SACRED HEART COLLEGE (AUTONOMOUS)

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Ready for Every Good Work

A Don Bosco Institution of Higher Education, Founded in 1951 * Affiliated to Thiruvalluvar University, Vellore * Autonomous since 1987

Accredited by NAAC (4th Cycle – under RAF) with CGPA of 3.31 / 4 at 'A+' Grade

M.Sc Chemistry Program Structure (from 2021-2022)

Sem	Sub	Title of the paper	Ins Hrs	Cr	CA Mks	Sem Mks	Total
I	Core	Organic Chemistry – I	4	4	50	50	100
	Core	Inorganic Chemistry – I	4	4	50	50	100
	Core	Physical Chemistry – I	5	4	50	50	100
	Core Practicals	Organic Practicals – I	4	-	-	-	-
		Inorganic Practicals – I	4	-	-	-	-
		Physical Practicals – I	4	-	-	-	-
	Elective - I	1. Analytical Chemistry 2. Green Chemistry 3. Pharmaceutical Chemistry	5	5	50	50	100
II	Core	Organic Chemistry – II	4	4	50	50	100
	Core	Inorganic Chemistry – II	4	4	50	50	100
	Core	Physical Chemistry – II	5	4	50	50	100
	Elective - II	1. Research Methodology 2. Heterocyclic Chemistry 3. Bio-organic Chemistry	5	5	50	50	100
	SSP	Reagents in Organic Chemistry	0	2*			
	Core Practicals	Organic Practicals – I	4	4	50	50	100
		Inorganic Practicals – I	4	4	50	50	100
		Physical Practicals – I	4	4	50	50	100
III	Core	Organic Chemistry – III	4	4	50	50	100
	Core	Inorganic Chemistry – III	4	4	50	50	100
	Core	Spectroscopy	5	4	50	50	100
	Elective - III	1. Inorganic photochemistry and materials science 2. Polymer Chemistry 3. Chemoinformatics	5	5	50	50	100
	Core Practicals	Organic Practicals – II	4	-	-	-	-
		Inorganic Practicals – II	4	-	-	-	-
		Physical Practicals – II	4	-	-	-	-
IV	Core	Organic Chemistry – IV	4	4	50	50	100
	Core	Inorganic Chemistry - IV	4	4	50	50	100
	Core	Physical Chemistry – III	5	4	50	50	100
	Core Practicals	Organic Practicals – II	4	4	50	50	100

		Inorganic Practicals – II	4	4	50	50	100
		Physical Practicals – II	4	4	50	50	100
	HR	Human Rights	2	1	50	50	100
	Project	Project Work	3	2	20 Viva	80 Thesis	100
	IDC /Internship	Advanced analytical technique/BMT /		2*			
	SSP	Chemical Sciences For CSIR-UGC–NET/JRF/ GATE		2*			
		Total	**120**	**90+6 ***			**2200**

Required Credits = 90 (89 + 1–HR)

I. PSO – PO Mapping

PSO	PO1	PO2	PO3	PO4	PO5	Mean Score
PSO1	3	3	3	3	2	2.8
PSO2	3	3	3	3	2	2.8
PSO3	3	3	2	2	2	2.4
PSO4	3	3	3	3	1	2.6
PSO5	3	3	3	3	2	2.8
PSO6	3	3	3	3	2	2.8
Mean Overall Score						2.7
Result						High

High – (2.1 – 3), Medium – (1.1 – 2), Low – (0 – 1)

Semester I
CH716 – Organic Chemistry I

Course Code	Type	Total Hours	Lecture	Tutorial	Practical
CH716	Theory	60	55	5	0
		Course Name		**Max Marks**	**Credits**
		ORGANIC CHEMISTRY-I		100	4

Objectives:

- To know about the nature of aromaticity in the compounds
- To learn the kinetic and non-kinetic methods of determining organic reaction mechanism.
- To understand the substitution in aromatic and aliphatic reactions.
- To learn the addition and elimination reactions and their mechanisms

Course Outcomes:

At the end of this course, the students will be able to

S.No	Course outcome	Cognitive level
CO-1	Define and distinguish the organic compounds based on the nature of aromaticity and characterizing them using NMR technique	**(K1, K4)**
CO-2	Interpret the intermediates involved in various organic reactions and integrate the kinetic and non-kinetic methods in determining organic reaction mechanism.	**(K2, K3)**
CO-3	Relate and categorize the nucleophilic substitutions in aromatic and aliphatic molecules with mechanism	**(K2)**
CO-4	Predict the product between electrophilic substitution in aromatic and aliphatic molecules reactivity and products formation with mechanism	**(K5)**
CO-5	Predictand write the addition and elimination reactions and their mechanisms	**(K5, K6)**
CO-6	Formulate the synthetic routes based on addition/elimination reactions in synthetic organic chemistry	**(K6)**

Course Content

Unit - I: Aromaticity **12 Hours**

Naming and numbering of alicyclic, bicyclic and tricyclic compounds (Basic skeletal structures only with or without one substituent). Concept of aromaticity and anti-aromaticity, delocalization of electrons - Hückel's rule, criteria for aromaticity, examples of neutral and charged aromatic, non-aromatic, antiaromatic systems.

Aromaticity in charged rings and fused ring systems. - Benzenoid – Non-benzenoid aromatics – annulenes - NMR as a tool for aromaticity - anti- and homo-aromatic systems. Aromatic characterization of azulenes, tropones, annulenes and fullerenes.

Unit - II: Reactive Intermediates and Methods of Determining Reaction Mechanism
12 Hours

Structure, stability, generation and reactions of Carbocations (classical and nonclassical), carbanions, carbenes, nitrenes and free-radicals.

Thermodynamic and Kinetic controlled reactions - non-kinetic methods - Product analysis and its importance Intermediates and Transition states- Trapping, testing and detection of intermediates-Cross over experiments. Isotopic labeling stereochemical studies.
Kinetic methods- Order-rate and rate constants-Energy of activation-entropy of activation-Influence of solvents, ionic strength, and salt and isotopic effects on the rate of the reaction.

Unit - III: Aromatic and Aliphatic Electrophilic Substitution Reactions 12 Hours

Aromatic – Mechanism – Orientation and reactivity – Reactions: Nitrogen electrophiles: nitration, nitrosation and diazonium coupling - Sulphur electrophiles: sulphonation - Halogen electrophiles: chlorination and bromination - Carbon electrophiles: Friedel-Crafts alkylation, acylation and arylation reactions.
Aliphatic - Mechanisms: S_E2, S_E1 and S_Ei; Substitution by double bond shifts; other mechanism: addition-elimination and cyclic mechanism. Reactivity; Reactions: Hydrogen as electrophile: Hydrogen exchange; hydro-dehydrogenation; keto-enol tautomerism. - Halogen electrophiles: Halogenation of aldehydes and ketones; carboxylic acids - Nitrogen electrophiles: aliphatic diazonium coupling; direct formation of diazo compounds; direct amination; - sulphur electrophiles: sulphonation, - carbon electrophiles: acylation; alkoxy carbonyl alkylation; alkylation.

Unit - IV: Aromatic and Aliphatic Nucleophilic Substitution Reactions 12 Hours

Aromatic -Mechanisms- S_NAr, S_N1 and Benzyne mechanisms. - Reactivity, Effect of structure, leaving group and attacking nucleophile.
Typical reactions: O and S-nucleophiles, Bucherer and Rosenmund reactions, von Richter, Sommelet-Hauser and Smiles rearrangements.
Aliphatic-Mechanisms- S_N1, S_N2, S_Ni and neighbouring group mechanisms. Nucleophilic substitutions at an allylic carbon, aliphatic trigonal carbon and vinyl carbon.
Reactivity: Effect of substrate, attacking nucleophile, leaving group and the medium - Swain-Scott, Grunwald-Winstein relationship - Ambident nucleophiles.

Unit - V: Addition and Elimination Reactions 12 Hours

Additions-Addition to carbon-carbon multiple bonds-addition mechanisms-electrophilic, nucleophilic and free-radical additions cyclo addition-orientation and reactivity. Selected reactions – Birch reduction- Diels-Alder reaction- Hydroboration- Michael reaction. hydroxylation, 1,3-dipolar additions. -Simon Smith reaction, Mannich, Darzens, Wittig, Wittig-Horner, benzoin reactions and Cope eliminations..Stereochemical aspects of each reaction.
E1, E2, and E1cb mechanisms. - Syn Eliminations - E1-E2-E1cb spectrum - Orientation of the double bond: Hoffmann and Saytzeff rules. Reactivity: Effect of substrate, attacking bases, leaving group and medium. -Mechanisms and orientation in pyrolytic eliminations.

References

1. R.O.C.Norman, Chapman, Organic Synthesis Prentice and Hall, NY, 1980.
2. Niel Isaacs, Physical Organic Chemistry, ELBS publications, 1987.
3. S.M.Mukherji and S.P.Singh, Organic Reaction Mechanism, MacMillan India Ltd., Chennai, 1990.
4. Francis A. Carey and Richard Sundberg, Advanced Organic Chemistry, Part A and B, , 3rd E dition, Plenum Press, 1990.
5. C Wentrup, Reactive Molecules, John Wiley and Sons, New York, 1984.
6. J.March, Advanced Organic Reaction mechanism and structure, Tata McGraw Hill, 2000.
7. V.K.Ahluwalia, Pooja Bhagat, Intermediates for Organic Synthesis, I.K International, 2005.

8. S.C.Pal, Nomenclature of organic compounds, Revised Edn. Narosa Publications, 2008.
9. Ahluwalia and Parashar, Organic Reaction Mechanisms, 4thEdn., Narosa Publications, 2012
10. P.S.Kalsi, Organic Reaction Mechanism, 3rdEdn. New Age Publications, 1994.

Online Resources:
http://eacharya.inflibnet.ac.in/ Organic Chemistry- (Reaction Mechanisms-I)

Mapping of CO with PO and PSO

CO	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)						
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**Mean Scores of COs**
CO1	3	3	2	2	1	3	3	3	3	3	2	2.5
CO2	3	3	3	2	1	3	3	3	3	2	2	2.5
CO3	3	3	2	2	1	3	3	3	3	3	2	2.5
CO4	3	3	3	2	1	3	3	3	3	3	3	2.7
CO5	3	3	3	3	1	3	3	3	3	3	2	2.7
CO6	3	3	2	3	1	3	3	3	2	3	2	2.5
Mean Overall Score												2.6
Result												High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	20
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	10

CH717 - Inorganic Chemistry-I

Course Code	Type	Total Hours	Lecture	Tutorial	Practical
CH717	Theory	60	55	5	0
		Course Name		**Max Marks**	**Credits**
		INORGANIC CHEMISTRY-I		100	4

Course Objectives:

- To impart the knowledge about the structure of materials and their significance.
- To understand the theories of coordination complexes and their importance.
- To study the basic chemistry of rare earth elements and nano materials

Course Outcomes

At the end of this course, the students will be able to

CO1	Gain knowledge about the structure and bonding of Inorganic compounds like polyacids, Inorganic Polymers, polysulphur – nitrogen and their significance	**K1, K2**
CO2	Correlate the structure, bonding, stability and applications of metallocarboranes and Metal Clusters	**K4**
CO3	Relate and asses the applications of organometallic compounds in the field of synthetic chemistry and catalysis	**K3, K5**
CO4	Analyse the solid materials with defects that can be used in field of electronic industries foe designing energy materials.	**K5**
CO5	Understand the Solid-state Transformation, its thermodynamic, kinetics and nucleation in solid state materials	**K2**
CO6	Design and synthesis the energy producing nano materials and energy storage nanomaterials to meet the energy crisis in the future	**K6**

Course Content

Unit - I: Structure and Bonding – I **12 Hours**

Polyacids: Isopolyacids and hetereopolyacids of vanadium, chromium, molybdenum and Tungsten.Inorganic Polymers: Silicates, structure – properties – correlation and applications – molecular sieves, polysuphur – nitrogen compounds and poly organophosphazenes.

Unit - II: Structure and Bonding – II **12 Hours**

Boron hydrides: Polyhedral boranes, hydroboration, carboranes and metallocarboranes Metal Clusters: Chemistry of low molecularity metal clusters (upto) trinuclear metal Clusters: multiple metal-metal bonds.

Unit - III: Solid State Chemistry – I **12 Hours**

Introduction-Single and polycrystalline materials-Solid state Reactions-Co-precipitation as precursor to solid state reactions-Other Precursor Methods-Kinetics of solid-state reactions-Perfect and imperfect crystals. Defects in solids: Point defects-Schottky defects-Frenkeldefects.Thermodynamics of Schottky and Frenkel defect formation. Non-stoichiometric defects: metal excess and metal deficiency. Spinels-solid state lasers-inorganic phosphors-Ferrite.

Unit - IV:Solid State Chemistry – II **12 Hours**

Colourcentres-Vacancies and interstitials in non-stoichiometric crystals. Extended defects – subgrain boundaries and antiphase domains-Solid state transformations-Classification of transformations-Thermal decomposition reactions-Laws governing nucleation-Crystal growth

of nuclei-Reaction between two solids-polymorphism-Characterization and properties of polymorphs.

Unit - V: Chemistry of rare earths and nanomaterials 12 Hours

The Chemistry of solid state, lanthanides and actinides, oxidation state spectral, magnetic characteristics, coordination numbers, nuclear and non-nuclear applications.

Nanomaterials: General introduction - Synthesis of nanoparticles of gold and silver - Synthesis of nanoparticle semiconductors (TiO_2 and Fe_2O_3) - Nanowires and nanorods - Self-assembled nanostructures - Self-assembly and bottom-up fabrication – Graphenes, fullerenes and nanotubes - Applications of nanoparticles-application as sensors, biomedical applications, application in optics and electronics.

