraw- Hill Int., New York, 1985. W. Kemp, Organic Spectroscopy, 3rd Ed., Palgrave, New York, 1991. D. A. Skoog, D. M. West, F. J. Hollar, S. R. Crouch, Fundamentals of Analytical Chemistry, 9th Ed., Cengage learning, USA, 2014. R. M. Silverstein, F. X. Webster, Spectrometric identification of Organic Compounds, 6th Ed., Wiley, USA, 1998. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, B. Sivasankar, Vogel's Text Book of Quantitative Chemical Analysis, 6th Ed., Pearson, New Delhi, 2009 F. J. Holler, D. A. Skoog, S. R. Crouch, Principles of Instrumental Analysis, 6th Ed., Thomson Books, London, 2007. H. Willard, L. L. Merritt, J. A. Dean, F. A. Settle, Instrumental methods of Analysis, 7th Ed., HCBS Publishing, India, 2004. C. N. Banwell, E. M. McCash, Fundamentals of Molecular Spectroscopy, 4th Ed., Tata McGraw-Hill, India, 2006. P. S. Kalsi, Spectroscopy of Organic Compounds, 2nd Ed., New Age International, New Delhi, 2000. 				
References/ Readings:	 J. H. Kennedy, Analytical Chemistry: Principles, 2nd Ed., Saunders College Publish H. Gunzler, A. Williams, Handbook of Analytical Techniques, 1st Ed., Wiley, Germ E. Pretsch, P. Buhlmann, C. Affolter, Structural Determination of Organic Con 	nany, 20	001.		



- 4. L. D. Field, S. Sternhell, J. R. Kalman; Organic Structures from Spectra, 4th Ed., Wiley, Singapore, 2007.
- 5. R. A. Day, A. L. Underwood, Quantitative Analysis, 6th Ed., Prentice Hall, USA, 2001.
- 6. B. K Sharma, Instrumental methods of chemical analysis, Goel Publishing House, Meerut, 2004.
- 7. K. Nakamoto, Infrared and Raman Spectra of Inorganic and Coordination Compounds, 6th Ed., Wiley, USA, 2009.
- 8. P. J. Larkin, Infrared and Raman Spectroscopy: principles and spectral interpretation, 2nd Ed., Elsevier, Netherland, 2018.









SEMESTER II

Discipline Specific Core (DSC) Courses

Title of the Course	Coordination and Organometallic Compounds: Bonding to Reactivity
Course Code	CHI-5001
Number of Credits	04
Theory/Practical	Theory
Level	500
Effective from AY	2025-26
New Course	No No
Bridge Course/ Value added Course	No Service Control of the Control of
Course for advanced learners	No Constant Total Constant Con
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Pre-requisites	Nil
for the Course:	From all a Divine
	To understand the bonding, spectroscopic, and magnetic properties of compounds.
Course Objectives:	To explain the thermodynamic and kinetic principles governing reaction mechanisms.
	To learn reaction pathways of coordination and organometallic compounds.
	To learn synthetic strategies for transformation of transition metal compounds.

Course Outcomes:	Students will be able to		Mapped	to PSO	
	CO 1. explain the bonding, properties and reaction mechanisms of coordination and organometallic compounds.		PSO1, PSO2		
	CO 2. utilize spectroscopic data, mechanistic principles and bonding model to predict properties, stability, and reactivity of transition metal compounds.		PSO1, PSO2		
	CO 3. analyze spectroscopic data and deduce mechanistic pathways to correlate with the structural, electronic, and catalytic features of coordination and organometallic compounds.		PSO1, PSO3		
COAUNVER	CO 4. design synthetic routes, propose catalytic cycles, and critically assess mechanistic alternatives for transformations involving coordination and organometallic compound.		PSO4		
Content:		No of hours	Mapped to CO	Cognitive Level	
	Bonding, electronic and magnetic properties of coordination compounds		CO1,	K1, K2,	
Module 1:	Electronic structure and bonding: Crystal field theory and its applications in (i) Octahedral compounds; (ii) tetrahedral compounds; (iii) square-planar compounds and (iv) tetragonally distorted compounds (Jahn-Teller Effect); Molecular orbital theory (MOT): $\sigma \& \pi$ -bonding in octahedral, tetrahedral, square planar compounds.		CO2, CO3, CO4	K3, K4, K5	
	Electronic spectra of compounds: Selection rules, colour and intensities; Charge transfer bands; Correlation diagrams: examples and problem solving using (i) Orgel diagrams and (ii) Tanabe-Sugano diagrams.	15			
	Magnetic studies: Cooperative magnetism, basic concepts of magnetic properties: diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism, temperature dependent magnetism, Curie law, Curie Weiss law, Spin cross over phenomenon.				

		ı			
	Inorganic reaction mechanisms		CO1,	K1,	
	Thermodynamics of complex formation: Formation constants; Trends in successive		CO3,	K3,	K4,
Module 2:	formation constants; The chelate and macrocyclic effects; Steric effects and electron delocalization.		CO4	K5	
	Ligand substitution reactions and mechanisms: Rates of ligand substitution; The classification of mechanisms; Ligand substitution in square-planar compounds: the nucleophilicity of the entering group, the shape of the transition state; Ligand substitution in octahedral compounds: rate laws and their interpretation, the activation of octahedral compounds, and stability of coordination compounds; Hydrolysis reaction: acid and base hydrolysis.	15			
SUNVA DE LA CONTRACTION DE LA	Redox reactions: The classification of redox reactions; The inner-sphere mechanism; The outer-sphere mechanism: self-exchange and cross exchange reaction, Marcus equation; Photochemical reactions: Prompt and delayed reactions; Transitions in metal-metal bonded systems.				
THE PART OF THE PA	Organometallic chemistry of transition metals		CO1,	K1,	K2,
Transfer of De 19	Organometallic compounds with ligands such as Carbon monoxide, Phosphines, Hydrides and dihydrogen compounds, η^1 -Alkyl, -alkenyl, -alkynyl, and - aryl ligands,		CO2, CO3,	K3, K5	K4,
Module 3:	η^2 -Alkene and -alkyne ligands, nonconjugated diene and polyene ligands, butadiene, cyclobutadiene, and cyclooctatetraene, benzene and other arenes, the allyl ligand, cyclopentadiene and cycloheptatriene, carbenes, alkanes, agostic hydrogens, and noble gases, dinitrogen and nitrogen monoxide.	15	CO4		
	Metal carbonyls: Classification, bonding, evidences for synergistic bonding, factors affecting the magnitude of stretching frequency; Carbonylate ions: synthesis, properties, reactions and synthetic applications.				
	Metal clusters: metal carbonyl clusters, electron counting in clusters, metal-metal bonding, binuclear clusters containing metal-metal bonds; Metallocenes: bonding,				

	molecular orbital diagram, synthesis, properties and reactions of metallocene; Isolobal analogy; fluxionality in cyclic polyene compounds.				
Module 4:	Reactions and mechanism of organometallic compounds Ligand substitution reactions, Oxidative addition and reductive elimination, σ -Bond metathesis, 1,1-Migratory insertion reactions, 1,2-Insertions and β -hydride elimination, α -, β -, and δ -Hydride eliminations and cyclometallations. Catalysis: general concepts, catalytic cycle for isomerization of prop-2-en-1-ol to prop-1-en-1-ol, alkene metathesis, hydrogenation of alkenes, hydroformylation, Wacker oxidation of alkenes, asymmetric oxidations, palladium catalyzed C-C bond forming reactions, methanol carbonylation (Monsanto acetic acid process).	15	CO1, CO2, CO3, CO4	K1, K3, K5	K2, K4,
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-st of these can also be used. ICT mode should be preferred. Sessions should be interactive i learning.	•			
Texts:	 F. A. Cotton, G. Wilkinson, P. L. Gauss, Basic Inorganic Chemistry, 3rd ed., Wiley India. J. D. Lee, Concise Inorganic Chemistry, 5th ed., Wiley India, New Delhi, 2008. J. E. Huheey, E. A. Kieter, R. L. Kieter, O. K. Medhi, Inorganic Chemistry: Principle 4th ed., Pearson, New Delhi, 2011. P. W. Atkins, T. Overton, J. Rourke, M. Weller, F. Armstrong, Shriver & Atkins I Oxford University Press, Oxford, 2009. 	les of St	ructure &	z Reacti	ivity,
References/ Readings:	 A. Kumar, Organometallic and Bioinorganic Chemistry, 4th Ed; Aaryush Education, F. A. Cotton, G. Wilkinson, Advanced Inorganic Chemistry, 6rd ed., Wiley India, Ne G. C. Miessler, D. A. Tarr, Inorganic Chemistry, 3rd ed., Pearson, New Delhi, 2004. 		•		012).