Text Books

References

1. K.F. Purcell and J.C. Kotz, Inorganic Chemistry, WB Saunders Co., USA, 1977.
2. J.E. Huheey, Harper and Collins, Inorganic Chemistry, NY, IV Edition, 1993.
3. FA Cotton and G.W. Wilkinson, Advanced Inorganic Chemistry, – A comprehensive Text, John Wiley and Sons, 1988.
4. B.E. Dogulas DH McDaniel's and Alexander Concepts and Models of Inorganic Chemistry, Oxford IBH, 1983.
5. S. J. Lippard and J. M. Berg, Principles of Bioinorganic Chemistry, Univ. Science Books, 1994.
6. W. Kaim and B. Schwederski, Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life (An introduction and Guide), John Wiley & Sons, 1994.
7. WU. Mallik, G.D. Tuli, R.D. Madan,Selected topics in Inorganic Chemistry, S. Chand and Co., New Delhi, 1992.
8. A.R. West, Basic solid-state chemistry, John Wiley NY, 1991.
9. W.E. Addison, Structural principles in Inorganic chemistry, Longman, 1961.
10. D.M. Adams, Inorganic solids, John Wiley Sons, 1974.
11. J.N. Gurtu, Solid State Chemistry, Second Edition, PragatiPrakashan Publishers, 2015.
12. Dieter Vollath, Nanomaterials: An Introduction to Synthesis, Properties and Applications, 2nd Edition Wiley,2013.
13. Zhong Cao G, "Nanostructures and Nanomaterials: Synthesis, Properties and Applications", Imperial College Press, London, United Kingdom, 2004

Online Resources

1. http://eacharya.inflibnet.ac.in/ (Bioinorganic Chemistry-40 lectures)

Mapping of CO with PO and PSO

CO	Programme Specific Outcomes (PSO)						Programme Outcomes (PO)					Mean Scores of COs
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	
1	3	3	3	3	3	2	3	3	2	3	2	2.7
2	3	3	3	3	3	2	3	3	3	3	2	2.8
3	3	3	3	3	3	3	3	3	3	3	3	3.0
4	3	3	3	3	3	3	3	3	3	3	3	3.0
5	3	3	3	3	2	2	3	3	3	3	2	2.7

6	3	3	3	3	3	3	3	3	3	3	2	2.9
											Mean Overall Score	2.9
											Result	**High**

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	20
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	10

CH718 – PHYSICAL CHEMISTRY I

Course Code	**Type**	**Total Hours**	**Lecture**	**Tutorial**	**Practical**
CH718	Theory	75	65	10	0
		Course Name		**Max Marks**	**Credits**
		PHYSICAL CHEMISTRY-I		100	4

Objectives:

- To study the basic concepts of various theories in chemical kinetics
- To illustrate the mechanism of acid, base and enzyme catalyzed reaction and their applications.
- To apply and analyse the kinetics of complex reactions and fast reactions by various methods.
- To learn and apply the symmetry elements and symmetry operations in molecules
- To understand the concepts of selection rules in for transitions and find out the vibrational modes of the molecules.
- To construct the character table for simple molecules.

Course Outcomes

At the end of this course, the students will be able to

CO. No.	**Course Outcome Statement**	**Cognitive Level**
CO 1	Understand the various theories of kinetics and compare their applications to reactions.	**K1, K3**
CO 2	Compare and contrast the different catalytic reaction and analyse their applications.	**K2, K4**
CO 3	Hypothesize mechanistic pathways for reactions based on the kinetic parameters.	**K6**
CO 4	Learn and sketch the different symmetry elements and evaluate the implications of symmetry operations in molecules.	**K3, K5**
CO 5	Assess the vibrational modes of molecules and thereby formulate the selection rules for transitions	**K5, K6**

CO 6	Develop the character table and analyse the symmetry operations of molecules	**K4, K6**

Course Content

Unit - I: Chemical Kinetics – I **15 Hours**

Collision theory, ARRT - partition function and activated complex - Eyring equation - estimation of free energy, enthalpy and entropy of activation and their significance - Theories of unimolecular gaseous reactions - RRK theory - limitations - RRKM theory. Reactions in solutions - effect of pressure, dielectric constant and ionic strength on reactions in solutions - kinetic isotope effects - linear free energy relationships - Hammett and Taft equations.

Unit - II: Chemical Kinetics – II **15 Hours**

Acid - Base catalysis - mechanism of acid - base catalyzed reactions - Bronsted catalysis law. Catalysis by enzymes - rate of enzyme catalyzed reactions - effect of substrate concentration, pH and temperature on enzyme catalyzed reactions - inhibition of enzyme catalyzed reactions, Michaelis-Menton equation - Autocatalysis and oscillatory reactions.

Unit - III: Chemical Kinetics – III **15 Hours**

Study of surfaces - Langmuir and BET adsorption isotherms-mechanism of heterogenous catalysis. Kinetics of complex reactions, reversible reactions, consecutive reactions, parallel reactions, chain reactions, general treatment of chain reactions - chain length - Rice Herzfeld mechanism - explosion limits.

Study of fast reactions - relaxation methods - temperature and pressure jump methods-stopped flow and flash photolysis methods.

Unit - IV: Group Theory – I **15 Hours**

Symmetry elements and symmetry operation –group multiplication table-subgroups, similarity transformation and classes-identifications of symmetry operations and determination of point groups- Matrix representation of symmetry operations - reducible and irreducible representations – direct product representation-The great orthogonality theorem and its consequences.

Unit - V: Group Theory – II **15 Hours**

Construction of character table for C_2V and C_3V - Mulliken symbols -application of group theory. -hybrid orbital in nonlinear molecules (CH_4, XeF_4, BF_3, SF_6 and NH_3). Determination of representations of vibrational modes in non-linear molecules (H_2O, CH_4, XeF_4, BF_3, SF_6 and NH_3). Symmetry selection rules for infrared and Raman Spectra-Electronic Spectra of Ethylene and formaldehyde.

References

1. J. Rajaram and J.C. Kuriacose, Kinetics and Mechanism of Chemical Transformations. Mac Millan India Ltd, 1993.
2. R.J. Laidler, Chemical Kinetics, Harper and Row, New York, 1987.
3. K.V. Ramakrishnan and M.S. Gopinath, Group Theory in Chemistry, Vishal Publications, 1998.
4. K.V. Raman, Group Theory and its Applications to Chemistry, Tata Mc Graw Hill Publishing Co., 1990.
5. G.M. Barrow, Physical Chemistry, McGraw Hill, 1988.
6. R.G. Frost and Pearson, Kinetics and Mechanism, Wisely, New York, 1961.
7. F.A. Cotton, Chemical Applications of Group Theory, John Wiley and Sons inc., New York, 1971.

8. B.S. Garg, Chemical Applications of Molecular symmetry and Group Theory, Laxmi Publications/Triniti/Macmillan, 2012
9. S. Swarnalakshmi, Simple Approach to Group Theory in Chemistry, Universities Press, 2008

Online Resources:

1. http://eacharya.inflibnet.ac.in/ Applications of molecular symmetry and group theory [31 lectures]
2. http://nptel.ac.in/courses/104104080/

Mapping of CO with PO and PSO

CO	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)						
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**Mean Scores of COs**
CO1	3	3	3	3	2	3	3	3	3	2	1	2.64
CO2	3	3	3	3	2	3	3	3	3	3	2	2.82
CO3	3	3	3	3	2	3	3	3	3	2	3	2.82
CO4	3	3	3	2	2	3	3	3	3	2	1	2.55
CO5	3	3	3	3	2	3	3	3	2	3	3	2.82
CO6	3	3	2	2	2	3	3	3	3	2	2	2.55
Mean Overall Score												2.70
Result												High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	20
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	10

CH719A – ANALYTICAL CHEMISTRY

Course Code	Type	Total Hours	Lecture	Tutorial	Practical
CH719A	Theory	75	65	10	0
		Course Name		**Max Marks**	**Credits**
		ANALYTICAL CHEMISTRY		100	4

Objectives:

- To study the different types of molecular spectroscopy and NMR spectroscopy and its applications
- To study the analytical techniques, instrumentation and applications.

Course Outcomes

At the end of this course, the students will be able to

CO. No.	Course Outcome Statement	Cognitive Level
CO 1	Explain and evaluate the theory and principle of electro analytical techniques, various factors involved in analysis and its applications.	**K1 & K5**
CO 2	Understand the fundamentals of microwave spectroscopy and how to identify molecules using structural factors like moment of inertia and intermolecular distances.	**K1 & K6**
CO 3	Explore the vibrating diatomic molecule, the simple harmonic oscillator, the anharmonic oscillator, and their applications in spectroscopy.	**K3 & K5**
CO 4	Illustration of Infrared Spectroscopy - Group frequencies Rotational and Vibrational Raman	**K3 & K4**
CO 5	Application of advanced chromatographic separation technique principles for isolation and characterization of compounds.	**K2 & K4**
CO 6	Identify and structurally categorize new using X-ray diffraction. Analyze nanomaterials using advanced electron microscopy characterization techniques.	**K2 & K6**

Course Content

Unit - I: Polarography and Amperometry **15 Hours**

Polarography – theory, apparatus, DME, Diffusion, Kinetic and catalytic currents, Current-Voltage curves for reversible and irreversible system; Qualitative and quantitative applications to inorganic and organic systems. Principle and Instrumentation of Cyclic Voltammetry. Stripping analysis-Anodic and Cathodic Stripping-Modified electrodes-need- fabrication-applications. Amperometry- principle- curves in amperometric titrations, apparatus, advantages of rotating platinum electrode and advantages of biamperometric titrations.

Unit - II: Chromatographic Techniques **15 Hours**

Gas liquid Chromatography - principle, Retention Volume, Relationship between Vg and K-Effect of mobile phase flow rate. Instrumentation-Carrier gas, sample injection system, column configurations and column ovens, Detectors systems FID and TCD. Column and stationary Phases-Open and tubular column, packed column, Stationary Phase. Applications of GLC. HPLC – principle, Scope, column efficiency, instrumentation, pumping system, column packing, detectors and applications.

Unit - III: Spectroscopy – I **15 Hours**

Electronic spectroscopy -selection rules-types of transition solvent effects.

Spin Resonance spectroscopy-origin of NMR signals, chemical shift-factors affecting chemical shift, spin spin coupling-NMR of simple AX and AMX type molecules-^{13}C, ^{19}F, ^{31}P NMR spectra-applications-a brief discussion of Fourier transformation resonance spectroscopy.

Unit - IV: Spectroscopy- II **15 Hours**

Interaction of matter with radiation-Rotational spectroscopy of a rigid and non-rigid diatomic rotors-and polyatomic molecules-vibrational spectroscopy of harmonic and anharmonic oscillators and polyatomic molecules-overtones-fermi resonance and combination of bands-group frequencies –Raman spectroscopy- classical and quantum theories-

Rotational and vibrational Raman spectra- spectra of diatomic molecules-frank condon principle- Morse function. Polyatomic molecules, types of transition, solvent effects.

Unit - V: XRD and Microscopic Techniques **15 Hours**

X-ray diffraction- The laue method-the rotating crystal method- the powder method – the powder method – determination of grain size/ crystallite size using X-ray line broadening studies (Scherrer's formula) - Determination of crystallite size distribution using X-ray line shape analysis- X-ray diffraction pattern and analysis of same commercially important oxides – small angle X-ray scattering (SAXS).

Electron microscopy- Principle and instrumentation –Applications of scanning electron microscope (SEM)- Energy dispersive X-ray analysis (EDX)- Transmission electron microscope (TEM)- Scanning tunnelling microscope (STM)-Atomic force microscope (AFM).

References

1. D.A.Skoog, D.M. West and F. J. Holler, Analytical Chemistry an Introduction,SaundersCollege Publishers, 1990.
2. J. Mendham, R.C. Denney, J.D. Barnes and M. Thomas, Vogel's Text book of Quantitative
3. Chemical Analysis, Pearson Education Pvt. Ltd..2004.
4. J.G. Dick, *Analytical Chemistry.*Sir George Williams University, McGraw-Hill
5. Book Company, New. York. 1973.
6. H.H. Willard, L.L. Merritt, J.A. Dean and F.A. Seattle, *Instrumental methods of analysis,*5thEdn., Harcourt Asia Pvt. Ltd., India, 2001.
7. Fundamentals of Molecular spectroscopy .by C.N.Banwell and E.M.Mccash, IV Edition, Tata McGraw Hill, 2005.
8. Vibrational Spectroscopy, by D.N.Sathyanarayana, New Age International Publishers, 2004.
9. Introduction.to Magnetic Resonance by Carington and Ad.Mclachlan, Harper and Row, New York, 1967.

Mapping of CO with PO and PSO

CO	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)						
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**Mean Scores of COs**
CO1	3	3	3	3	2	3	2	3	3	3	2	2.73
CO2	3	3	3	3	2	3	3	3	3	3	2	2.82
CO3	3	3	2	3	2	3	3	3	3	2	2	2.64

CO4	3	3	3	3	2	3	3	3	3	3	3	2.91
CO5	3	3	3	3	2	3	3	2	3	3	3	2.82
CO6	3	3	3	3	2	3	3	3	2	3	3	2.82
Mean Overall Score												2.79
Result												High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	20
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	10

CH719B – GREEN CHEMISTRY

Course Code	**Type**	**Total Hours**	**Lecture**	**Tutorial**	**Practical**
CH719B	Theory	75	65	10	0
		Course Name		**Max Marks**	**Credits**
		GREEN CHEMISTRY		100	4

Objectives:

- To know eco-friendly methods of synthesis.
- Understanding the synthesis of any type of organic compounds with the revolution of Green Chemistry

Course Outcomes

At the end of this course, the students will be able to

CO. No.	**Course Outcome Statement**	**Cognitive Level**
CO 1	Understand and compare the eco-friendly methods of synthesis.	**K1, K2**
CO 2	Appraising the measurement, Prevention and control of life-cycle assessment	**K4**
CO 3	Relate and asses the Renewable energy as Biomass, Fossil Fuels, solar energy and some other natural chemical resources.	**K3, K5**
CO 4	Analyse the organic compounds which found in application of green synthesis with the revolution of Green Chemistry.	**K5**
CO 5	Compare and analyze Green Technology and Alternative Energy Sources such as Microwaves, Electrochemical synthesis	**K2**
CO 6	Design the next generation agrochemicals and Industrial Case Studies from natures, using green reagents and bio catalyst.	**K6**

Course Content

Unit - I: Principles & Concept of Green Chemistry **15 Hours**

Introduction –Concept and Principles-development of Green Chemistry- Atom economy reactions –rearrangement reactions, addition reactions- atom uneconomic-sublimation-elimination-Wittig reactions-toxicity measures- Need of Green Chemistry in our day-to-day life.

Unit - II: Measuring and Controlling Environmental Performance **15 Hours**

Importance of measurement – lactic acid production-safer Gasoline – introduction to life cycle assessment-four stages of Life Cycle Assessment (LCA) –Carbon foot printing-green process Matrics-eco labels -Integrated Pollution and Prevention and Control (IPPC)-REACH (Registration, Evaluation, Authorization of Chemicals).

Unit - III: Emerging Green Technology and Alternative Energy Sources **15 Hours**

Design for Energy Efficiency-Photochemical reactions- Advantages-Challenge faced by photochemical process. Microwave technology on Chemistry- Microwave heating – Microwave assisted reactions-Sono chemistry and Green Chemistry –Electrochemical Synthesis-Examples of Electrochemical synthesis.

Unit - IV: Renewable Resources **15 Hours**

Biomass –Renewable energy – Fossil Fuels-Energy from Biomass-Solar Power- Other forms of renewable energy-Fuel Cells-Alternative Economics-Syngas economy- hydrogen economy-Bio refinery chemicals from fatty acids-Polymer from Renewable Resources –Some other natural chemical resources.

Unit - V: Industrial Case Studies **15 Hours**

Methyl Methacrylate (MMA)-Greening of Acetic acid manufacture-Vitamin C-Leather manufacture –Types of Leather –Difference between Hide and Skin-Tanning –Reverse tanning –Vegetable tanning –Chrome Tanning-Fat liquoring –Dyeing –Application-Polyethylene-Ziegler Natta Catalysis-Metallocene Catalysis-Eco friendly Pesticides-Insecticides.

References

1. Mike Lancaster, Green Chemistry and Introductory text, II Edition,2003.
2. P.T.Anastas and J.C Warner,Green Chemistry theory and Practice, Oxford University press, Oxford, 1988..
3. P.Tundo*et. al.*, Green Chemistry, Wiley –Blackwell, London, 2007.
4. V.K. Ahluwalia, Environmental chemistry, Ane Books, India, 2003.
5. T.E Graedel, Streamlined Life cycle Assessment, Prentice Hall, NewJersey, 1998.
6. V.K. Ahluwalia, Methods and Reagents of Green Chemistry: An Introduction to Green Chemistry, 2013.

Online Resource

www.clri.org.

Mapping of CO with PO and PSO

CO	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)						
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**Mean Scores of COs**
CO1	3	3	2	3	3	3	3	2	3	3	3	2.82
CO2	3	3	2	2	3	3	2	3	3	2	3	2.64
CO3	3	3	3	3	3	3	2	3	3	3	3	2.91
CO4	3	3	3	2	3	3	3	2	3	3	3	2.82

CO5	3	3	3	3	3	3	2	3	3	3	3	2.91
CO6	3	3	3	3	3	3	3	3	2	3	3	2.91
Mean Overall Score												2.83
Result												High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	20
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	10

CH719C – PHARMACEUTICAL CHEMISTRY

Course Code	**Type**	**Total Hours**	**Lecture**	**Tutorial**	**Practical**
CH719C	Theory	75	65	10	0
		Course Name		**Max Marks**	**Credits**
		PHARMACEUTICAL CHEMISTRY		100	4

Objectives:

- To understand the composition and the kinetics of drugs
- To know the different types of drugs and its composition

Course Outcomes

At the end of this course, the students will be able to

CO. No.	Course Outcome Statement	Cognitive Level
CO 1	Learn the terminologies and mechanism of action of drugs and analyse them	K1& K4
CO 2	Discuss about the different types of drugs and their applications and evaluate their structures	K2 & K5
CO 3	Explain the causes of certain ailments and treatment and relate them	K2 & K3
CO 4	Understand the extraction and uses of some specific drugs and categorize them	K1 & K4
CO 5	Enumerate various therapeutic agents and combine them for potential applications	K1 &K6
CO 6	Tabulate the various hematological factors assess their effects on human body	K1 & K5

Course Content

Unit - I: Introduction **15 Hours**

Importance of chemistry in pharmacy, important terminologies used their meaning- molecular pharmacology, pharmacodynamics, pharmacophore, metabolites, virus antimetabolites, bacteria, fungi, actinomycetes.
Mechanism of action of drug types: assay- biological, chemical immunological-statement only. Mechanism: metabolism of drugs and their effect on pharmacological activity. Absorption of drugs. Drug delivery system, sustained release of drugs. Physiological effects of different functional groups in drugs. Testing of potential of drugs and their side effects. Indian medicinal plants and trees-adathode, tulsi, thoothuvalai, shoeflower, fia, neem, mango, kizhanelliocimum,grass and greens. Causes and symptoms of common diseases- tuberculosis, asthma, jaundice, piles,leprosy,epilepsy,typhoid,malaria, cholera, filarial.

Unit - II: Antibiotics and Vitamins **15 Hours**

Antibiotics: definition, structure, uses of chloramphenicolampicillin, streptomycin, tetracycline, rifamycin Macrolides-Erythromycin-properties and uses.
Structural features-SAR functional group responsible for drug action, structural modification that changes the potency of the above drugs. Conditions for their use as therapeutic agents. Fields of application.Sulphonamides: substituents in the amide group. General properties and drug action. Preparation and uses of sulphadiazin, sulphapyridine, sulphathiazole, sulphafurazole and prontosil. Vitamins: classification. Role in Chemotherapy. Uses. Deficiency and symptoms. Estimation of vitamins A, B_1, B_2 and C.

Unit - III: **Antipyretic, analgesics, anti-inflammatory agents** **15 Hours**

Classification: action of analgesics. Narcotic analgesics: Morphine and its derivatives. SAR. Synthetic analgesics-pethidine and methadones. Salicylic acid and its derivatives, indolyl derivatives, aryl-acetic acid derivatives, pyrazole, p-aminophenol derivatives-mechanism of action. Antiseptics and disinfectants: definition, standardization of disinfectants. Use of phenols, dyes, chloramines, chlorhexadiene, organomercurials. Dequalinium chloride, formaldehyde, cationic surface-active reagents, chloraminet-nitrofurazone. Distinction between antiseptics and disinfectants. Anaesthetics: definition, classification. Uses of volatile anaesthetics- nitrous oxide, ethers, cyclopropane, chloroform, halothane, trichlorethlene.

Unit - IV: Alkaloids **15 Hours**

Alkaloids: sources, isolation and purification, colour reactions and detection general. Quinine and Morphine- sources, extraction, structure, important features and SAR. Tranquilisers, sedatives, hypnotics, psychedelic drugs. Organic pharmaceutical aids: role as preservatives, antioxidants, colouring, flavouring, sweetening, emulsifying agents, stabilizing and suspending agents. Ointment bases. Solvents. Minerals: biological role of salts of Na, K and Ca, trace elements Cu, Zn and I. deficiency. Sources. Diagnostic agents: organic types for different actions, examples.

Unit: V Blood and Haematological agents **15 Hours**

Blood: composition.Analysis of blood sample-grouping, Rh factor. Tests for urea, bile carbonyls compounds, serum and protein in a sample. Physiological function of plasma protein. Roel of blood as oxygen carrier. Structure of heme. Clotting mechanisms. Factors involved. Blood pressure-normal, low and high – causes and control, anemia causes, detection. Antianemic drugs.
Haematological agents: coagulants and anticoagulants. Coagulants-vitaminK, Protamine,sulphate, dried thrombin, proteins, amino acids, anti-coagulants- coumarins, indanedioals, citric acid, 2-sulphonyloacids, quinoxaline, thromlodyn,haemostatics, amino-caproic acid, tranexamic acid, anemia: causes, detection, antianemic drugs.

References

1. Charles R. Craig, Robert E. Stitzel, Modern Pharmacology, 3rd edition, little brown and company, Boston, 1990.
2. Saradasubrahmanyam, K. Madhavankulty, Textbook of human physiology, 4th edition, S.Chand and company Ltd., New Delhi, 1995.
3. G.R.Chatwal, pharmaceutical chemistry, Vol.II, 1st edition, Himalaya Publishing House, Bombay, 1991.
4. Harold Varley, Practical clinical biochemistry, 4th edition, Arnold-Heinemann, New Delhi,1976.
   Jacques Wallach, Interpretation of Diagnostic Tests, Little Brown and Company, Boston, 1992.

Mapping of CO with PO and PSO

CO	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)						
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**Mean Scores of COs**
CO1	3	3	3	3	2	3	3	3	2	3	3	2.82
CO2	3	3	3	3	3	3	3	2	3	3	3	2.91
CO3	3	3	2	2	3	3	2	3	3	3	3	2.73
CO4	3	3	3	2	3	3	3	2	3	3	3	2.82
CO5	3	3	3	3	3	3	3	3	2	3	3	2.91
CO6	3	3	3	2	3	3	2	3	3	2	3	2.73
Mean Overall Score												2.82
Result												High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	20
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	10

Semester II

CH818 – Organic Chemistry II

Course Code	Type	Total Hours	Lecture	Tutorial	Practical
CH818	Theory	60	55	5	0
		Course Name		**Max Marks**	**Credits**
		ORGANIC CHEMISTRY II		100	4

Objectives:

- To understand the addition, elimination, reduction and oxidation reaction mechanisms
- To learn the concept of bonding, structure and reactivity of organic molecules.

Course Outcomes:

At the end of this course, the students will be able to

S.No	Course outcome	Cognitive level
CO-1	Define the concept of chirality and categorize the structure of organic molecules through stereo isomerism and various molecular 3D-models and stereochemical rules	**(K1, K2, K4)**
CO-2	Annotate and integrate the conformations and reactivity, chirality concepts involved in cyclic, acyclic, bicyclic systems	**(K2, K3)**
CO-3	Relate the product formation from various oxidation reactions and various oxidizing reagents with detailed mechanism	**(K2)**
CO-4	Write and justify the product of reduction reactions and various reducing reagents with detailed mechanism.	**(K3, K6)**
CO-5	Illustrate the various selective naming reactions with mechanistic route and predict the product formation	**(K3,K5)**
CO-6	Justify the synthetic organic chemistry problems and predict the product with specific stereochemistry in oxidation, reduction and selective naming reactions	**(K3)**

Course Content

Unit - I: Stereochemistry – I **12 Hours**

Introduction to molecular symmetry and chirality – examples from common objects to molecules – axis, plane, center, alternating axis of symmetry. Stereoisomerism – definition based on symmetry and energy criteria – configuration and conformational stereoisomers.

Chirality – molecules with C, N, S based chiral centers – absolute configuration - enantiomers – racemic modifications - R and S nomenclature using Cahn-Ingold-Prelog rules – molecules with a chiral center and Cn – molecules with more than one center of chirality – definition of diastereoisomers – constitutionally symmetrical and unsymmetrical chiral molecules - erythro, threo nomenclature – E and Z nomenclature. Asymmetry synthesis - Cram's rule – Optical and geometrical isomerism of disubstituted cycloalkanes- Stereoselective and stereospecific synthesis.

Unit - II: Stereochemistry – II **12 Hours**

Axial, planar and helical chirality – examples – stereochemistry and absolute configuration of allenes, biphenyls, trans cyclooctene, transcyclononene and binaphthyls, ansa and cyclophanic compounds, spiranes, exo-cyclic alkylidene cycloalkanes.

Topicity and prostereoisomerism – topicity of ligands and faces, and their nomenclature – NMR distinction of enantiotopic/diastereotopic ligands. Conformational analysis and stereochemical features of acyclic and cyclic systems – substituted n-butanes – cyclohexane and its derivatives – decalins – fused and bridged bicyclic systems – conformation and reactivity - some examples – chemical consequence of conformational equilibrium - Curtin-Hammett principle.

Unit - III: Selected Organic Name Reactions with Mechanism **12 Hours**

Arbuzov reaction, Barmford-stevens reaction, Duff reaction, Claisen condensation, Stork Enamine reaction, Hunsdieker,Ulmannraction, Swern Oxidation, Kolbe reaction, Meerweinarylation, Hofmann-Loffler-Fretag, Peterson olefination, and Chugaev reaction. Wohl-zieglerbromination, Stephen reaction, Schotten-Baumann reaction, Suzuki reaction. Stereochemical aspects of each reaction. Stereochemical aspects of each reaction.

Unit - IV: Oxidation Reactions **12 Hours**

Metal based and non-metal-based oxidations of alcohols to carbonyls (Chromium, Manganese, aluminium, silver, and ruthenium. DMSO, hypervalent iodine and TEMPOL based reagents). Phenols (Fremy's salt, silver carbonate). Alkenes to epoxides: (peroxides/per acids based), Sharpless asymmetric epoxidation, Jacobsen epoxidation, Shi epoxidation. Alkenes todiols: (Manganese, Osmium based), Sharpless asymmetric dihydroxylation, Prevost reaction and Woodward modification. Alkenes to carbonyls with bond cleavage (Manganese, Osmium, Ruthenium and lead based, ozonolysis). Alkenes to alcohols/carbonyls without bond cleavage (hydroboration-oxidation, Wacker oxidation, selenium, chromium based allylic oxidation) - ketones to ester/lactones (Baeyer-Villiger).