Title of the Course	Solid State Chemistry
Course Code	CHI-5002
Number of Credits	04
Theory/Practical	Theory
Level	500
Effective from AY	2025-26
New Course	No Co
Bridge Course/ Value added Course	No
Course for advanced learners	No No

Pre-requisites For the Course:	Nil	
Course Objectives:	 To understand the fundamentals of solid-state chemistry, including atomic structure, bonding, of solids and their reactivity and transformations. To gain knowledge about the synthesis of materials and characterization techniques. To study the relationship between the structure, composition, and material properties. To learn material synthesis with desired properties and applications. 	lefects, and properties
Course Outcomes:	Students will be able to CO 1. explain the fundamental relationship between the crystal structure, method of preparation,	Mapped to PSO PSO1, PSO2, PSO4
	reactivity and properties of various materials.	

	CO 2. apply different preparative techniques for synthesis of materials and establish the structure-property relationship.			P SO4	SO2,
	CO 3. correlate the properties of the materials with respect to various types of bone preparation methods.	ds and	PSO1, PS	SO2, F	PSO3
	CO 4. design materials for various applications in electronics, catalysis, sensors, etc.		PSO1, PS	SO2, F	PSO4
Content:	AUNIVERS	No of hours	Mapped to CO		nitive evel
Module 1:	Structure, bonding, crystal defects & non-stoichiometry in Solids Materials Chemistry: properties, structure and applications of materials. Structure and bonding in solid materials: Crystal lattice; unit cell; Miller indices and planes; X-Ray diffraction method; Molecular, Metallic, Covalent and Ionic solids, Hydrogen bonding; Structural classification of binary and tertiary compounds; Spinel and Perovskite structures. Crystal defects & Non-stoichiometry in Solids: Types of defects: Point defects, Dislocations: Line defects and Plane defects, Oxygen deficient oxides; Metal deficient oxides and classification of non-stoichiometry.	15	CO1, CO2, CO3	· ·	K2, K4,
Module 2:	Materials preparation techniques Broad Classification of methods: Ceramic method, and Different wet chemical methods. Types of Materials: Powdered bulk materials, Single crystal and Thin films, Amorphous materials, and Nanomaterials. Preparation methods for different materials with their advantages and disadvantages: i. Powder materials: Co-precipitation method, Precursor method, Combustion method: Solid state and solution method, Precursor-combustion method, Sol-gel method, Spray roasting method, Freeze drying method, Flux method.	15	CO1, CO2, CO3, CO4	K1, K3, K6	K2, K4,

	 ii. Single crystals: (a) Growth from melt (b) from solution (c) using Flux method (d) Epitaxial growth of single crystal thin films: Using Chemical and Physical methods (e) Chemical vapour transport (f) Hydrothermal method (g) Dry high pressure method. iii. Amorphous Materials: Synthesis & applications. Nanomaterials: Synthesis, properties: structural, optical and magnetic and applications. 			
Module 3:	Reactivity and phase transformations in solid materials Reactivity in solids: Tarnish reactions, decomposition reaction, solid-solid reactions, addition reactions, double decomposition reaction, electron transfer reaction, solid-gas reactions, sintering, factors influencing reactivity of solids. Phase transformations in solid: Thermodynamic consideration, Burgers classification, structural change in phase transformation, Martensite transformation, temperature and pressure induced transformations, order-disorder transitions, electronic transition, transformation with a change in composition, enantiotropy and monotropy, Ehrenfest classification, ternary phase diagram.	10	CO1, CO2, CO3	K1, K2, K3, K4
Module 4:	Electrical, magnetic, optical, and dielectric Properties Electrical conductivity, free electron theory, Fermi energy, insulators, semiconductors and conductors, band theory of semiconductor, Brillouin zones, Hall effect, Peltier effect, Seebeck effect, photo conductivity and ionic conductivity, Semiconductor devices: Diodes and transistors, Junction field effect transistor and metal oxide semiconductor field effect transistor, light meter, photodiode, phototransistor, solar cells, light emitting diodes. Laser materials. Superconductivity: BCS theory, Meissner effect, high temperature superconductor. Introduction to magnetism, behavior of substance in a magnetic field, magnetic moments, diamagnetism, paramagnetism, experimental determinations of susceptibility,	20	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5

	ferromagnetism, anti-ferromagnetism and ferrimagnetism, magnetization of ferromagnetic substance. Luminescence, piezoelectric, ferroelectric materials and applications, thermal conductivity, phonon interaction, thermal expansion coefficient.
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.
Texts:	 R. West, Solid State Chemistry and Its Applications, 2st Ed., John Wiley & Sons, Singapore, 2022. D. K. Chakraborty, Solid State Chemistry, 2nd Ed.; New Age International Publisher, New Delhi, 2010. H. V. Keer, Principles of the Solid State, 1st Ed., New Age International (P) Ltd., (Wiley Eastern Ltd.), New Delhi, 1993, (Reprint 2008). L. V. Azaroff, Introduction to solids, 1st Ed., McGraw Hill Education, Delhi, 2016, (40th Reprint). N. B. Hannay, Treatise on Solid State Chemistry Vol.4 Reactivity of Solids, 1st Ed.; Plenum Press, New York, 1976.
References/ Readings:	 B. D. Fahlman, Materials Chemistry, 2nd Ed.; Springer, Michigan, 2011. C. N. R Rao & Gopalkrishnan, New directions in solid state chemistry, 2nd Ed.; Cambridge University Press, Cambridge, 1997. C. N. R. Rao & K. J. Rao, Phase Transitions in Solid, 1st Ed.; McGraw Hill, England, 1977. H. R. Allcock, Introduction to materials chemistry, 1st Ed.; John Wiley & Sons, New Jersey, 2011. W. D. Callister, Materials Science and Engineering: An Introduction, 7th Ed.; John Wiley, New Jersey, 2007.



Title of the Course	Molecular Symmetry and Spectroscopy
Course Code	CHI-5003
Number of Credits	4
Theory/Practical	Theory
Level	500
Effective from AY	2025-26
New Course	No Co
Bridge Course/ Value added Course	No
Course for advanced learners	No Carte San Day
319 1015	

Pre-requisites for the Course:	Nil Tayrage Division of the Control		
	To describe concepts in molecular symmetry and spectroscopy.		
Course • To understand fundamental aspects of molecular symmetry and spectroscopy.			
Objectives:	• To study the spectral data for structure determination of molecules.		
	• To learn the application of molecular symmetry and spectroscopy.		
	Students will be able to	Mapped to PSO	
Course Outcomes:	CO 1. explain symmetry and spectroscopic aspects of molecules.	PSO1	
	CO 2. apply concepts of molecular symmetry and spectroscopy in structural analysis.	PSO2	

	CO 3. analyse spectra of molecules to determine molecular geometry.		PSO3		
	CO 4. evaluate molecular symmetry and spectroscopic data for chemical analysis.		PSO4		
Content:	Touristic + Day of	No of hours	Mapped to CO	Cogn	
Module 1:	Molecular symmetry Group and it's defining properties, order of the group, examples of group, group multiplication table, cyclic group, acyclic group, abelian group, non-abelian group. Sub groups, classes, properties of conjugate elements. Symmetry elements and operations, symmetry planes and reflections, the inversion centre, proper axes and proper rotations, improper axis and improper rotations. Products of symmetry operations, equivalent symmetry elements and equivalent atoms, relations among symmetry elements and operations, symmetry elements and optical isomerism, symmetry point groups, symmetries with multiple high order axes, classes of symmetry operations, procedure for symmetry classification of molecules. Representation of groups, some properties of matrices and vectors, the great orthogonality theorem, reducible and irreducible representations, irreducible representations, direct product. Symmetry Adapted Linear Combinations and its applications. Symmetry aspects of molecular orbital theory and molecular vibrations in organic, inorganic and organometallic compounds. Crystal symmetry, crystallographic point groups, space groups and X-ray Crystallography.	30	CO1, CO2, CO3, CO4	K1, K3, K5	K2, K4,
Module 2:	Spectroscopy Magnetic Resonance Spectroscopy; interaction between electron spin / nuclear spin and magnetic field, Resonance condition, instrumental requirements, Presentation of	30	CO1, CO2, CO3,	K1, K3, K5	K2, K4,