Unit - V: Reduction Reactions **12 Hours**

Catalytic hydrogenation (Heterogeneous: Palladium/Platinum/Rhodium/Nickel etc; Homogeneous: Wilkinson). Noyori asymmetric hydrogenation. Metal based reductions using Li/Na/Ca in liquid ammonia, Sodium, Magnesium, Zinc, Titanium and Samarium (Birch, Pinacol formation, McMurry, Acyloin formation, dehalogenation and deoxygenations) - Hydride transfer reagents from Group III and Group IV in reductions. - $NaBH_4$ triacetoxyborohydride, L-selectride, K-selectride, Luche reduction; $LiAlH_4$, DIBAL-H, and Red-Al,Trialkylsilanes and Trialkylstannane, Meerwein-Pondorff-Verley reduction) - Stereoselective and enantioselective reductions (Chiral Boranes, Corey-Bakshi-Shibata).

References

1. Francis A. Carey and Richard J, Sundberg, Advanced Organic Chemistry – Part B, 3rd Edition 1990.
2. S.M. Mukherji and S.P. Singh, Organic Reaction Mechanism, MacMillan India Ltd., Chennai – 1990.
3. P.S. Kalsi, Stereochemistry and Mechanism through solved problems, Wiley Eastern Ltd., 1994.
4. W Carruthers, Some Modern Methods of Organic Synthesis, 4thEdn. Edition, Cambridge University Press, 1996.
5. H.O. House, Modern Synthetic Reactions, The Benjamin Cummings Publishing Company, London, 1972.
6. P.S.Kalsi, Stereochemistry, Conformation analysis and Mechanism by 2nd Edition Wiley Eastern Limited , 1993.
7. Ernest Eliel, Stereochemistry of carbon compounds, New Age Publications, 2012.
8. D.Nasipuri, Sterochemistry of Organic compounds, 2ndEdn. New Age Publications,
9. 2008.
10. J.March, Advanced Organic Reaction mechanism and structure, Tata McGraw Hill, 2000.
11. Ahluwalia and Parashar, Organic Reaction Mechanisms, 4thEdn., Narosa Publications, 2012
12. P.S.Kalsi, Organic Reaction Mechanism, 3rdEdn. New Age Publications, 1994.

Online resources:

1. http://eacharya.inflibnet.ac.in/ Organic Chemistry- (Reaction Mechanisms-II)

Mapping of CO with PO and PSO

CO	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)						
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**Mean Scores of COs**
- CO 1	2	3	2	3	1	3	2	3	2	3	3	2.5
- CO 2	3	3	3	2	1	3	3	3	2	2	2	2.5
- CO 3	3	3	3	3	1	3	3	3	3	3	2	2.7
- CO 4	3	3	3	3	1	3	3	3	3	3	2	2.7
- CO 5	3	3	3	2	1	3	3	3	2	2	3	2.5
- CO 6	3	3	2	2	1	3	3	3	2	3	3	2.5
Mean Overall Score												2.6
Result												High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	20
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	10

CH819 - Inorganic Chemistry-II

Course Code	Type	Total Hours	Lecture	Tutorial	Practical
CH819	Theory	60	55	5	0
		Course Name		**Max Marks**	**Credits**
		INORGANIC CHEMISTRY II		100	4

Objectives:

- To study the concept of coordination Chemistry, stability of the complexes and stereochemistry of complexes.
- To study about structure and bonding in coordination complexes.
- To learn the use of Inorganic Compounds in Biological systems
- To study the electron transfer processes and substitution reactions in Coordination complexes

Course Outcomes

On successful completion of this Course, students will be able to

CO1	Deduce the reaction mechanism and stability of the coordination compounds	**K5**
CO2	Understand the theories of coordination compounds and relate their importance.	**K2, K3**
CO3	Know the basic chemistry of various elements and their functions in biological systems	**K1**
CO4	Comprehend and integrating the role of coordination compound in living system	**K4**
CO5	Analyse the basic application of electronic spectroscopy of complexes and apprise the stability of coordination compounds	**K5**
CO6	Design and synthesis coordination compounds of biological and medicinal importance	**K6**

Course Content

Unit - I: Coordination Chemistry – I **12 Hours**

Thermodynamic aspects of complex formation; Stability of complexes, factors affecting stability, Determination of stability constants by spectrophotometric, polarographic and potentiomteric methods. Electronic spectroscopic studies of coordination complexes.

Unit - II: Coordination Chemistry – II **12 Hours**

Stereochemical aspects; Stereoisomerism in inorganic compelexes; isomerism arising out of ligand and ligand conformation; chirality and nonmenclature of chiral complexes; optical rotatory dispersion and circular dichroism, Absolute configuration, Cotton effect.
Macrocyclic. Ligands; types; porphyrins; corrins, Schiff bases; crown ethers; cryptates

Unit - III: Bio-Inorganic Chemistry – I **12 Hours**

Transition elements in biology - their occurrence and function, active-site structure and function of metalloproteins and metalloenzymes with various transition metal ions (carbonic anhydrase and carboxy peptidase) and ligand systems; O_2 binding properties of heme (haemoglobin and myoglobin) and non-heme proteins hemocyanin & hemerythrin), their

coordination geometry and electronic structure, co-operativity effect, Hill coefficient and Bohr Effect. Na-K pump.

Unit - IV: Coordination Chemistry – III **12 Hours**

Electron transfer reactions, outer and inner sphere processes, atom transfer reaction, formation and rearrangement of precursor complexes, the binding ligand, successor complexes, Marcus Theory. Complementary, non-complementary and two electron transfer reactions.

Unit - V: Coordination Chemistry - IV **12 Hours**

Substitution Reaction: Substitution in square planar complexes, reactivity of platinum complexes, influences of entering, leaving and other groups. The trans effect, Theories of trans effect and its applications. Substitution of octahedral complexes of cobalt and chromium, replacement of coordinated water, solvolytic (acids and bases) reaction applications in synthesis (Platinum and cobalt complexes only).

Text Books

References

1. J.E. Huheey, Inorganic Chemistry – Principles, Structure and Reactivity, Harper Collins, New York, IV Edition, 1993.
2. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry – A Comprehensive Text, John Wiley and Sons, V Edition, 1988.
3. K.F. Purcell and J.C. Kotz, Inorganic Chemistry – WB Saunders Co., USA, 1977.
4. M.C. Day and J. Selbin, Theoretical Inorganic Chemistry, Van Nostrand Co., New York, 1974.
5. D.F. Shrivers, P.W. Atkins and C.H. Langford, Inorganic Chemistry, OUP,1990,
6. S.F.A.Kettle, Coordination Chemistry, EIBS, 1973.
7. K. Burger, Coordination Chemistry, Burter. Worthy, 1973.
8. F. Basolo and R.G. Pearson, Mechanism of Inorganic Reaction, Wiley NY, 1967.

Online Resource:

http://nptel.ac.in/courses/104105033/ Coordination chemistry (Chemistry of transition elements)

Mapping of CO with PO and PSO

CO	Programme Specific Outcomes (PSO)						Programme Outcomes (PO)					Mean Scores of COs
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	
1	3	3	3	3	3	3	3	3	3	3	2	2.9
2	3	3	3	3	3	3	3	3	3	3	2	2.9
3	3	3	3	3	2	2	3	3	3	2	3	2.7
4	3	3	3	3	3	2	3	3	3	3	2	2.8
5	3	3	3	3	3	3	3	3	2	2	3	2.8
6	3	3	3	3	3	3	3	3	3	3	2	2.9
											Mean Overall Score	2.8
											Result	**High**

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	20
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	10

CH820 – PHYSICAL CHEMISTRY II

Course Code	**Type**	**Total Hours**	**Lecture**	**Tutorial**	**Practical**
CH820	Theory	75	65	10	0
		Course Name		**Max Marks**	**Credits**
		PHYSICAL CHEMISTRY-II		100	4

Objectives:

- To study and apply the fundamentals and principles of quantum mechanics in chemistry
- To illustrate the physical significance of the wave functions and Schrodinger equation
- To learn and analyse the principles and significance of partial molar property and fugacity.
- To learn the fundamentals and applications of statistical thermodynamics.
- To understand and assess the concepts of equilibrium and non – equilibrium thermodynamics in various phenomenon.
- To apply non – equilibrium thermodynamics to chemical and biological systems.

Course Outcomes

At the end of this course, the students will be able to

CO. No.	**Course Outcome Statement**	**Cognitive Level**
CO 1	Understand and explain the principles of quantum mechanics and apply it to chemical systems**.**	**K1, K3**
CO 2	Describe the physical significance of the wave functions and apply the Schrödinger equation for some simple systems	**K2, K3**
CO 3	Understand the concepts and significance of thermodynamics and evaluate their applicability to chemical systems.	**K1, K5**
CO 4	Assess the different statistical approaches to chemical system and evaluate the thermodynamic quantities in terms of partition function.	**K5**
CO 5	Recognize the principles that govern equilibrium and non-equilibrium thermodynamics and analyse the impact on non-equilibrium thermodynamics in electrokinetic and thermoelectric phenomenon	**K1, K4**
CO 6	Integrate the concepts and its implications of non – equilibrium thermodynamics to chemical and biological systems	**K3, K6**

Course Content

Unit - I: Introduction to Quantum Chemistry **15 Hours**

Need for quantum mechanics. Black body radiation, photoelectric effect, Wave - particle dualism, Compton effect- Bohr's theory for hydrogen atom - Radius of Stationary Orbits-Energy of Electron in a Stationary Orbit-Heisenburg uncertainty principle and its applications

Solving One-dimensional wave equation for a standing wave-Separation of variables-Interpretation of results-Schrodinger's wave equation-Eigen value-Eigen function.

Postulates of Quantum mechanics –Normalization of wave functions, orthogonality of wave functions - Operators – Algebra of operators – commutative property – Linear operator and Hermitian property -Properties of Hermitian Operator– momentum operator, KE operator, Hamiltonian operator.

Solution of Schrodinger's wave equation for simple systems: Free particle- Particle in one dimensional box (Origin of quantization)

Unit - II: Quantum mechanics to simple systems in chemistry **15 Hours**

Particle in one dimensional box (Expectation Values for momentum and position meaning of <x>, <p>, Verification of Heisenberg's Uncertainty Principle) -Applications of particle in a box -and particle in three-dimensional (3D) box.

Harmonic oscillator-interpretation of results, Rigid rotor-interpretation of result-angularmomentum operator

Hydrogen atom-Hydrogen atomic orbitals-Analytical and graphical representations

Radial probability distribution function-Orthogonality of 1s, 2s, 2p orbitals

Pauli's exclusion principle, Slater's determinant. Introduction to perturbation and Variational method (Qualitative)

Unit - III: Thermodynamics **15 Hours**

Partial molar properties – Partial molar free energy (Chemical potential) – Partial molar volume and partial molar heat content – their significance and determination of these quantities. Gibbs-Duhem equation- variation of chemical potential with temperature and pressure.

Thermodynamics of real gases – gas mixture – fugacity definition Gibbs-Duhem-Marghules equation– determination of fugacityby graphical and equation of state – variation of fugacity with temperature and pressure – thermodynamics of ideal and non - ideal binary solutions-dilute solutions- the concepts of activity and activity coefficients-determination of standard free energies. Choice of standard states – determination of activity and activity coefficients for non-electrolytes.

Unit IV: Statistical thermodynamics – I **15 Hours**

Statistical mechanics of a system of independent particles – Bose – Einstein system and Fermi Dirac systems. Distribution laws – Boltzmann Distribution law – Partition function and its significance. Bose – Einstein and Fermi Dirac Distribution law.

Limit of applicability of distribution law. Relationship between partition and thermodynamic functions – Internal energy, Heat capacity, Entropy, Pressure and Chemical potential.

Distribution law of distinguishable and indistinguishable molecules or particles – Thermodynamic quantities in terms of partition function. Evaluation of independent molecular function – Translational, rotational and vibrational – the law of equipartition energy – Heat capacity.

Unit V: Application of Statistical and Irreversible thermodynamics: **15 Hours**

Application of statistical to ideal monoatomic and Diatomic ideal gases. Heat capacity and the residual entropies of gases. Heat capacity of solids.Maxwell-Boltzmann probability distribution of molecular velocities and speeds. The concept of ensemble, Treatment of canonical ensemble, expression of entropy, enthalpy, Helmholtz free energy.

Near equilibrium process: General theory- Conservation of mass and energy- Entropy

production in open system by (i) heat (ii) matter and (iii) current flow. Onsager theory: Validity and verification. Thermoelectricity-Electro kinetic and thermo mechanical effects. Application of irreversible thermodynamics to biological and non-linear systems.

References

1. Donald A McQuarrie, Quantum chemistry, Indian Edition, Viva Books Private Limited 2005
2. K.L. Kapoor, A text book of Physical Chemistry, Vol 4, Mac Millan India Ltd., 2001.
3. Prasad R.K. Quantum Chemistry, 1st Edition, New Delhi, Wiley Eastern Ltd, 1992.
4. M.C.Gupta, Statistical thermodynamics Second edition, Wiley Easter, New Delhi, 1990.
5. S. Glasstone, Thermodynamics for chemists, Affiliated East West Press, New Delhi, 1960
6. Francis W. Sears, Gerhard L. Salinger. Thermodynamics, Kinetic theory and Statistical thermodynamics. Addison Wesley (1975)
7. J. Rajaram and J.C. Kuriacose, Thermodynamics for students of chemistry, Lal Nagin Chand, New Delhi, 1986
8. K.L. Kapoor, A text book of Physical Chemistry, Vol 5, Mac Millan India Ltd., 2015.

Online Resources

http://eacharya.inflibnet.ac.in/Physical Chemistry-I (Quantum Chemistry) [32 lectures]

Mapping of CO with PO and PSO

CO	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)						
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**Mean Scores of COs**
CO1	3	3	3	3	2	3	3	3	3	2	1	2.64
CO2	3	3	2	2	2	3	3	3	3	2	2	2.55
CO3	3	3	3	3	3	3	3	3	2	2	2	2.73
CO4	3	3	3	3	2	3	3	3	3	2	2	2.73
CO5	3	3	2	3	2	3	3	3	3	3	2	2.73
CO6	3	3	3	3	2	3	3	3	3	3	2	2.82
Mean Overall Score												2.70
Result												High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	20
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	10

CH821A – RESEARCH METHODOLOGY

Course Code	Type	Total Hours	Lecture	Tutorial	Practical
CH821A	Theory	75	65	10	0
		Course Name		**Max Marks**	**Credits**
		RESEARCH METHODOLOGY		100	4

Objectives:

- To learn the purpose and methods of research
- To study the interpretation of knowledge of e-sources in literature search
- To write a scientific report based on the research done

Course Outcomes

At the end of this course, the students will be able to

CO. No.	Course Outcome Statement	Cognitive Level
CO 1	Understanding the importance of the research and to demonstrate high ethical values in research	**K1, K6**
CO 2	Employ different methodologies to conduct a literature survey	**K3**
CO 3	Analyse and execute a proper literature survey for a chosen problem in their respective field of research	**K4, K5**
CO 4	Integrating various level of hypothesis in analysing the data obtained during the research and interpret them	**K4**
CO 5	Organizing and evaluating the data obtained using various software's	**K2, K4**
CO 6	Compile a research article using the art of technical writing and subsequently publish	**K6**

Course Content

Unit – I Introduction **15 Hours**

Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India

Unit – II Survey of literature **15 Hours**

Survey of literature including patents: Chemical nomenclature and literature-primary sources secondary sources including reviews, treatises, and monographs, -literature searching-review of work relevant to the chosen problems. Reviews: Annual and quarterly reviews, general reviews.

Unit III – Computers and web-based research **15 Hours**

Introduction, The Computer and Computer Technology, The Computer System, Important Characteristics Computer Applications Computers and Researcher,

Web sources for literature, Scifinder and other search engines Abbreviations used in scientific writing, ASAP Alerts, CA Alerts, Sci Finder, Chem Port, Science Direct, STN International. Google, scholar, Scopus-Journal home pages

Unit - IV: Data Analysis **15 Hours**

Data Analysis: Frequency distributions, the binomial distribution, the Poisson distribution and normal distribution – describing Data, population and sample, mean, variance, standard deviation.

Usage of data / graphical processing softwares (freeware)

Hypothesis testing, levels of confidence and significance, test for an outlier, testing variances, means t-Test, paired t-Test – Analysis – of variance (ANOVA) – Correlation and Regression – Curve fitting, Fitting of linear equations, simple linear cases. General polynomial fitting, linearizing transformations, exponential function fit – r and its abuse – Basic aspects of multiple linear regression analysis.

Unit – V - Writing a scientific paper and thesis **15 Hours**

Meaning of Interpretation, Why Interpretation, Technique of Interpretation: Precaution in Interpretation Significance of Report Writing Different Steps in Writing Report Layout of the Research Report Types of Reports Oral Presentation Mechanics of Writing a Research Report Precautions for Writing Research Reports

References

1. C.R Kothari, Research Methodology, New Age International publishers, 2nd Edn; 2009.
2. Goode, William J., and Natt, Paul K.Methods in social research, International Student edition, McGraw-Hill Co, and Kogakusha Ltd., 1995.
3. Bates, R.N and Schoofer, J.P., Research Techniques in Organic Chemistry, Prentice Hall
4. B. E. Cain, The Basis of Technical Communicating, ACS.,Washington, D.C., 1988.
5. J. W.Best, Research in Education, 4th ed. Prentice Hall of India, New Delhi, 1981.
6. H. F. Ebel, C. Bliefert and W.E. Russey, The Art of Scientific Writing, VCH, Weinheim,1988.
7. J. Gibaldi, and W.S. Achtert, Handbook for writers of Research Papers; 2nd ed.; Wiley Eastern,1987.
8. Joseph, Methodology for Research; Theological Publications, Bangalore, 1986.
9. R. L. Dominoswki, Research Methods, Prentice Hall, 1981.
10. H. M. Kanare, Writing the Laboratory Notebook; American Chemical Society: Washington, DC, 1985.

Mapping of CO with PO and PSO

CO	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)						
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**Mean Scores of COs**
CO1	3	2	2	3	3	3	2	2	3	3	2	2.55
CO2	3	3	2	3	2	3	2	2	3	3	3	2.64
CO3	3	3	3	2	3	3	2	3	3	3	3	2.82
CO4	3	3	3	3	2	3	2	3	3	3	3	2.82
CO5	3	2	3	3	3	3	3	2	2	3	3	2.73

CO6	3	3	3	3	3	3	2	2	3	3	3	2.82
Mean Overall Score												2.73
Result												High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	20
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	10

CH821B – HETEROCYCLIC CHEMISTRY

Course Code	**Type**	**Total Hours**	**Lecture**	**Tutorial**	**Practical**
CH821B	Theory	75	65	10	0
		Course Name		**Max Marks**	**Credits**
		HETEROCYCLIC CHEMISTRY		100	4

Objectives:

- To learn the nature and reactions of heterocyclic compounds
- To understand the classification and significance of heterocyclic compounds.

Course Outcomes

At the end of this course, the students will be able to

CO. No.	**Course Outcome Statement**	**Cognitive Level**
CO 1	Acquire basic knowledge on classifications of Heterocyclic Compounds, nomenclature of Heterocyclic Compounds, structural characteristics, physical properties, synthesis of Heterocyclic Compounds and chemical reactions.	K1, K2
CO 2	Analyze and discuss the Information and data related to Heterocyclic Compounds.	K3, K4
CO 3	Detecting and leading the reactivity and stability of hetero aromatic compounds.	K5, K6
CO 4	Demonstrate the proficiency in designing reaction schemes to achieve six and seven membered ring heterocycles.	K6
CO 5	Apply these hetero aromatic compounds in the synthesis of important industrial and pharmaceutical compounds.	K5, K6

CO 6	Understand the chemistry of large heterocyclic structures and plan to synthesize them	K1, K6

Course Content

Unit - I: Nomenclature of Heterocycles **15 Hours**

Replacement and systematic nomenclature (Hantzsch-Widman system) for monocyclic fused and bridged heterocycles.Aromatic Heterocycles General chemical behaviour of aromatic heterocycles, classification (structural type), criteria of aromaticity (bond lengths, ring current and chemical shifts in 1H NMR-spectra. Empirical resonance energy, delocalization energy and Dewar resonance energy, diamagnetic susceptibility exaltations). Heteroaromatic reactivity and tautomerism in aromatic heterocycles.

Unit - II: Non-Aromatic Heterocycles **15 Hours**

Strain-bond angle and torsional strains and their consequences in small ring heterocycles. Conformation of six-membered heterocycles with reference to molecular geometry, barrier to ring inversion, pyramidal inversino and 1,3-diaxial interaction. Stereo-electronic effects anomeric and related effects, Attractive interactions-hydrogen bonding and intermolecular nucleophilic, ectrophilic interactions. Heterocyclic Synthesis. Principles of heterocyclic synthesis involving cyclization reactions and cycloaddition reactions.

Unit - III: Small Ring Heterocycles **15 Hours**

Three-membered and four-membered heterocycles-synthesis and reactions of azirodines, oxiranes, thiranes, azetidines, oxetanes and thietanes.Benzo-Fused Five-Membered HeterocyclesSynthesis and reactions including medicinal applications of benzopyrroles, benzofurans and benzothiophenes.

Unit - IV: Meso-Ionic Heterocycles **15 Hours**

General classification, chemistry of some important meso-ionic heterocycles of type-A and B and their applications. Six-membered Heterocycles with one Heteroatom. Synthesis and reactions of pyrylium salts and pyrones and their comparison with pyridinium&thiopyrylium salts and phridones. Synthesis and reactions of quionlizinium and benzopyrylium salts, coumarins and chromones.

Unit - V: Higher Heterocycles **15 Hours**

Six membered Heterocycles with two or more Heteroatoms. Synthesis and reactions of diazones, triazines, tetrazines and thiazines. Seven-and Large-membered Heterocycles. Synthesis and reactions of azepines, oxepines, thiepines, diazepinesthiazepines, azocines, diazocines, dioxocines and dithiocines.

References

1. G. K. Chatwal, Organic Chemistry on Natural Products, Vol. 1, Himalaya Publishing House, Mumbai, 2009.
2. G. K. Chatwal, Organic Chemistry on Natural Products, Vol. 2, Himalaya Publishing House, Mumbai, 2009.
3. O. P. Agarwal, Chemistry of Organic Natural Products, Vol. 1, Goel Publishing House, Meerut, 1997.
4. O. P. Agarwal, Chemistry of Organic Natural Products, Vol. 2, Goel Publishing House, Meerut, 1997.
5. L. Finar, Organic Chemistry Vol-2, 5 th ed., Pearson Education Asia, 1975.
6. T. L. Gilchrist, Heterocyclic Chemistry, Longman Press, 1989.

7. J. A. Joule and K. Mills, Heterocyclic Chemistry, 4th ed., John-Wiley, 2010.
8. Raj K Bansal Heterocyclic chemistry, fourth edition, New Age International Publishers, 2005.

Mapping of CO with PO and PSO

CO	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)						
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**Mean Scores of COs**
CO1	3	3	3	3	2	3	3	2	2	3	3	2.73
CO2	3	3	2	3	2	3	3	3	2	3	2	2.64
CO3	3	2	3	3	2	3	3	2	2	3	3	2.64
CO4	3	2	3	3	2	3	3	3	2	2	3	2.64
CO5	3	3	3	3	3	3	3	2	3	3	3	2.91
CO6	3	3	3	3	2	3	3	3	3	3	3	2.91
Mean Overall Score												2.74
Result												High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	20
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	10

CH821C – BIO - ORGANIC CHEMISTRY

Course Code	**Type**	**Total Hours**	**Lecture**	**Tutorial**	**Practical**
CH821C	Theory	75	65	10	0
		Course Name		**Max Marks**	**Credits**
		BIO – ORGANIC CHEMISTRY		100	4

Objectives:

- To enable the student to understand and appreciate the importance of biomolecules.
- To understand the techniques involved in the extraction and methods of determination of structure of natural products.
- To describe the structure and function of nucleic acids
- To learn the synthetic procedure of alkaloids and terpenoids and their applications.
- To synthesis the steroids compounds and interpret their biological role.
- To Illustrate the method of synthesis of flavonoids.

Course Outcomes

At the end of this course, the students will be able to

CO. No.	Course Outcome Statement	Cognitive Level
CO 1	Understand and know the importance of the biomolecules	**K1, K2**
CO 2	Apply the extraction techniques and elucidate the structure of natural products.	**K3, K4**
CO 3	Describe the structure and function of DNA and RNA and justify the denaturation of nucleic acid	**K2, K5**
CO 4	Synthesis a common alkaloid and terpenoids and know their importance	**K5**
CO 5	Design the synthetic route of steroids and interpret their functions in biological system	**K3, K6**
CO 6	Describe the general method of synthesis of anthocyanins and flavonoids.	**K2**

Course Content

Unit - I: Carbohydrates **15 Hours**

Configuration and conformations of monosaccharides, anomeric effect, epimerization and mutarotation. Determination of ring size of monosaccharides. Synthesis, industrial and biological importance of glycosides, amino sugars, sucrose and maltose. Industrial and biological importance of cellulose, starch, glycogen, dextran, hemicellulose, pectin, agar-agar, cytosine, crysin. Glycolysis and its reversal; TCA cycle. Relation between glycolysis and respiration.

Unit - II: Proteins and Nucleic Acids **15 Hours**

Classification – properties - 3D structure of protein; Determination of C and N-terminal amino acid sequence – denaturation and renaturation of proteins. Separation and purification of proteins – dialysis – gel filtration - electrophoresis. Catabolism of amino acids: transamination, oxidative deamination, decarboxylation and urea cycle. Introduction, structure and synthesis of nucleosides and nucleotides, protecting groups for hydroxy group in sugar, amino group in the base and phosphate functions. Methods of formation of internucleotide bonds: Structure of RNA and DNA, Crick-Watson model. Solid phase synthesis of oligonucleotides. Role of nucleic acids in the biosynthesis of proteins.

Unit - III: Alkaloids and Terpenoids **15 Hours**

General methods of structural elucidation of alkaloids. Structural elucidation of apaverine and cocaine; synthesis and functions of atropine, heptaphylline, morphine. General methods of determination of structure of terpenoids. Structural elucidation of cadinene, vitamin A, abietic acid; synthesis and functions of gibberelic acid, zingiberine and squalene

Unit - IV: Steroids **15 Hours**

Conformations of stereoids - molecular rearrangements (acid, base catalysed, and photochemical). Synthesis of steroids – ring forming reaction and control of ring junction stereochemistry. Synthesis and functions of cholesterol, androgens, oestrone, progesterone and cortisone.

Unit - V: Anthocyanins and flavonoids **15 Hours**

General nature and structure of anthocyanins. General methods of synthesizing anthocyanidins. Structural elucidation of cyanidin chloride, pelargolidin chloride, Hirsutidin chloride. Flavones – flavonols – isoflavones. Biosynthesis of flavonoids.

References

1. T. K Lindhorst, Essentials of Carbohydrate Chemistry and Biochemistry, Wiley VCH, 2007.
2. G. K. Chatwal, Organic Chemistry on Natural Products, Vol. 1, Himalaya Publishing House, Mumbai, 2009.
3. G. K. Chatwal, Organic Chemistry on Natural Products, Vol. 2, Himalaya Publishing House, Mumbai, 2009.
4. O. P. Agarwal, Chemistry of Organic Natural Products, Vol. 1, Goel Publishing House, Meerut, 1997.
5. O. P. Agarwal, Chemistry of Organic Natural Products, Vol. 2, Goel Publishing House,Meerut, 1997.
6. L. Finar, Organic Chemistry Vol-2, 5th ed., Pearson Education Asia, 1975.
7. L. Finar, Organic Chemistry Vol-1, 6th ed., Pearson Education Asia, 2004.
8. Pelletier, Chemistry of alkaloids, Van Nostrand Rein

Mapping of CO with PO and PSO

CO	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	Mean Scores of COs
CO1	3	2	3	3	2	3	3	3	2	3	3	2.73
CO2	3	2	3	3	3	3	3	2	3	3	3	2.82
CO3	3	3	3	2	2	3	3	2	3	2	3	2.64
CO4	3	3	3	2	2	3	3	2	3	3	3	2.73
CO5	3	3	3	3	2	3	3	2	3	3	3	2.82
CO6	3	3	3	2	2	3	3	3	2	3	3	2.73
Mean Overall Score												2.74
Result												High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	20
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	10

PCH813 – Organic Chemistry Practicals I

Course Code	Type	Total Hours	Lecture	Tutorial	Practical
PCH813	Practical	60	4	0	56
		Course Name		**Max Marks**	**Credits**
		ORGANIC CHEMISTRY PRACTICALS-I		100	4

Objectives:

- To learn the separation of an organic compound from the mixture and identify them using various chemical tests.
- To enable the student to learn the methods of preparation for some organic compounds.