	CO4		
and the state of t			
their use in determination of molecular structure.			
Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-st	=		
some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature group learning.			
1. C. N. Banwell, E. M. McCash, Fundamentals of Molecular Spectroscopy, 4 th Ed.; Tata N 1994.	AcGraw Hill, New Delhi,		
2. F. A. Cotton, Chemical applications of group theory, 3 rd Ed.; Wiley Eastern, New York,	2012 (reprint).		
3. G. Aruldhas, Molecular structure and spectroscopy, Prentice Hall of India, New Delhi, 2	2001.		
4. G. R. Desiraju, J. J. Vittal, A. Ramanan, Crystal Engineering, 1 st Ed.; IISC Press, wor 2011.	ld Scientific, New York,		
5. J. E. Huheey, E. A. Kieter, R. L. Kieter, O. K. Medhi, Inorganic Chemistry: Principles o 4 th Ed.; Pearson, Chennai, 2011.	f Structure & Reactivity,		
6. R. L. Dutta, A. Syamal, Elements of Magnetochemistry, 2 nd Ed.; Affiliated East-West Pr	ress, New Delhi, 1993.		
7. R. S. Drago, Physical Methods in Inorganic Chemistry, 1st Ed.; Affiliated East West Pre	D I 4 J N D-11-:		
_	 Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-st some of these can also be used. ICT mode should be preferred. Sessions should be interactive group learning. 1. C. N. Banwell, E. M. McCash, Fundamentals of Molecular Spectroscopy, 4th Ed.; Tata N. 1994. 2. F. A. Cotton, Chemical applications of group theory, 3th Ed.; Wiley Eastern, New York, 3. G. Aruldhas, Molecular structure and spectroscopy, Prentice Hall of India, New Delhi, 2th G. R. Desiraju, J. J. Vittal, A. Ramanan, Crystal Engineering, 1sth Ed.; IISC Press, wor 2011. 5. J. E. Huheey, E. A. Kieter, R. L. Kieter, O. K. Medhi, Inorganic Chemistry: Principles of 4th Ed.; Pearson, Chennai, 2011. 6. R. L. Dutta, A. Syamal, Elements of Magnetochemistry, 2th Ed.; Affiliated East-West Press. 		

	2017.
	1. A.K. Brisdon, Inorganic Spectroscopic Methods, 1 st Ed.; Oxford University Press, New York, 1998.
	2. E. A. V. Ebsworth, D. W. H. Rankin, S. Cradock, Structural Methods in Inorganic Chemistry, 1 st Ed.; Blackwell Scientific Publications, New York, 1988.
	3. J.M. Hollas, Symmetry in Molecules, 1 st Ed.; Chapman & Hall Ltd., London, 1972.
D.f D 1:	4. K. Nakamoto, Infrared and Raman Spectra of Inorganic and Coordination Compounds, Part A: Theory and Applications in Inorganic Chemistry, 6 th Ed.; Wiley, New Jersey, 2009.
References/ Readings:	5. K. Nakamoto, Infrared and Raman Spectra of Inorganic and Coordination Compounds, Part B: Applications in Coordination, Organometallic and Bioinorganic Chemistry, 6 th ed.; Wiley, New Jersey, 2009.
AUNIVER	6. LL. Ooi, Principles of X-ray Crystallography, 1st Ed.; Oxford University Press, New York, 2010.
	7. P. Atkins, J. De Paula, J. Keeler, Atkins' Physical Chemistry, 1st Ed.; Oxford University Press, New York, 2018.
	8. P. W. Atkins, T. Overton, J. Rourke, M. Weller, F. Armstrong, Shriver & Atkins Inorganic Chemistry, 5 th Ed.; Oxford Publications, New York, 2009.
Web Resources:	https://symotter.org/



Title of the Course	Concepts and Applications in Inorganic Chemistry
Course Code	CHI-5004
Number of Credits	04
Theory/Practical	Theory
Level	500
Effective from AY	2025-26
New Course	No Co
Bridge Course/ Value added Course	No
Course for advanced learners	No Company of the second of th
AF ME	(D 1 9 7 0 0 0 0 0 0 0 0 0

Pre-requisites for the Course:	Nil Conduction of the Conducti	
Course Objectives:	 To develop a comprehensive understanding and explore the applications of s-block compounds. To introduce the role of inorganic compounds in medicinal chemistry. To establish a strong conceptual foundation in nuclear chemistry. To strengthen theoretical and practical understanding of acid-base chemistry. 	unds.
	Students will be able to	Mapped to PSO
Course Outcomes:	CO 1. explain the fundamental principles of inorganic chemistry including atomic structure, periodic properties, acid-base theories, and chemical bonding.	PSO1, PSO2, PSO3, PSO4

	CO 2. analyze the roles and applications of inorganic compounds in medicine, a chemistry, and industry.	nuclear	PSO1, PS	SO2, P	SO3,
	CO 3. evaluate the physico chemical behavior of inorganic compounds under conditions, including redox processes, solubility patterns, and the effects of solve acids and bases.		PSO1, PSO2, PSO3, PSO4 PSO1, PSO2, PSO3, PSO4		SO3,
	CO 4. demonstrate awareness of the societal and technological relevance of incohemistry, including its impact in healthcare, energy, and environmental manage	•			
Content:	Control of the contro	No of hours	Mapped to CO	Cogn	
Module 1:	s-Block elements and their compounds Hydrogen and hydrides; Electronic structure, position in periodic table, abundance, preparation, properties, isotopes, ortho and para hydrogen. Classification of hydrides, preparation & properties of hydrides; hydrogen ion, hydrogen bonding and its influence on properties. Group 1 elements; Introduction, abundance, extraction, physical and chemical properties, solubility and hydration, solutions of metal in liquid ammonia, complexes, crowns and cryptands, electrides, alkalides, difference between lithium and the other group 1 elements, diagonal relationship between Li and Mg. Group 2 elements; Introduction, abundance, extraction, physical and chemical properties, solutions of metal in liquid ammonia, complexes, anomalous behaviour of beryllium, difference between beryllium and the other group 2 elements, diagonal relationship between Be and Al, preparation and properties of Grignard reagent.	15	CO1, CO2, CO3, CO4	K1, K3, K5	K2, K4,
Module 2:	Inorganic medicinal chemistry Anticancer agents; Platinum and Ruthenium complexes as anticancer drugs, chemotherapy, phototherapy, radiotherapy using borane compounds.	15	CO1, CO2, CO3,	K1, K3, K5, F	,

	Chelation therapy. Gadolinium and technetium complexes as MRI contrast agents, X-ray contrast agents. Anti-arthritis drugs. Anti-bacterial agents (Ag, Hg, Zn and B compounds). Antiseptic and anti-biotic. Deodorants and anti-perspirants.		CO4		
Module 3:	Chemistry of radioactive elements Atomic nucleus; Classification of nuclides and nuclear stability. Review of Nuclear models. Radioactivity, Decay processes and decay energy, half-life of radioactive elements. Nuclear reactions; Nuclear fission and fusion processes. Nuclear Reactors; Nuclear reactor components and functions, Q values for nuclear reactions. Detection and measurement of activity; Radiation detection principles. Physical and Chemical separation techniques of radioactive elements. Radio-analytical techniques, Activation analysis. Nuclear waste management. Applications of radioactivity.	15	CO1, CO2, CO3, CO4	K1, K3, K5	K2, K4,
Module 4:	Acids and Bases Brønsted acidity; Proton transfer equilibria in water, Solvent levelling, The solvent system definition of acids and bases, Characteristics of Brønsted acids, Periodic trends in aqua acid strength, Simple oxoacids, Anhydrous oxides, Polyoxo compound formation, Nonaqueous solvents.	15	CO1, CO2, CO3, CO4	K1, K3, K5, H	K2, K4, K6