Course Outcomes:

At the end of this course, the students will be able to

S.No	Course outcome	Cognitive level
CO-1	Identify and relate the nature of the organic compound mixture given based on solubility and reactivity	**(K1, K2)**
CO-2	Demonstrate the systematic analysis and separation of organic compound mixture into individual components	**(K4)**
CO-3	Experimenting organic chemistry theoretical knowledge into laboratory tests with respect to addition, oxidation, substitution reactions and other reactions	**(K3)**
CO-4	Correlate functional group and corresponding derivatives formed during qualitative analysis in the laboratory	**(K4)**
CO-5	Implement synthetic approach with single stage preparations in laboratory using oxidation, reduction etc.	**(K3)**
CO-6	Build and reflect the synthetic ability to prepare and purify organic compounds from single stage reactions	**(K5, K6)**

Course Content

1. **Separation and identification of components in a two-component mixture and preparation of their derivatives.**
2. **Any Six preparations from the following:**
    - p-Nitrobenzoic acid from p-nitrotoluene
    - Anthroquinone from anthracene
    - Benzhydrol from benzophenone
    - m-Nitroaniline from m-dinitrobenzene
    - 1,2,3,4 - Tetrahydrocarbazole from cyclohexanone
    - p-Chlorotoluene from p-toluidine
    - 2,3 - Dimethylindole from phenyl hydrazine and 2 - butanone
    - Methyl orange from sulphanilic acid
    - Diphenyl methane from benzyl chloride

Reference Books:

1. Arthur I. Vogel, "A Textbook of Practical Organic Chemistry", ELBS, 1969.
2. N.S. Gnanapragasam and B. Ramamoorthy, "Organic Chemistry Lab Manual", S. Visvanathan Printers & Publishers, 2006.

Mapping of CO with PO and PSO

CO	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	Mean Scores of COs
CO1	3	3	2	3	2	3	2	3	3	3	2	2.6
CO2	3	3	3	3	1	3	2	3	3	3	2	2.6
CO3	2	3	3	3	1	2	3	2	3	3	2	2.5
CO4	3	3	2	2	1	3	2	2	3	2	2	2.3
CO5	3	3	2	3	1	3	3	3	2	3	3	2.6
CO6	3	3	2	2	1	2	2	2	3	3	2	2.3
Mean Overall Score												2.5
Result												High

Scheme of Valuation

External Component:

60 Marks and it has to be converted to 50 Marks

S. No	Components	Mark Distribution
1	Qualitative analysis of Organic mixtures	30
2	Single stage organic compound preparation	15
3	Record	05
4	Viva	10
	Total Marks	**60 Marks**

i) Qualitative Analysis of Organic compounds

Identification of TWO organic compounds in a given mixture

Pilot test report = 4 Marks

Identification of TWO individual organic compounds (2×13 M) = 26 Marks

Without procedure TWO components report (2*5 M) = 10 marks

For each single organic compound, mark distribution as follows:

Components	Mark distribution
Aliphatic/ Aromatic	1 mark
Saturation/Unsaturation	1 mark
Special elements (N,S,X)	3 marks
Functional group	5 marks
Derivative	3 marks
Total	**13 Marks**

ii) Single stage preparation:

Crude sample in single stage preparation = 10 Marks

Recrystallization = 05 Marks

Internal Component:

S. No	Components	Mark Distribution
1	Qualitative analysis of Organic Mixtures*	20
2	Single stage organic compound preparation	10
3	Viva‡	05
4	Theory of Practical's‡	05

5	Model practical examination	10
	Total Marks	**50 Marks**

Conditions for Internal Component:
For Component **1** to **3** 60% of the work done has to take into account
ONE Viva and One TOP per semester has to be taken into account
* In-case of Pandemic Outbreak an average practical's that is done has to be taken into consideration.
‡ In-case of Pandemic Outbreak the best of Viva and Theory of Practical's conducted has to be taken for calculation in internal component.

PCH814 - Inorganic Chemistry Practicals – I

Course Code	**Type**	**Total Hours**	**Lecture**	**Tutorial**	**Practical**
PCH814	Practicals	60	4	0	56
		Course Name		**Max Marks**	**Credits**
		INORGANIC CHEMISTRY PRACTICALS-I		100	4

Course Objectives:

1. To learn the basic principles of qualitative analysis of an inorganic mixture
2. To understand and apply the principles of complexometric titrations.

Course Outcomes
At the end of the course, the students will be able to:

S. NO	Course Outcomes Statement	Cognitive level
CO1	Understand the methodology of determining ions using complexometric titrations.	**K1**
CO2	Devise methods to prepare a complex from simple starting materials	**K3**
CO3	Employ a standard procedure to identify the common and rare ions	**K4, K6**
CO4	Demonstrate the ability to identify and separate any ions from any mixtures by evolving the procedure	**K6**
CO5	Analyse the data obtained through various experiments and deduce conceptual explanations for theoretical concepts	**K5**

Course Content
Semimicro qualitative analysis of mixture containing two common and two rare cations.
The following are the rare cations to be included. W, Ti, Te, Se, Ce, Th, Zr, V, U, Li, Mo, Be.

Complexometric Titrations (EDTA) - Estimation of Ca, Mg and Zn.

- Preparation of the followings:
- Potassium tris (oxalate) aluminate (III) trihydrate
- Tris (thiourea) copper (I) chloride
- Potassium tris (oxalaato) chromate (III) trihydrate
- Sodium bis(thiosulphato) cuprate (I)
- Tris (thiourea) copper (I) sulphate
- Sodium hexanitrocobaltate (III)

- Chloropentammine cobalt (III) chloride
- Bis (acetylacetonato) copper (II)
- Hexamminenickel (II) chloride
- Bis (thiocyanato) pyridine manganese (II)

Text Books

1. V. V. Ramanujam, Inorganic Semimicro Qualitative Analysis; 3rd ed., The National Publishing Company, Chennai, 1974.
2. Vogel's Text book of Inorganic Qualitative Analysis, 4 th Ed, ELBS, London, 1974.

Mapping of CO with PO and PSO

CO	Programme Specific Outcomes (PSO)						Programme Outcomes (PO)					Mean Scores of COs
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	
1	3	2	2	2	3	2	3	3	2	3	1	2.4
2	3	3	2	2	3	3	3	3	2	3	1	2.5
3	3	2	2	3	3	3	3	3	2	3	1	2.5
4	3	3	2	3	3	2	3	3	3	3	1	2.6
5	3	3	2	2	3	2	3	3	2	3	2	2.5
6	3	2	2	2	3	2	3	3	2	3	1	2.4
											Mean Overall Score	2.5
											Result	High

Scheme of Valuation

External Component:

100 Marks and it has to be converted to 50 Marks

S. No	Components	Mark Distribution	
1	Quantitative analysis of Inorganic Mixtures	40	20
2	Volumetric Analysis-Complexometric titration	20	10
3	Preparation of Complexes	20	10
4	Viva	10	05
5	Record	10	05
	Total Marks	**100 Marks**	**50 M**

i) Quantitative Analysis:

Detection of TWO Common radicals and TWO Uncommon Radicals
With complete procedure (4×10 M) = 40 Marks
Identification of radicals/Group (4×2 M) = 08 Marks

ii) Volumetric Analysis:

Error Calculation
≤ 2% Error = 20 Marks
2-3 Error = 20-15 Marks
3-4 Error = 15-10 Marks
≥ 4 Error = 10 Marks

ii) Complex Preparation:

Preparation of Complex = 15 Marks

Quality and Quantity of the Complex Prepared = 05 Marks

Internal Component:

100 Marks and it has to be converted to 50 Marks

S. No	Components	Mark Distribution	
1	Quantitative analysis of Inorganic Mixtures*	40	20
2	Volumetric Analysis-Complexometric titration*	20	10
3	Preparation of Complexes*	20	10
4	Viva‡	05	2.5
5	Theory of Practical's‡	05	2.5
6	Model Examination	10	05
	Total Marks	**100 Marks**	**50 M**

Conditions for Internal Component:

For Component **1** to **3** 60% of the work done has to take into account

ONE Viva and One TOP per semester has to be taken into account

* In-case of Pandemic Outbreak an average practical's that is done has to be taken into consideration.

‡ In-case of Pandemic Outbreak the best of Viva and Theory of Practical's conducted has to be taken for calculation in internal component.

PCH815 – PHYSICAL CHEMISTRY PRACTICALS I

Course Code	Type	Total Hours	Lecture	Tutorial	Practical
PCH815	Practicals	60	4	0	56
		Course Name		**Max Marks**	**Credits**
		PHYSICAL CHEMISTRY PRACTICALS-I		100	4

Objectives:

- To learn various physical and electrochemical methods to perform chemical measurements

Course Outcomes

At the end of this course, the students will be able to

CO. No.	Course Outcome Statement	Cognitive Level
CO 1	Knowledge of measuring and determining the rate, order, rate constants of chemical reactions experimentally.	K1
CO 2	Understand and use the concept of distribution coefficient to measure the equilibrium constant.	K2
CO 3	Applying the concept of optical activity to measure the rate constant and to compare the strength of acids.	K3
CO 4	Experimenting the relation between the amount of molecule adsorbed on the surface of a adsorbent and apply the concepts of adsorption in the field of catalysis.	K3, K5
CO 5	Construct the phase diagram and apply it to metallurgical industry.	K3

CO 6	Estimate the minimum energy required for the molecules to undergo chemical reactions.	K4
CO 7	Evaluate the speed of chemical reactions in terms of temperature, concentration, and ionic strength.	K5
CO 8	Apply chemical kinetics in solving problems related to dosage and stability of drugs, absorption, distribution, and elimination of drugs from the body.	K3, K6
CO 9	Linking between the theoretical concepts with the experimental data obtained in the chemical kinetics.	K4

Course Content

Experiments in Thermodynamics, colligative properties, phase rule, chemical equilibrium and chemical kinetics. Typical examples are given and a list of experiments is also provided from which suitable experiments can be selected as convenient.

- Heat of solution from Solubility measurements
- Determination of molecular weight
- Determination of activity and activity coefficient
- Phase diagram construction involving two/three component systems
- Determination of partial molar quantities
- Adsorption isotherm
- Reaction rate and evaluation of other kinetic parameters using polarimetry, analytical techniques, conductometry, dilatometry
- Verification of Beer Lambert law

Detailed list of Experiments for Physical Chemistry Practical I

Typical list of possible experiments is given. Experiments of similar nature and other experiments may also be given. The list given is only a guideline. Any 15 experiments have to be performed in a year

1. Determine the temperature coefficient and energy activation of hydrolysis of ethyl acetate.
2. Study the kinetics of the reaction between acetone in iodine and - acidic medium by half-life method and determine the order with respect to iodine and acetone.
3. Study the effect of solvent (DSMO-water, acetone-water system). On the rate of acid catalyzed hydrolysis of acetal by dilatometry.
4. Study the Saponification of ethyl acetate with sodium hydroxide by conductometrically and determine the order of the reaction.
5. Determine the order with respect to Silver (I) in the oxidation by spt and rate constant and for uncatalyzed reaction.
6. Study the inversion of cane sugar in the presence of acid using Polari meter.
7. Determine the rate constant and order of the reaction between potassium persulphate and potassium iodide and determine the temperature coefficient and energy of activation of the reaction.
8. Study the effect of ionic strength on the rate constant for the saponification of an ester.
9. Study the salt effect on the reaction between acetone and iodine.
10. Study the kinetics of the decomposition of sodium thiosulphate by mineral acid (0.5M HCI).
11. Study the primary salt effect on the kinetics of ionic reactions and test the Bronsted relationship (iodide ion is oxidized by persulphate ion).

12. Study the kinetics of enzyme catalysed reactions (Activity of tyrosinase upon tyrosine spectrophotometrically).
13. Study the salt effect, the solvent effect on the rate law of alkaline hydrolysis of crystal violet.
14. Study the reduction of aqueous solution of ferric chloride by stannous chloride.
15. Determine the molecular weight of benzoic acid in benzene and find the degree of association.
16. Determine the activity coefficient of an electrolyte by freeing point depression method.
17. Study the phase diagram form-toluidine and glycerine system.
18. Construct the phase diagram for a simple binary system naphthalene - phenantherene and benzophenone-diphenyl amine.
19. Construct the boiling point composition diagram for a mixture having maximum boiling point and minimum boiling point.
20. Study the complex formation between copper sulphate and ammonia solution by partition method.
21. Study the simultaneous equilibria in benzoic acid - benzene water system.
22. Determine the degree of hydrolysis and hydrolysis constant of aniline hydrochloride by partition method.
23. Determine the molecular weight of a polymer by viscosity method.
24. Determine the viscosities of mixtures of different compositions of liquids and find the composition of a given mixture.
25. Determine the partial molal volume of glycine/methanol/formic acid/sulphuric acid by graphical method and by determining the densities of the solutions of different compositions.
26. Study the temperature dependence of the solubility of a compound in two solvents having similar inter molecular interactions (benzoic acid in water and in DMSO water mixture) and calculate the partial molar heat of solution.
27. Determine the polar molar volume of glycine/methanol/formic acid /sulphuric acid by graphical method and by determining the densities of solutions of different concentrations.
28. Construct the phase diagram of the three component of partially immiscible liquid system (DMSO-water-benzene; acetone-chloroform -water; chloroform-acetic acid-water)
29. Construct the phase diagram of a ternary aqueous system of glucose -potassium chloride and water
30. Study the surface tension - concentration relationship for solutions (Gibb's equation)
31. Study the absorption of acetic acid by charcoal (Freundlich isotherm)
32. Study the complex formation and find the formula of silver-ammonia complex by distribution method.
33. Determine the dissociation constant of picric acid using distribution law.