	Lewis acidity, Examples of Lewis acids and bases, Group characteristics of Lewis acids.				
	Reactions and properties of Lewis acids and bases; The fundamental types of reaction,				
	Hard and soft acids and bases, Thermodynamic acidity parameters, Solvents as acids and bases.				
	Applications of acid-base chemistry, Superacids and superbases, Heterogeneous acid-base reactions.				
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.				
	1. F. A. Cotton, G. Wilkinson, P. L. Gauss, Basic Inorganic Chemistry, 3 rd Ed.; Wiley, India, 2008 (reprint).				
	2. H. J. Arnikar, Essentials of Nuclear Chemistry, 4 th Revised Ed.; New Age Intl. Publishers, India, 2011.				
	3. J. D. Lee, Concise Inorganic Chemistry, 5 th Ed.; Wiley, India, 2008.				
Texts:	4. J. E. Huheey, E. A. Kieter, R. L. Kieter, O. K. Medhi, Inorganic Chemistry: Principles of Structure & Reactivity, 4 th Ed.; Pearson, India, 2011.				
400 Memper in Direction	5. P. W. Atkins, T. Overton, J. Rourke, M. Weller, F. Armstrong, Shriver & Atkins Inorganic Chemistry, 5 th Ed.; Oxford University Press, Great Britain, 2009.				
	1. A. G. Sykes, Advances in Inorganic Chemistry, 1st Ed.; Academic Press Ltd., UK, 1990.				
	2. F. A. Cotton, G. Wilkinson, Advanced Inorganic Chemistry, 3 rd Ed.; Wiley Eastern, India, 2001.				
	3. G. C. Miessler, D. A. Tarr, Inorganic Chemistry, 3 rd Ed.; Pearson, India, 2004.				
References/ Readings:	4. G. R. Choppin, J-O. Linjenzin, J. Rydberg, C. Ekberg, Radiochemistry and Nuclear Chemistry, 4 th Ed.; Academic Press, USA, 2013.				
	5. K.A. Strohfeldt, Essentials of Inorganic Chemistry, 1 st Ed.; John Willey & Sons, UK, 2015.				
	6. N. N. Greenwood, A. Earnshaw, Chemistry of the Elements, 2 nd Ed., Butterworth-Heinemann Ltd, UK, 1997.				

SEMESTER I & II

Discipline Specific Elective Courses

Title of the Course	Organic Chemistry Practical - I
Course Code	CHO-5201
Number of Credits	2
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No V
Course for advanced learners	No Classification of the Control of
lear ners	

Pre-requisites for the Course:	NIL		
Course Objectives:	 To understand essential laboratory equipment, safety protocols, and fundamental experimental purification techniques To create practical skills in basic organic synthesis through key reactions, including electrophilic substitution and other important transformations. To understand the methods of isolation and purification of naturally occurring organic compounds. 		
Course Outcomes:	Students will be able to:	Mapped to PSO	
	CO 1. Understand stoichiometric requirements during organic syntheses.	PSO1, PSO3, PSO4	

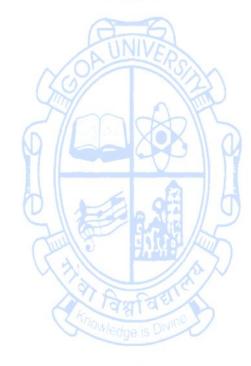
	CO 2. Apply safe and good laboratory practices and develop skills in h laboratory glassware, equipment and chemical reagents.	andling	PSO1, PSO3, PSO4 PSO1, PSO3, PSO4	
	CO 3. Create the practical knowledge to perform experiments involving collaboratory techniques like reflux, distillation, steam distillation, distillation, aqueous extraction, thin layer chromatography (TLC).			
	CO 4. Assess their expertise in isolation of some important natural products.		PSO1, PSO2,	PSO3, PSO4
Content:	OF UNIVERS	No of hours	Mapped to CO	Cognitive Level
Tanta drive	 1.1 Introduction to laboratory equipment, apparatus and safety a. Use of common laboratory equipment like fume hood, vacuum pump, weighing balance. b. Introduction to various types of quick fit joints and apparatus. c. Safety Techniques: i. Disposal of chemicals ii. Personal Protective Equipment (PPE) iii. First aid iv. Fire extinguishers, types of fire v. Chemical hazards and risk assessment 		CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5
Module 1:	 1.2 Laboratory Techniques-I a. Simple distillation (any one): i. Toluene-dichloromethane mixture using water condenser. ii. Nitrobenzene and aniline using air condenser. b. Steam distillation (any one): i. Separation of o- and p- nitrophenols. ii. Naphthalene from its suspension in water. iii. Clove oil from cloves. c. Crystallisation: Concept of induction of crystallization (any one) i. Crystallisation of phthalic acid from hot water using fluted filter paper and stemless funnel. 	16		

	ii. Acetanilide from boiling wateriii. Naphthalene from ethanol.iv. Decolorisation and crystallization of brown sugar (sucrose) with animal charcoal using gravity filtration.			
Module 2:	 2 Laboratory Techniques-II a. Sublimation: Simple or vacuum sublimation of camphor, naphthalene, anthracene or succinic acid (any one). Vacuum distillation (any one): odichlorobenzene, diphenyl ether. Explanation of use of nomograph. b. Thin layer Chromatography (any one): Separation of o and p-nitroanilines. Separation of analgesic drugs (ibuprofen/paracetamol) Separation of o and p-nitrophenols 	12	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5
Module 3:	 3. Organic synthesis (Any Four experiments) a. Aliphatic electrophilic substitution: Preparation of iodoform from ethanol & acetone. b. Aromatic electrophilic substitution (any one): i. Preparation of p-bromoacetanilide. ii. Bromination of acetophenone to phenacyl bromide iii. Nitration of napththalene to 1-nitronaphthalene iv. Nitration of benzaldehyde to 3-nitrobenzaldehdye. c. Oxidation (any one) i. Benzoic acid from toluene. ii. Cyclohexanone from cyclohexanol. iii. Isoborneol to camphor using Jones reagent. d. Reduction (any one) i. Reduction of o-nitroaniline to o-phenylenediamine using Sn/HCl ii. Reduction of p-nitro benzaldehyde to p-nitrobenzyl alcohol using NaBH4. 	16	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5
	e. Bromination of an alcohol using CBr₄/ triphenylphosphine.f. Grignard reaction: Triphenylmethanol from benzoic acid ester or benzophenone.			

	g. Aldol condensation: Dibenzalacetone from benzaldehyde h. Acetoacetic ester condensation: Preparation of ethyl n-butylacetoacetate or ethyl acetoacetate.			
Module 4:	 Organic synthesis and synthetic reagents (Any two) a. Cannizzaro reaction using 4-chlorobenzaldehyde as substrate. b. Friedel Craft's reaction i. using toluene and succinic anhydride ii. Resorcinol to resacetophenone, benzene and maleic anhydride to benzoylacrylic acid. c. Solvent free preparation of coumarin by the Knoevenagel condensation under MW irradiation. d. Preparation of oxidizing agent (any one): Pyridinium chlorochromatesilica, pyridinium chlorochromate-alumina, MnO₂. e. Preparation of cuprous chloride. Isolation from natural sources (Any two) i. Caffeine from tea powder. ii. Piperine from pepper. iii. Cinnamaldehyde from cinnamon iv. Lemongrass oil from lemongrass 	16	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5, K6
Pedagogy:	Students should be given suitable pre- and post-lab assignments and explanational laboratory experiments prior to the conduct of each experiment.	on revisir	ng the theoretica	ll aspects of
Texts:	 A. I. Vogel, A. R. Tatchell, B. S. Furniss, A. J. Hannaford, Vogel's Textbooked. Prentice Hall, New Delhi, 2011 K. Tanaka, Solvent-Free Organic Synthesis, 2nd ed, Wiley-VCH, Weinheir J. L. F. Fieser, K. L. Williamson, Organic Experiments, 7th ed. D. C. Heath, I. K. L. Williamson, K. M. Masters, Macroscale and Microscale Organic Experiments, 2010 R. K. Bansal, Laboratory Manual in Organic Chemistry, 5th ed. New Age I. O. R. Rodig, C. E. Bell Jr., A. K. Clark, Organic Chemistry Laboratory: Star 	m, 2009. Lexington aperiment onternation	n, 1992. ts, 6th ed. Ceng nal, New Delhi,	gage Learning,

	ed. Saunders College Publishing, Philadelphia, 2009
References/ Readings:	1. S. Delvin, Green Chemistry, 1st ed. Sarup & Sons, New Delhi, 2005
	2. J. Mohan, Organic Analytical Chemistry, 1st ed. Narosa Publishing House, New Delhi, 2014
	3. T. Laue, A. Plagens, Named Organic Reactions, 1st ed. John Wiley and Sons, Inc., Hoboken, 2005









Title of the Course	Organic Chemistry Practical - II
Course Code	CHO-5202
Number of Credits	
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No Company of the Com
Course for advanced learners	No O Sold Sold Sold Sold Sold Sold Sold Sold

Pre-requisites for the Course:	NIL 15	
Course Objectives:	 To familiarize students with essential laboratory equipment, safety protocols, a purification techniques To develop practical skills in basic organic synthesis through key reactions, including other important transformations. To introduce the methods of isolation and purification of naturally occurring organic 	ng electrophilic substitution and
	Students will be able to:	Mapped to PSO
	CO 1. Understand stoichiometric requirements during organic syntheses.	PSO1, PSO3, PSO4
Course Outcomes:	CO 2. Apply safe and good laboratory practices and develop skills in handling laboratory glassware, equipment and chemical reagents.	PSO1, PSO3, PSO4
	CO 3. Create the practical knowledge to perform experiments involving common	PSO1, PSO3, PSO4

	laboratory techniques like reflux, distillation, steam distillation, distillation, aqueous extraction, thin layer chromatography (TLC).	vacuum		
	CO 4. Assess their expertise in isolation of some important natural products.		PSO1, PSO2,	PSO3, PSO4
Content:	Townships - Day 5	No of hours	Mapped to CO	Cognitive Level
Module 1:	1.1 Introduction to laboratory equipment, apparatus and safety a. Common Hazards in Chemical Laboratory, Risk assessment b. Accidents and Emergency procedures 1.2 Laboratory Techniques (Any Three) a. Simple distillation: i. Simple distillation of thionyl chloride under anhydrous condition ii. Simple distillation under Nitrogen atmosphere of THF b. Fractional distillation: i. Chloroform-dichloromethane mixture using water condenser. ii. Toluene and cyclohexane using fractionating column. c. Vacuum distillation under inert atmosphere: Distillation of DMF, o-dichlorobenzene, POCl3 d. Thin layer Chromatography: i. Purification and isolation of mixture of acids (o-nitrobenzoic acid and p-nitrobenzoic acid) by using Preparative TLC. ii. Purification and isolation of pharmaceutical drugs (ibuprofen tablet) using Preparative TLC.	16	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5
Module 2:	Organic Synthesis (Any Four) a. p-Iodonitrobenzene by Sandmeyer reaction b. Pinacol- Pinacolone rearrangement	16	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5

	 c. Hydrogenation of Maleic acid (Hydrogen balloon) d. Preparation of nitrostyrene from aldehyde e. Preparation of dibromocinnamic acid f. Reduction of nitro compounds g. Synthesis of Urea from ammonium cyanate 			
Module 3:	3. Two-step Organic Synthesis (Any Two) a. Benzamide-Benzoic acid-Ethyl Benzoate b. Phthalic anhydride-Phthalimide-Anthranilic acid. c. Methyl benzoate- m-nitrobenzoate- m-nitrobenzoic acid d. Chlorobenzene-2, 4 -dinitrochlorobenzene-2,4 dinitrophenol e. Acetanilide-p-Bromoacetanilide-p-Bromoaniline f. Acetophenone-Oxime-Acetanilide	16	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5
Module 4:	 4.1 Solvent Free Organic synthesis (Any One) a. Reduction using ball milling technique b. Oxidation of 2° alcohol using KMnO₄/Alumina by grinding technique. c. Synthesis of 1,1'-Bi-2-naphthol (BINOL) d. Hunsdiecker reaction of cinnamic acid derivatives e. Beckmann rearrangement of oxime derivatives 4.2 Separation, Isolation and Identification of Organic compounds (Any One) Separation, purification and identification of compounds of binary mixture (Solid-Solid, Solid-liquid and Liquid-liquid) using the TLC and column chromatography, chemical tests. IR spectra to be used for functional group identification. 	12	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5, K6
Pedagogy:	Students should be given suitable pre- and post-lab assignments and explanation revising the theoretical aspects of laboratory experiments prior to the conduct of each experiment.			
Texts:	 A. I. Vogel, A. R. Tatchell, B. S. Furniss, A. J. Hannaford, Vogel's Textbook of Practical Organic Chemistry, 5th ed. Prentice Hall, New Delhi, 2011 K. Tanaka, Solvent-Free Organic Synthesis, 2nd ed, Wiley-VCH, Weinheim, 2009 			

	3. L. F. Fieser, K. L. Williamson, Organic Experiments, 7th ed. D. C. Heath, Lexington, 1992
	4. K. L. Williamson, K. M. Masters, Macroscale and Microscale Organic Experiments, 6th ed. Cengage Learning, Boston, 2010
	5. R. K. Bansal, Laboratory Manual in Organic Chemistry, 5th ed. New Age International, New Delhi 2016
	6. O. R. Rodig, C. E. Bell Jr., A. K. Clark, Organic Chemistry Laboratory: Standard and Microscale Experiments, 3rd ed. Saunders College Publishing, Philadelphia, 2009
	1. S. Delvin, Green Chemistry, 1st ed. Sarup & Sons, New Delhi, 2005.
References/ Readings:	2. J. Mohan, Organic Analytical Chemistry, 1st ed. Narosa Publishing House, New Delhi, 2014.
ixeaungs.	3. T. Laue, A. Plagens, Named Organic Reactions, 1st ed. John Wiley and Sons, Inc., Hoboken, 2005









Title of the Course	Inorganic Chemistry Practical-I
Course Code	CHI-5201
Number of Credits	2
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No Service Ser
Course for advanced learners	No O

Pre-requisites for the Course:	NILO SE LO		
Continue to De	To acquire skills in synthetic inorganic chemistry.		
Course	To gain knowledge about various laboratory chemicals.		
Objectives:	To determine metal and ligand content in a material.		
	• To evaluate compounds molecular formula to find lattice water molecules.		
	Students will be able	Mapped to PSO	
Course Outcomes:	CO 1. explain the synthesis of coordination compounds.	PSO1, PSO4	
	CO 2. estimate metals in the coordination compounds by classical methods of analysis.	PSO1, PSO3	
	CO 3. characterise commercially available ores and alloys.	PSO2, PSO3	

	CO 4. choose the appropriate instrumental methods of analysis for characte of	rization	PSO1, PS	SO4
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	 Preparations of Inorganic Compounds (ANY 07) a. Preparation of hexaamminenickel(II) chloride or hexaamminenickel(II) sulfate. b. Preparation of tris(ethylenediamine)cobalt(III) chloride. c. Preparation of potash alum from scrap aluminum. d. Preparation of potassium trioxalatoaluminate(III) trihydrate. e. Preparation of potassium hexathiocyanato-κN-chromate(III) tetrahydrate. f. Preparation of potassium trioxalatochromate(III) trihydrate. g. Preparation of α- and γ-Fe₂O₃. h. Preparation of Zinc acetate or [Zn₄O(CH₃CO₂)₆]. (Powder X-Ray Diffraction (PXRD), Infrared (IR), UV-vis spectroscopy and magnetic studies is expected) 	28	CO1, CO2	K2, K3, K4, K5
Module 2:	 2. Estimations / Determinations (ANY 08) a. Estimation of nickel by complexometry or Gravimetry. b. Estimation of cobalt in [Co(en)₃]Cl₃ by complexometry. c. Estimation of oxalate in K₃[Al(C₂O₄)₃]·xH₂O or K₃[Cr(C₂O₄)₃]·xH₂O d. Estimation of nitrite by redox titration. e. Estimation of calcium from calcite ore. f. Iodometric determination of copper in commercial copper compounds / alloys. g. Estimation of sulfate by gravimetry. h. Estimation of zinc by complexometric titration. i. Determination of chromium in chrome alum and K₃[Cr(C₂O₄)₃]·xH₂O and to determine degree of hydration. 	32	CO3, CO4	K2, K3, K4, K5

	j. Estimation of potassium from synthesized compounds. k. Colorimetric/Spectrophotometric determination of nickel or chromium or manganese.	
Pedagogy:	Students will be given pre-lab and post-lab assignments on theoretical aspects of laboratory experiments prior to the conduct of each experiment. Exams will be in the form of ISA, SEA which will involve performing given experiments and conduct of viva, systematic reporting of experiments, results and observations in laboratory report. Sessions should be interactive in nature to enable peer group learning.	
Texts:	 J. Mendham, R.C. Denney, J.D. Barnes, M.J. K. Thomas, Vogel's Text Book of Quantitative Chemical Analysis, Ed., Pearson, New Delhi, 2002. G. Svehla, Vogel's Text Book of Qualitative Inorganic Analysis, 7th Ed., Pearson, New Delhi, 2011. G. Brauer, Handbook of Preparative Inorganic Chemistry, Vol. 1 & 2, Academic Press, New York, 1963. G. Pass & H. Sutcliffe, Practical Inorganic Chemistry, Preparations, Reactions and Instrumental Methods, 2nd Ed. Chapman & Hall, New York, 1974. W. L. Jolly, The Synthesis & Characterization of Inorganic Compounds, Prentice-Hall, INC, New Jersey, 1970. G. Marr, B. W. Rockett, Practical Inorganic Chemistry, Van Nostrand Reinhold, London, 1972. 	
References/ Readings:	 S. De Meo, J. Chem. Ed., 80 (2003) 796-798. A. J. Elias, General Chemistry Experiments, Revised Ed., University Press, Hyderabad, 2008. 	