Text books

1. B. Viswanathan and P.S.Raghavan, Practical Physical Chemistry, Viva Books, New Delhi,2009.
2. K. Sundaram, Practical Chemistry, S. Viswanathan Co. Pvt., 1996.

Mapping of CO with PO and PSO

CO	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)						
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**Mean Scores of COs**
CO1	3	3	2	3	2	3	1	3	3	3	1	2.45
CO2	3	3	2	3	2	3	1	3	3	3	1	2.45
CO3	3	3	3	3	2	3	2	3	3	2	1	2.55
CO4	3	3	3	2	3	3	1	3	3	3	1	2.55
CO5	3	3	3	3	3	3	2	3	3	3	1	2.73
CO6	3	3	2	3	2	3	2	3	3	2	1	2.45
CO7	3	3	3	3	2	3	2	3	3	3	1	2.64
CO8	3	3	3	3	2	3	3	3	3	3	3	2.91
CO9	3	3	2	3	2	3	2	3	3	2	2	2.55
Mean Overall Score												2.59
Result												High

Scheme of Valuation

External Component (50 Marks):

Component	Marks
Principle and procedure (Written)	05
Experiment	30
Record	10
Viva	05
Total	**50 Marks**

Internal Component (50 Marks):

Component	Marks
Regular practical (Average of best 70% of the practicals)	30
Model exam	10
Theory of practical (At least one per semester)	05
Viva (At least one per semester)	05
Total	**50 Marks**

Mark distributions for Experiment (30 marks)

1. Phase Study

Component	Marks
Determination of unknown composition **% of error** / **Marks** ≤10 / 15 10 - 15 / 10 >15 / 05	15
Phase diagram	05
Eutectic temperature and composition	10

Total	**30**

2. Equilibrium constant

Component	**Marks**
Determination of unknown concentration **% of error** / **Marks** ≤10 / 1 10 - 15 / 10 >15 / 05	15
Determination of equilibrium constant	05
Determination of Distribution coefficient	05
Calculations	05
Total	**30**

3. Salt effect (Persulfate Vs Iodide)

Component	**Marks**
Determination of unknown concentration of salt **% of error** / **Marks** ≤10 / 15 10 - 15 / 10 >15 / 05	15
Determination of rate constant by graphical method	10
Calculations of ionic strength of salt	05
Total	**30**

4. Determination of order of reaction (Persulfate Vs Iodide)

Component	**Marks**
Determination of order with respect to KI (Or) Determination or order with respect to $K_2S_2O_8$ **% of error** / **Marks** ≤10 / 15 10 - 15 / 10 >15 / 05	15
Determination of total order	05
Determination of Rate of reactions of each mixture (4x2.5)	10
Total	**30**

5. Determination of order of reaction (Reaction of Iodination of acetone)

Component	**Marks**
Determination of order with respect to acetone *Result: Deviation from* ***1.0 to 1.1- 10 marks*** ***1.1 – 1.5 – 08 marks***	10

>1.5 - 05 marks	
Determination of order with respect to Iodine *Result: Deviation from* ***Zero up to 0.1- 10 marks*** ***>0.1 - 05 marks***	10
Determination of rate constant of each mixture by graphical method	05
Calculations	05
Total	**30**

6. Adsorption of acetic acid on charcoal:

Component	**Marks**
Determination of unknown concentration of acetic acid **% of error** / **Marks**: ≤10 / 15; 10 - 15 / 10; >15 / 05	15
Graph	05
Calculations	10
Total	**30**

7. Comparison of acid strengths by Polarimeter and Ester hydrolysis

Component	**Marks**
Comparison of acid strength **% of error** / **Marks**: ≤10 / 15; 10 - 15 / 10; >15 / 05	15
Rate constant determination by graphical method	7.5
Rate constant determination by calculation	7.5
Total	**30**

8. Determination of Energy of Activation (Ester hydrolysis reaction)

Component	**Marks**
Determination of energy of activation **% of error** / **Marks**: ≤10 / 15; 10 - 15 / 10; >15 / 05	15
Determination Rate constant at two different temperatures for both graphical and calculation	10
Determination of pre exponential factor	05
Total	**30**

M.Sc Chemistry–2022-2023

The following details should be given before syllabus of each programme (PG)

Vision	To educate and empower young students in the field of Chemistry and its allied subjects in order to create intellectuals with integrity, responsibility and vision towards the furtherance of knowledge and wisdom
Mission	
Name of the Programme	Postgraduate Programme
B. Sc / M. Sc Chemistry	M.Sc Chemistry
Programme Outcomes	*Postgraduates will be able to*: PO1 Demonstrate intense knowledge in the subject PO2 Exhibit specialized skills to plan, analyze and draw conclusions related to their respective field of study in theory and practice PO3 Prepare themselves to incorporate new technologies in their own discipline and demonstrate excellence in their area of specialization PO4 Develop expertise in their field of study through projects and research activities PO5 Develop social and ethical responsibility in the transfer and management of knowledge
Programme Specific Outcomes	*Postgraduates in Chemistry are supposed to* PSO1 Understanding comprehensively the various principles and theories in the domain of Chemistry and learn to apply it in the field of production, formulation and research. PSO2 Summarize, compare and contrast the structures, properties, types and applications of chemical entities by understanding the stereochemistry, structures, reactivity etc. PSO3 Learn to solve equations and to correlate the various concepts and facts about chemical systems and their behavior and arrive at proper conclusions and inferences. PSO4 To evaluate, criticize and defend the theories, concepts and methods / processes and suggest the modification of the same. PSO5 To formulate / create - methods / processes / designs in the field of Chemistry with improved efficacy and performance through carrying out individual research projects PSO6 Acquire adequate skills to design and synthesize new organic drug molecules to cater to the needs of pharma and other industries and to impart industrial training to become entrepreneurs and towards establishing green/sustainable practices.

II. PSO – PO Mapping

PSO	PO1	PO2	PO3	PO4	PO5	Mean Score
PSO1	3	3	3	3	2	2.8
PSO2	3	3	3	3	2	2.8
PSO3	3	3	2	2	2	2.4
PSO4	3	3	3	3	1	2.6
PSO5	3	3	3	3	2	2.8
PSO6	3	3	3	3	2	2.8
Mean Overall Score						2.7
Result						High

High – (2.1 – 3), Medium – (1.1 – 2), Low – (0 – 1)

CH918 – Organic Chemistry III

Course Code	Type	Total Hours	Lecture	Tutorial	Practical
CH918	Theory	60	55	5	0
		Course Name		**Max Marks**	**Credits**
		ORGANIC CHEMISTRY III		100	4

Course Objectives

- To learn photochemical reactions, pericyclic reactions and their importance.
- To learn the synthetic application of Organometallic compounds.

Course Outcomes:

Sl. No.	Course Outcome Statements On successful completion of this Course, students will be able to	Knowledge level
CO1	Identify the nature of rearrangement involved and intermediates generated in various organic molecules; Writing mechanism for the rearrangement involved in organic molecules.	**K1, K6**
CO2	Interpret the role of reagents in multistep organic synthesis and correlate the next synthetic work up involved.	**K2**
CO3	Integrate the concept of organometallic compounds as homogeneous, hetereogeneous catalysts and reagents in organic functional group conversions.	**K3**
CO4	Illustrate list of electronic transitions involved in various organic molecules and correlate them with photochemical reactions and based on their photophysical processes.	**K4**
CO5	Invent corresponding mechanism based on thermal/photochemical condition and predicting the product with specific stereochemistry in various pericyclic reactions.	**K5**
CO6	Build the synthetic route theoretically for a given reactant and product with set of reagents.	**K6**

Course Content

Unit - I: Molecular Rearrangements **12 Hours**

Types of rearrangements: Nucleophilic; free radical and electrophilic reactions. Mechanisms: Nature of migration; migratory aptitude and memory effects, ring enlargement and ring contraction rearrangements Reactions: Wagner-Meerwin and related reactions, Benzil-benzilic acid, Favorskii, Hofmann and related rearrangements, Beckmann, Neber, Baeyer-Williger, Stevens, boron-carbon migration, Non-1,2-rearrangements, Fischer-indole synthesis, Arndt-Eistert synthesis

Unit - II: Reagents in Organic Synthesis **12 Hours**

Enammine chemistry and its synthetic applications,aluminiumIsopropoxide, DCC, *n*-BuSnH, baker yeast, Woodward and Prevost dihydroxylations, NBS, DDQ, LTA, LDA , wilkinson's catalyst, and Diazomethane, wittig Reagent, Gilman reagent, Corey's reagent, Merrifield reagent.

Unit - III: Synthetic Applications of Organometallic Compounds **12 Hours**

Synthesis and applications of organoboranes – Grignard reagents - organomercury compounds – aromatic mercuration, organolithium compounds - organothallium compounds - organocopper compounds, organolead compounds and organoaluminium compounds.

Unit - IV: Organic Photochemistry **12 Hours**

Introduction- Photochemical laws-electronic transitions- photochemistry of excited molecule-physical processes- photochemistry of carbonyl compounds- Norrish type I and II reactions-Hydrogen abstraction- photocycloaddition- Paterno – Buchi reactions- photorearrangement of cyclopentenone, cyclohexenone-Lumiketone rearrangement- photorearrangement of β,γ-unsaturated ketones-di- π-methane rearrangement-Aza- di- π-methane rearrangements-Analysis of cis-trans isomerisations

Unit - V: Pericyclic Reactions **12 Hours**

Introduction to pericyclic reaction - Characteristics-types-applications of FMO and MO correlation diagram methods to electrocyclic and cycloaddition reactions- Woodward-Hoffmann rules and their applications to simple systems-cycloadditions involving hydrogen transfer- Analysis of Cycloaddition and Diels –Alder reactions, Detail study of Sigmatropic reactions- Cope and Claisenrearrangements,Chelotropicreaction,Group transfer reactions,Ene and retro enereactions,Coarctate reaction.

References

1. Clayden, Greeves, Warren and Wothers, Organic chemistry, Oxford University press, 2001.
2. Francis A Carey and Richard J. Sundberg, Advanced organic chemistry, 4thEdn., part B, 2001.
3. I.L. Finar, Organic Chemistry V Edition, Vol :ll ELBS Publication, 1986.
4. J. March, Advanced Organic Reaction mechanism and structure, Tata McGraw Hill, 2000.
5. Jagadamba Singh and Jaya Singh, Photochemistry and Pericyclic reactions, 3r^{d}edn., New Academic Science, 2012.
6. K. K. Rohatji Mukherjee, Fundamentals of photochemistry, 1st, edn., New Age Publications, 2008.
7. S. H. Pine, *Organic Chemistry*, 5thedn, McGraw Hill International Edition, 1987.
8. L. F. Fieser and M. Fieser, *Organic Chemistry*, Asia Publishing House, Bombay, 2000.
9. E.S. Gould, *Mechanism and structure in organic chemistry*, Holt, Rinehart and Winston Inc.,1959.

Online Resources

http://eacharya.inflibnet.ac.in/ Organic chemistry and pericyclic reactions [40 lectures]

Mapping of CO with PO and PSO

CO	Programme Specific Outcomes (PSO)						Programme Outcomes (PO)					Mean Scores of COs
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	
CO1	3	2	3	2	2	1	3	3	3	3	1	2.3636364
CO 2	3	2	3	1	2	1	3	2	1	3	1	2
CO 3	3	2	3	3	2	2	3	3	2	3	2	2.5454545
CO 4	3	3	3	2	1	2	3	3	1	2	1	2.1818182
CO 5	3	2	3	1	1	2	2	2	1	3	2	2
CO 6	3	2	3	2	3	2	3	3	2	3	2	2.5454545
											Mean Overall Score	2.272727
											Result	

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	20
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	10

CH919 - Inorganic Chemistry-III

Course Code	Type	Total Hours	Lecture	Tutorial	Practical
CH919	Theory	60	55	5	0
		Course Name		**Max Marks**	**Credits**
		INORGANIC CHEMISTRY III		100	4

Course Objectives:

- To study about the basic theory of Inorganic spectroscopy.
- To illustrate the UV, IR and Raman spectral properties of some inorganic compounds and complexes.
- To study and illustrate the different types of magnetic behaviour in inorganic materials.
- To learn the basic concepts of superconductivity behaviour in the materials
- To apply the NMR, NQR, ESR and Mossbauer techniques in to simple inorganic systems.
- To learn the instrumentation of advance inorganic spectroscopy techniques.

Course Outcomes

At the end of the course, the students will be able to:

S. NO	Course Outcomes Statement	Cognitive level
CO1	Students can recognize and interpret the spectroscopic techniques in terms of interaction of electromagnetic radiation with molecules	**K1 & K2**
CO2	Students can infer about the magnetic properties and superconductivity of materials and can able to calculate the magnetic susceptibility of the materials.	**K2, K3 & K4**
CO3	Students can describe the principles and to interpret the instrumentation of various spectroscopic techniques.	**K1 & K3**
CO4	Students can illustrate the principle involved in ESR, NQR and Mossbauer Spectroscopy and distinguish chemical species using these spectroscopy	**K2 & K4**
CO5	Students can apply the principles of spectroscopy to predict the structure of compounds and analyse the various spectra of complexes	**K3, K4 &K5**
CO6	Students can able to propose and formulate the structure of a new compound based on the spectroscopic data	**K6**

Course Content

Unit - I: Inorganic Spectroscopy - I and Magnetic Susceptibility 12 Hours

Applications to inorganic systems of the following: ultra violet, visible, infra-red and Raman spectra of metal complexes, organometallic and simple inorganic compounds with special reference to coordination sites, isomerism. Magnetic Susceptibility and measurements - Guoy method, Faraday method; applications.