Title of the Course	Inorganic Chemistry Practical-II
Course Code	CHI-5202
Number of Credits	2
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No Carte de la Car
345	

Pre-requisites for the Course:	Nil Consume to the second seco		
	To acquire skills in synthetic inorganic chemistry.		
Course	To gain knowledge about various laboratory chemicals.		
Objectives:	To determine metal and ligand content in a material.		
	To evaluate compounds molecular formula to find lattice water molecules.		
	Students will be able to	Mapped to PSO	
Course Outcomes:	CO 1. understand methodologies related to compound synthesis.	PSO1, PSO4	
	CO 2. experiment with various reagents and metal salts to synthesize useful compounds.	PSO1, PSO4	

	CO 3. analyse synthesized and commercially available compounds.		PSO1, PS	SO3
	CO 4. interpret the chemical composition of materials using chemical methor instrumental techniques.	ds and	PSO1, PS	SO3, PSO4
Content:	Transation Devices	No of hours	Mapped to CO	Cognitive Level
Module 1:	 Preparations / Estimation of Inorganic Compounds: (Any Nine) a. Preparation of hexaamminecobalt(III) nitrate. b. Estimation of cobalt in hexaamminecobalt(III) nitrate by volumetric titration. c. Preparation of Potassium Trioxalatoferrate(III) Trihydrate d. Estimation of iron and oxalate by redox titration e. Synthesis of metal nanoparticles (Cu, Ag, Au, Ni) and determining the absorption maxima by UV-visible spectrophotometer. f. Estimation of amount of calcium in given sample by gravimetric method. g. Estimation of amount of nickel in given sample by gravimetric method. h. Estimation amount of zinc present in given sample by gravimetric method. i. Estimation of iron by colorimetric / spectrophotometry method. j. Estimation of barium by complexometric titration method. k. Estimation of manganese in presence of iron by complexometric titration method. (Powder X-Ray Diffraction (PXRD), Infrared (IR), UV-vis spectroscopy and magnetic studies is expected) 	40	CO1, CO2, CO3	K2, K3, K4, K5
Module 2:	2. Semi-micro qualitative analysis of cation and anion in a given inorganic mixture: (Any four mixture) Mixture containing total six cations and/or anions.	20	CO3, CO4	K2, K3, K4, K5

	Cations: Pb ²⁺ , Cu ²⁺ , Cd ²⁺ , Sn ²⁺ , Fe ²⁺ , Fe ³⁺ , Al ³⁺ , Cr ³⁺ , Zn ²⁺ , Mn ²⁺ , Ni ²⁺ , Co ²⁺ , Ba ²⁺ , Sr ²⁺ , Ca ²⁺ , Mg ²⁺ , (NH ₄) ⁺ , K ⁺ Anions: Cl ⁻ , Br ⁻ , I ⁻ , NO ₂ ⁻ , NO ₃ ⁻ , SO ₃ ²⁻ , CO ₃ ²⁻ , SO ₄ ²⁻ , PO ₄ ³⁻ , S ²⁻	
Pedagogy:	Students will be given pre-lab and post-lab assignments on theoretical aspects of laboratory experiments prior to the conduct of each experiment. Exams will be in the form of ISA, SEA which will involve performing given experiments and conduct of viva, systematic reporting of experiments, results and observations in laboratory report. Sessions should be interactive in nature to enable peer group learning.	
A TINVE	 J. Mendham, R.C. Denney, J.D. Barnes, M.J. K. Thomas, Vogel's Text Book of Quantitative Chemical Analysis, 6th Ed., Pearson, New Delhi, 2002. G. Svehla, Vogel's Text Book of Qualitative Inorganic Analysis, 7th Ed., Pearson, New Delhi, 2011. 	
	3. G. Brauer, Handbook of Preparative Inorganic Chemistry, Vol. 1 & 2, Academic Press, New York, 1963.	
Texts:	4. G. Pass & H. Sutcliffe, Practical Inorganic Chemistry, Preparations, Reactions and Instrumental Methods, 2nd Ed., Chapman & Hall, New York, 1974.	
	5. G. Marr, B. W. Rockett, Practical Inorganic Chemistry, Van Nostrand Reinhold, London, 1972.	
विमारिय गरिय	6. A. J. Elias, General Chemistry Experiments, Revised Ed., University Press, Hyderabad, 2008.	
	7. W. L. Jolly, The Synthesis & Characterization of Inorganic Compounds, Prentice-Hall, INC, New Jersey, 1970.	
References/ Readings:	1. S. De Meo, J. Chem. Ed., 80 (2003) 796-798.	



Title of the Course	Physical Chemistry Practical-I
Course Code	CHP-5201
Number of Credits	02
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No Service Ser
Course for advanced learners	No O

Pre-requisites for the Course:	NILO SE 15	
Course Objectives:	 To develop experimental skills on basic lab techniques in physical chemistry To understand fundamental laboratory concepts and acquire skills for data acquisition, and To understand and follow safety protocols for handling chemicals, equipment and instrum To apply the practical laboratory concepts for synthesis, problem solving and critical thinl To develop research skills through the principles of laboratory chemical research. 	nents.
	Students will be able to:	Mapped to PSO
	CO 1. Explain and perform various fundamental lab techniques and experiments.	PSO1
Course Outcomes:	CO 2. Handle and operate basic laboratory equipment and use it for research work.	PSO1, PSO4
	CO 3. Apply the laboratory knowledge and skills for their dissertation and research work.	PSO4, PSO5, PSO6, PSO7

	CO 4. Design synthesis and/or experimental methods.		PSO5, PS	O6, PSO7
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	 Non- instrumental Experiments (Any 08) To study the kinetics of hydrolysis of ethyl acetate and to determine a) Energy of activation b) Entropy of activation and c) Free energy change. To determine the order of reaction between potassium persulphate and potassium iodide by graphical, fractional change and differential methods. To study the three-component system such as acetic acid, chloroform and water and obtain tie line. To determine the molecular weight of polyvinyl alcohol by viscosity measurement. To study the electro-kinetics of rapid reaction between SO₄²⁻ and I in an aqueous solution. To determine the buffer capacity of acidic buffer solution. To determine the partial molal volume of ethanol-water mixture at a given temperature. To measure energy content of various types of plastics using bomb calorimetry To determine number average molecular weight of a polymer sample with an indirect titration method. To investigate basic hydrolysis of ethyl acetate at four different temperatures and find out energy of activation To construct a phase diagram for a two-component system by plotting cooling curves for mixtures of different compositions. To find the surface tension of methyl alcohol, ethyl alcohol and n-hexane at room temperature and then calculate the atomic parachors of carbon, hydrogen and oxygen. 	32	CO1, CO3, CO4	K2, K3, K4, K5
Module 2:	2. Instrumental Experiments (Any 07)1. To determine the degree of hydrolysis of salt of weak base and strong acid using conductometer.	28	CO2, CO3, CO4	K3, K4, K5

(3-5)	 To determine the dissociation constants of a tribasic acid (Phosphoric acid obtain derivative plot to get equivalence point. To determine formal redox potential of Fe²⁺/Fe³⁺ and Ce³⁺/Ce⁴⁺ system obtain derivative plot to get equivalence point. To study spectrophotometric titration of ferrous ammonium sulphate with potassium permanganate (or dichromate vs permanganate) To determine Avogadro's number by improved electroplating. To determine the zeta potential of colloidal system and investigate the effect of different surfactants on stability of the colloids. To verify the Kohlrausch's law for weak electrolyte by conductometry. To determine the transport numbers of Cu²⁺ and SO₄²⁻ ions in CuSO₄ solution by Hittorf's method.
Pedagogy:	Students will be given pre-lab and post-lab assignments on theoretical aspects of laboratory experiments prior to the conduct of each experiment. Exams will be in the form of ISA, SEA which will involve performing given experiments and conduct of viva, systematic reporting of experiments, results and observations in laboratory report. Sessions can preferably be interactive in nature to enable peer group learning.
Texts:	 V. D. Athawale, P. Mathur, Experimental Physical Chemistry, New Age International Publishers, 1st ed., New Delhi, 2001. J.N. Gurtu, A. Gurtu, Advanced Physical Chemistry Experiments, Pragati Publications, 1st ed., Meerut, 2008. A. Findlay & J. A. Kitchener, Practical Physical Chemistry, Longmans, Green and Co., 1st ed., London 1954. F. Daniels & J. H. Mathews, Experimental Physical Chemistry, McGraw-Hill, 1st ed., New York, 1941.
References/ Readings:	 A. M. James, Practical Physical Chemistry, Prentice Hall Press, 3rd ed., 1974. D.P. Shoemaker & C. W. Garland, Experiments in Physical Chemistry, McGraw-Hill, 1st ed., New York, 1962. T. Kandow & F. Mafune, Progress in experimental and theoretical studies of clusters, World Scientific publishers, 1st ed., New Jersey, 2002. C. Arora & S. Bhattacharya, Advanced Physical Chemistry Practical Guide, Bentham Science Publishers, 1st ed., UAE, 2022. A. K. Hagi, L. Pogliani, A. C. F. Ribeiro, Practical applications of Physical Chemistry in food science and technology, 1st ed., Apple Academic Press, USA, 2021.

Title of the Course	Physical Chemistry Practical-II
Course Code	CHP-5202
Number of Credits	02
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No No
Course for advanced learners	No Young Table 1
(D \\ a=2 _ 9E / (I)	

Pre-requisites for the Course:	NIL TOTAL TO	
Course Objectives:	 To develop experimental skills on basic lab techniques in physical chemistry To understand fundamental laboratory concepts and acquire skills for data acquisition, an To understand and follow safety protocols for handling chemicals, equipment and instrun To apply the practical laboratory concepts for synthesis, problem solving and critical thin To develop research skills through the principles of laboratory chemical research. 	nents.
	Students will be able to:	Mapped to PSO
	CO 1. Explain and perform various fundamental lab techniques and experiments.	PSO1
Course Outcomes:	CO 2. Handle and operate basic laboratory equipment and use it for research work.	PSO1, PSO4
	CO 3. Apply the laboratory knowledge and skills for their dissertation and research work.	PSO4, PSO5, PSO6, PSO7

	CO 4. Design synthesis and/or experimental methods.		PSO5, PS	O6, PSO7
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	 Non- instrumental Experiments (Any 09) To determine the radius of a molecule by viscosity measurements. To determine ΔG, ΔH and ΔS of silver benzoate by solubility product method. To investigate the adsorption of oxalic acid by activated charcoal and test the validity of Freundlich and Langmuir's isotherms. To determine the molecular weight of a given polymer by turbidimetry. To study the rate of reaction between ethyl bromoacetate and sodium thiosulphate kinetically. To determine the percentage composition of a given mixture of two liquids by stalagmometer method. To study the kinetics of hydrolysis of methyl acetate and to determine a) Energy of activation b) Entropy of activation and c) Free energy change. To study the kinetics of the reaction between potassium persulphate (K₂S₂O₈), and potassium iodide (KI), and to determine a) Energy of activation b) Entropy of activation and c) Free energy change. To determine the order of reaction for hydrolysis of ethyl acetate by graphical, fractional change and differential methods. To determine the molecular weight of polystyrene by viscosity measurement. 	36	CO1, CO3, CO4	K1, K2, K3, K4, K5
Module 2:	 Instrumental Experiments To determine the relative strength of chloroacetic acid and acetic acid by conductometry. To determine the degree of hydrolysis of salt of weak base and strong acid using conductometry. To determine the composition of a mixture of acetic acid, dichloroacetic acid and hydrochloric acid by conductometric titration. To determine the dissociation constants of monobasic acid and dibasic acid and obtain derivative plot to get equivalence point. 	24	CO2, CO3, CO4	K2, K3, K4, K5

	 5. To determine the redox potential of Fe²⁺/Fe³⁺ system by titrating it with standard K₂Cr₂O₇ solution. 6. To study the electrodeposition of metal. 		
Pedagogy:	Students will be given pre-lab and post-lab assignments on theoretical aspects of laboratory experiments prior to the conduct of each experiment. Exams will be in the form of ISA, SEA which will involve performing given experiments and conduct of viva, systematic reporting of experiments, results and observations in laboratory report. Sessions can preferably be interactive in nature to enable peer group learning.		
	1. V. D. Athawale, P. Mathur, Experimental Physical Chemistry, New Age International Publishers, 1st ed., New Delhi, 2001.		
Texts:	2. J.N. Gurtu, A. Gurtu, Advanced Physical Chemistry Experiments, Pragati Publications, 1st ed., Meerut, 2008.		
A DINIVA	3. A. Findlay & J. A. Kitchener, Practical Physical Chemistry, Longmans, Green and Co., 1st ed., London 1954.		
(SCONTINUE)	4. F. Daniels & J. H. Mathews, Experimental Physical Chemistry, McGraw-Hill, 1st ed., New York, 1941.		
	1. A. M. James, Practical Physical Chemistry, Prentice Hall Press, USA 3rd ed., 1974.		
	2. D.P. Shoemaker & C. W. Garland, Experiments in Physical Chemistry, McGraw-Hill, 1st ed., New York, 1962.		
References/	3. T. Kandow & F. Mafune, Progress in experimental and theoretical studies of clusters, World Scientific publishers, 1st ed., New Jersey, 2002.		
Readings:	4. C. Arora & S. Bhattacharya, Advanced Physical Chemistry Practical Guide, Bentham Science Publishers, 1st ed., UAE, 2022.		
	5. A. K. Hagi, L. Pogliani, A. C. F. Ribeiro, Practical applications of Physical Chemistry in food science and technology, 1st ed., Apple Academic Press, USA, 2021.		



Title of the Course	Analytical Chemistry Practical - I
Course Code	CHA-5201
Number of Credits	2
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No No
Course for advanced learners	No O Company of the c

Pre-requisites for the Course:	Nil Carried Services	
Course Objectives:	 To perform various experimental techniques for analysis. To learn data analysis, handling and interpretation of spectra. To determine concentration of solutions. To use techniques for qualitative and quantitative estimation. 	
	Students will be able to	Mapped to PSO
	CO 1. explain data analysis, handling and interpretation of spectra.	PSO1, PSO3, PSO4
Course Outcomes:	CO 2. apply different techniques for qualitative and quantitative estimation.	PSO1, PSO4
course outcomes.	CO 3. determine concentration of solutions.	PSO1, PSO4
	CO 4. perform various experimental techniques for analysis.	PSO1, PSO2, PSO3, PSO4

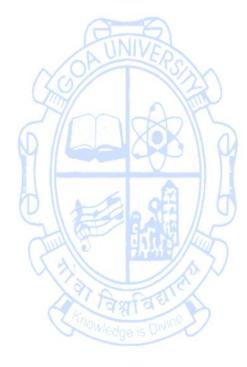
Content:	This course consists of 8 units of experiments in various areas of Analytical chemistry. Minimum 15 experiments which include at least 01 experiment from each unit to be performed.	No of hours	Mapped to CO	Cognitive Level
Module 1:	 1. Statistics a. Calibration of selected Volumetric apparatus b. Calibration of selected Laboratory instruments c. Preparation of standard solutions and standardisation. 	4	CO1, CO3	K3, K4
Module 2:	 2. Colorimetry/ UV-Visible Spectrophotometry a. Estimation of Iron from Pharmaceutical sample (Tablet/capsule) by thiocyanate method b. Estimation of phosphoric acid in cola drinks by molybdenum blue method. c. Estimation of KNO₃ by UV spectroscopy and K₂Cr₂O₇ by Visible spectroscopy d. Simultaneous determination and Verification of law of additivity of absorbances (K₂Cr₂O₇ and KMnO₄). 	8	CO2, CO3	K3, K4, K5
Module 3:	 3. Flame Spectrophotometry and AES/AAS/ICP Spectroscopy a. Estimation of Na and K in food supplements or cosmetic products. b. Estimation of Pb in water sample by AES/AAS/ICP. c. Estimation of Fe and Al in Iron ore sample by AES/AAS/ICP. 	8	CO1, CO2	K4, K5
Module 4:	 4. Ion Exchange Chromatography and High-Performance Liquid Chromatography (HPLC) a. Separation and Estimation of chloride and bromide using Ion exchange chromatography. b. Separation of anthracene and naphthalene using reverse phase chromatography c. Separation of benzaldehyde and benzyl alcohol using normal phase chromatography. 	8	CO2, CO4	K4, K5
Module 5:	5. Volumetric Titrations a. Estimation of Ca in pharmaceutical tablet. b. Estimation of Al and Mg in antacid tablet. c. Estimation of CaO in cement.	8	CO3, CO4	K4, K5

	6. Solvent Extraction and spectrophotometry a. Extraction of Cu as copper dithiocarbamate (DTC) using solvent extraction and	8	CO3, CO4	K4, K5
Module 6:	estimation by spectrophotometry.b. Determination of Ni as dimethylglyoxime complex by spectrophotometry.c. Determination of silver as ion association complex with 1,10- phenanthroline and bromopyrogallol red.			
Module 7:	 7. Demonstration and Interpretation Exercises a. Thermal studies: TG/DTA and Isothermal weight loss studies of various hydrated solids like CuSO₄·5H₂O, CaC₂O₄·H₂O, FeC₂O₄·2H₂O. b. X-ray powder diffractometry: Calculation of lattice parameters from X-ray powder pattern of cubic system such as NiMn₂O₄, CoFe₂O₄. c. IR spectra of urea, benzoic acid, copper sulphate pentahydrate etc. 	8	CO1, CO2	K3, K4
Module 8:	8. Demonstration a. Turbidimeter. b. KF instrument. c. Polarimeter. d. LCMS. e. NMR.	8	CO1, CO2	K3, K4
Pedagogy:	Prelab exercises / assignments / presentations / lab hand-out or a combination of some interactive in nature to enable peer group learning.	of the	ese. Sessio	ons shall be
Texts:	 J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, B. Sivasankar, Vogel's Text Book of Quantitative Chemical Analysis, 6th Ed., Pearson, New Delhi, 2009. R. A. Day & A.L. Underwood, Quantitative Analysis, 6th Ed., Pearson Education India, 2015. J. Kenkel, Analytical Chemistry for Technicians, 3rd Ed., Lewis publishers, USA, 2002. R. M. Silverstein, F. X. Webster, D. Kiemle, D. Bryce, S. Samant, V. S. Nadkarni, Spectrometric Identification of Organic compounds, An Indian Adaptation, Wiley, India, 8th Ed., 2022 A. J. Elias, Collection of interesting chemistry experiments, University press, Hyderabad, 2002. 			
References/ Readings:	 G. D. Christian, Analytical chemistry, 5th Ed., John Willey and Sons, USA, 1994 J. H. Kennedy, Analytical Chemistry: Principles, 2nd Ed., Saunders College Publishing 	g, Phila	delphia, 1	990.



- 3. A. Kar, Pharmaceutical Drug Analysis, New Age International, India, 2005.
- 4. M. Asadi, Beet-Sugar Handbook, John Wiley & Sons, USA, 2006.
- 5. R. E. Ardrey, Liquid Chromatography Mass Spectrometry: An Introduction, John Wiley & Sons, England, 2003.









Title of the Course	Analytical Chemistry Practical - II
Course Code	CHA-5202
Number of Credits	2
Theory/Practical	Practical Practical
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No Service Ser
Course for advanced learners	No O

Pre-requisites for the Course:	Nil Carried Asia / D	
Course Objectives:	 To perform various experimental techniques for analysis. To learn data analysis, handling and interpretation of spectra. To determine concentrations of solution. To use techniques for qualitative and quantitative estimation. 	
	Students will be able to	Mapped to PSO
	CO 1. explain data analysis, handling and interpretation of spectra.	PSO1, PSO3, PSO4
Course Outcomes:	CO 2. apply different techniques for qualitative and quantitative estimation.	PSO1, PSO4
Course Outcomes.	CO 3. determine concentration of solutions.	PSO1, PSO4
	CO 4. perform various experimental techniques for analysis.	PSO1, PSO2, PSO3, PSO4

Content:	This course consists of 8 units of experiments in various areas of Analytical chemistry. Minimum 15 experiments which include at least 01 experiment from each unit to be performed.		Mapped to CO	Cognitive Level
Module 1:	 1. Statistics a. Calibration of selected Volumetric apparatus b. Calibration of selected Laboratory instruments c. Preparation of standard solutions and standardisation. 	4	CO1, CO3	K3, K4
Module 2:	 2. Titrimetric Analysis a. Standardisation and estimation of Chloride using precipitation titration (Mohr's method) b. Analysis of commercial caustic soda by neutralisation method. c. Determination of sulphates by complexometric titration. 	8	CO2, CO3	K3, K4, K5
Module 3:	 3. Flame Spectrophotometry and AES/AAS/ICP Spectroscopy a. Estimation of sodium and potassium in food supplements or cosmetic products using flame photometer. b. Estimation of chromium in water sample by AES/AAS/ICP. c. Estimation of nickel, molybdenum in Hastelloy C-22 using AES/AAS/ICP. 	8	CO1, CO2, CO3	K4, K5
Module 4:	 4. Natural product isolation and Ion Exchange Chromatography a. Isolation of cinnamaldehyde from cinnamon. b. Isolation of caffeine from tea powder. c. Separation and estimation of cadmium and zinc. 	8	CO2, CO4	K4, K5
Module 5:	 5. UV-Visible Spectrophotometry and High-Performance Liquid Chromatography (HPLC) a. Estimation of KNO₃ and K₂Cr₂O₇ using UV- Visible spectroscopy. b. Separation of benzaldehyde and benzoic acid using reverse phase HPLC. c. Quantification of naphthalene in a sample using reverse phase HPLC. 	8	CO3, CO4	K4, K5
Module 6:	6. Solvent Extraction and spectrophotometry a. Spectrophotometric determination of aspirin/phenacetin/caffeine in APC tablet using	8	CO3, CO4	K4, K5

	solvent extraction. b. Colorimetric determination of iron with salicylic acid. c. Determination of copper in brass sample by colorimetry.					
Module 7:	 7. Data Interpretation Exercises a. NMR/Mass spectra. b. HPLC and GC chromatograph. c. XRD powder pattern of cubic systems. d. Thermogram of coordination compounds. 	8	CO1, CO2	K3, K4		
Module 8:	8. Demonstration a. Turbidimeter. b. KF instrument. c. Polarimeter. d. LCMS. e. NMR.	8	CO1, CO2	K3, K4		
Pedagogy:	Prelab exercises / assignments / presentations / lab hand-out or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning.					
Texts:	 J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, B. Sivasankar, Vogel's Text Book of Quantitative Chemical Analysis, 6th Ed., Pearson, New Delhi, 2009. R. A. Day & A.L. Underwood, Quantitative Analysis, 6th Ed., Pearson Education India, New-Delhi, 2015. J. Kenkel, Analytical Chemistry for Technicians, 3td Ed., Lewis publishers, USA, 2002. R. M. Silverstein, F. X. Webster, D. Kiemle, D. Bryce, S. Samant, V. S. Nadkarni, Spectrometric Identification of Organic compounds, An Indian Adaptation, Wiley, India, 8th Ed., 2022 A. J. Elias, Collection of interesting chemistry experiments, University press, Hyderabad, 2002. A. Kar, Pharmaceutical Drug Analysis, New Age International, India, 2005. 					
References/ Readings:	 G. D. Christian, Analytical chemistry, 5th Ed., John Willey and Sons, USA, 1994. J. H. Kennedy, Analytical Chemistry: Principles, 2nd Ed., Saunders College Publishing, Philadelphia, 1990. M. Asadi, Beet-Sugar Handbook, John Wiley & Sons, USA, 2006. R. E. Ardrey, Liquid Chromatography - Mass Spectrometry: An Introduction, John Wiley & Sons, England, 2003. 					