Unit - II: Magnetic Properties and Superconductivity 12 Hours

Magnetic properties – classification - diamagnetic, paramagnetic, antiferromagnetic, ferro and ferri magnetic — magnetic susceptibility, Variation with temperature – Curie-Wiess law, Curie temperature and Neel temperature. Permanent and temporary magnets. Superconductivity – introduction, Meissner effect – mention of Bardeen, Cooper and Schrieffer theory and Cooper pairs – examples of superconducting oxides.

Unit - III: Inorganic Spectroscopy – II 12 Hours

Application to Inorganic systems of the following: NMR, NMR of 31P, 19F, NMR shift reagents, NQR introduction and NQR - Nitrosyl compounds. Mossbauer spectra – Theory and Mossbauer spectra of Fe and Sn systems.

Unit - IV: Inorganic Spectroscopy – III 12 Hours

ESR Introduction - Zeeman equation, g-value, nuclear hyperfine splitting, interpretations of the spectrum, simple carbon centered free radicals. Anisotropy - g-value and hyperfine splitting constant. McConnell's equation, Kramer's theorem. ESR of transition metal complexes of copper, manganese and vanadyl complex. Applications of ESR spectroscopy.

Photoelectron spectroscopy (UV and X-ray) - photo electron spectra - Koopman's theorem, time structure in PES, chemical shift and correlation with electronic charges.

Unit - V: AAS and ICP –AES 12 Hours

Atomic absorption spectroscopy- principle- Advantages and disadvantages of AAS. Instrumentation of AAS, Interferences in AAS - Applications of AAS – Determination of Mg in water and Lead in Petrol- principle of plasma spectroscopy - ICP-AES instrumentation - limitations of flame emission spectroscopy - applications of plasma spectroscopy - comparison of ICP-AES with AAS.

Text Books

References

1. C.N.R. Rao, I.R. Ferraro, Spectroscopy in Inorganic Chemistry, Vol. I and Vol. II, Academic Press, 1970.
2. G. Aruldhas, Molecular Structure and Spectroscopy – Prentice Hall, 1986.
3. D. A. Skoog and D.M.West, Principles of Instrumental Methods of analysis, Saunder's College Publ. III Edition, 1985.
4. E. A. V. Ebsworth, D. W. H. Rankin and S. Cradock, Structural Methods in Inorganic Chemistry, II Edition, Blackwell Scientific Publications, Oxford, London 1991.
5. G.D. Christian and J.E.G. Reily, Instrumental Analysis, AllegnBecon, II Edition, 1986.
6. H.A. Strobel, Chemical Instrumentation, Addison - Wesley Pub. Co., 1976.
7. R. S. Drago, Physical Methods for Chemists, Saunders College Publishing, Philadelphia 1992.
8. R.S. Drago, Physical methods in inorganic Chemistry, Reeindhod, NY, 1968.
9. Willard Merrit, Dean and Settle, Instrumental methods of analysis, CBS Publ. VI edition, 1986.

10. A.I Vogel, Text books of qualitative analysis, ELBS Editions, 1976 and IV Edition 1985.

Mapping of CO with PO and PSO

CO	Programme Specific Outcomes (PSO)						Programme Outcomes (PO)					Mean Scores of COs
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	
1	3	3	3	3	2	2	3	3	2	2	3	2.6
2	3	3	3	3	3	2	3	3	3	3	2	2.8
3	3	3	3	3	3	3	3	3	3	3	2	2.9
4	3	3	3	3	3	2	3	3	3	3	2	2.8
5	3	3	3	3	3	3	3	3	3	3	2	2.9
6	3	3	3	3	3	3	3	3	3	3	2	2.9
Mean Overall Score												2.8
Result												**High**

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	20
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	10

CH920 – SPECTROSCOPY

Course Code	Type	Total Hours	Lecture	Tutorial	Practical
CH920	Theory	75	65	10	0
		Course Name		**Max Marks**	**Credits**
		SPECTROSCOPY		100	4

Objectives:

- To understand the concepts of spectral techniques
- To apply these techniques for the quantitative and structural analysis of organic compounds

Course Outcomes

At the end of this course, the students will be able to

CO. No.	Course Outcome Statement	Cognitive Level
CO 1	Demonstrate the understanding of electromagnetic spectrum and applied to study of chemical molecules.	K1, K2
CO 2	Validate knowledge of the principles of mass spectrometry and instrumentation.	K2, K5
CO 3	Predict number of signals, splitting pattern in the proton NMR of a compound and interpret NMR spectra of simple molecules.	K3, K5
CO 4	Identify the absorption frequencies of major functional groups and comprehend the electronic absorption and apply to interpret IR and UV-Visible spectra of simple organic compounds.	K2, K4
CO 5	Develop an ability for combined usage of mass spectrometry, UV-Vis., IR and NMR for structural elucidation.	K3, K6
CO 6	Analyse, evaluate and interpret the spectroscopic data effectively	K4, K5

Course Content

Unit - I: Elemental Analysis and Mass Spectra **15 Hours**

Calculation of empirical and molecular formula-Mass Spectroscopy – Principles – measurement techniques – (EI, CI, FD, FAB, SIMS) Molecular ions – isotope ions – fragmentations of odd and even electron types – rearrangement ions –factors affecting cleavage patterns – simple and multicentre fragmentation – McLafferty rearrangement. Mass spectra for various organic compounds- nitrogen rule.

Unit - II: UV –Visible Spectroscopy **15 Hours**

Ultraviolet – Visible spectroscopy – Instrumentation-single and double beam instruments-– types of electronic transitions – chromophores and auxochromes – factors influencing positions and intensity of absorption bands – absorption spectra of dienes, polyenes and unsaturated carbonyl compounds – Woodward – Fisher rules. Applications to simple systems.

Unit - III: Infra-Red Spectroscopy **15 Hours**

IR Spectroscopy – Selection rule- Instrumentation-Sample preparation-FTIR- vibrational frequencies and factors affecting them – identification of functional groups – intra and inter

molecular hydrogen bonding – finger print region – Far IR region – metal ligand stretching vibrations.

Unit - IV: NMR **15 Hours**

Theory, Relaxation processes, spin – spin splitting Theory of Chemical Shift – Chemical exchange, Double Resonance techniques. Instrumentation - application to organic systems.

Nuclear spin – magnetic movement of a nucleus – nuclear energy levels in the presence of magnetic field relative populations of energy levels – macroscopic magnetization – basic principles of NMR experiments – CW and FT NMR –H NMR – Chemical shift and coupling constant – factors influencing proton chemical shift and vicinal proton – proton coupling constant - ^{1}H NMR spectra of simple organic molecules such as CH_3CH_2Cl, CH_3CHO etc. AX and AB spin system – spin decoupling – nuclear overhauser effect – chemical exchange.

Unit - V: ^{13}C NMR, ORD and CD **15 Hours**

^{13}C NMR – proton decoupled and off – resonance ^{13}C NMR spectra – factors affecting ^{13}C chemical shift - ^{13}C NMR spectra of simple organic molecules- elementary idea about 2D NMR- COSY-NOSEY-DEPT90 and 135. (Combined problem)

Optical rotatory dispersion and circular dichroism: Introduction to theory and terminology – cotton effect – ORD curves – axial haloketone rule and its applications – octant rule – its applications – applications of ORD to determine absolute configuration of monocyclic ketones – comparison between ORD and CD – their inter relationships.

References

1. J. Dyer, Application of absorption spectroscopy of organic compounds, Prentice and Hall of India, Pvt., New Delhi.1991.
2. R.M. Silvarstein, G.d. Bassler and Monsu. Johr, Spectrometric identification of organic compounds by Wiley and Sons, New York. 2000.
3. Douglass, Introduction to the spectroscopic methods for the identification organic compounds – II, Oxford publications, 2009.
4. William Kemp, Organic Spectroscopy, 3rdEdn.McMillan, 1991.
5. Y.R.Sharma, Elementary Organic Spectroscopy 3rd., S.Chand, 1999.
6. R.M. Silverstein, G.D. Bassler and Monsu, Spectrometric identification of Organic compounds, Sixth Edn. John Willey and Sons, New York, 2005.
7. Carington and Ad.Mclachlan, Introduction to Magnetic Resonance, Harper and Row, New York, 1967.
8. P.S.Kalsi, Spectroscopy of Organic Compounds, 4

Mapping of CO with PO and PSO

CO	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	Mean Scores of COs
CO1	3	3	3	3	2	3	3	2	3	3	3	2.82
CO2	3	3	2	3	2	3	3	3	2	3	3	2.73
CO3	3	3	3	3	2	3	3	3	3	3	2	2.82
CO4	3	3	3	3	2	3	3	2	3	3	3	2.82
CO5	3	3	3	3	2	3	3	3	2	3	3	2.82
CO6	3	3	3	3	2	3	3	3	3	2	3	2.82
Mean Overall Score												2.80

Result	High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	20
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	10

CH921A – Inorganic Photochemistry & Materials Science

Course Code	Type	Total Hours	Lecture	Tutorial	Practical
CH921A	Theory	75	65	10	0
		Course Name		**Max Marks**	**Credits**
		INORGANIC PHOTOCHEMISTRY & MATERIALS SCIENCE		100	4

Objectives

- To provide the students with basic information on matter radiation interactions and their consequences excited state formation modes, photophysical and photochemical deactivation pathways, and application of theoretical knowledge.
- Students are equipped with the knowledge on composition, molecular and electronic structures of inorganic compounds.
- Students will know to identify and quantify the course of photophysical and photochemical processes.

Course outcomes

On successful completion of this Course, the students will be able to

S. No	Course outcomes Statement	Cognitive Level
CO-1	Understand the photochemical pathways in various chemical reactions	K1, K2
CO-2	Elucidate the photophysical kinetics of unimolecular reaction evaluating using Stern-Volmer equation.	K3, K4
CO-3	Understand weak and strong interaction in photochemical process and construct a mechanism for transformation of low energy reactants to high energy products.	K2, K5
CO-4	Elucidate the mechanism involved in various metal complex systems.	K4
CO-5	Learn and apply the principles of the materials and constructing a reaction methodology using various precursor molecules.	K3, K4, K6
CO-6	Elucidate the imperfections in the crystal lattice and describing the phase transformation in inorganic materials.	K4, K5

Course content:

Unit - I: Basics of Photochemistry 15 Hours

Principle-Light Dual nature-Basic Laws of Photochemistry-Quantum Yield. Selection rule-Notation for excited state Organic Compounds-Energy level for Inorganic Complexes.Absorption Spectra-Emission Spectra-Frank Condon Principle-Energy Dissipation by radiative and non radiative transfers. Quantum yield measurement-Actinometers-types of actinometers.Excited states of metal complexes-Charge transfer spectra, metal–centered transitions, charge transfer excitations, emission spectra. Photophysical Kinetics of Unimolecular reaction. Stern-Volmerequation.

Unit - II: Photochemistry of Transition Metal Complexes and Its Applications 15 Hours

Electron transfer reactions in transition Metal Complexes-Photo physical and photochemical implications of transition metal complexes. Weak Interactions and Strong interactions(Excited state as redox Reactants-redox Properties of bpy and Phencomplexes (Fe, Ru and Os). Energy and electron transfer-Application of redox processes of electronically excited states for catalytic purposes. Transformation of low energy reactants into high energy products, chemical energy into light. Storage of light energy-EndoergonicProcess(Honda's cell)-Photo electrochemical cell

Unit – III: Photochemical Applications of Inorganic Systems **15 Hours**

Metal complex sensitizer(Fe and Ru Systems) Metal Colloid systems, semiconductor supported metal or oxide systems (TiO_2 supported systems). Photoproduction of Hydrogen and Oxygen-Water photolysis. Spectra of Organometallics-Metal Carbonyl compounds, Organometallic compounds with metal-metal bonding. Photochemistry in the solid state.

Unit - IV: Preparative Techniques **15 Hours**

Principles of solid-state synthesis- ceramic methods, solid solution and compound precursors (nitrates, carbonates, hydroxides, cyanides and organometallics), sol-gel, spray pyrolysis, combustion, hydrothermal, electrosynthetic techniques -

New Materials: Fullerenes and fullerides: structure, synthesis, functionalization approaches, conducting properties of fullerides-applications. NASICON and alumina–structure and conducting properties. High-Tc Oxides - structure, perovskite A & B, structure and synthesis of La, Sr and Ba cuprates-applications.

Unit V **15 Hours**

Crystal imperfections, Diffusion in solids, phase transformations, elastic, inelastic and visco elastic behavior.

Point Imperfections, The Geometry of Dislocations, Other Properties of Dislocations, Surface Imperfections. Fick's Laws of Diffusion, Solution to Fick's Second Law, Applications Based on the Second Law Solution, The Kirkendall Effect, The Atomic Model of Diffusion, Other Diffusion Processes. Phase Transformations, Time Scale for Phase Changes, nucleation and growth, The Nucleation Kinetics, The Growth and the Overall Transformation Kinetics. Elastic Behaviour-Atomic Model of Elastic Behaviour, The Modulus as a Parameter in Design, Rubber-like Elasticity. Anelastic behaviour, Relaxation Processes. Viscoelastic behaviour, Spring-Dashpot Models.

References

1. Gerald B. Porter, J.Chem.Edu,1983, 60, 785.
2. K. K. Rohatgi-Mukerjee, Fundamentals of Photochemistry,New Age International Publishers, Calcutta.
3. Balzani, V.; Bolletta, F.; Scandola, F.; Ballardini. R.Pure and Appl. Chem.,1979, 51, 299.
4. John S. Connolly, Photochemical ConversionAnd Storage Of Solar Energy,Academic Press, New York,1981.
5. Balzani, V.; Cassarati, V.Photophysics and Photochemistry of coordination compounds, Academic Press, Newyork, 1970.
6. R. S. Becker, Theory and Interpretation of fluorescence and phosphorescence, JohnWiley and Sons, Newyork, 1969.
7. S. Arunachalam, Inorganic photochemistry, Kala publications, Trichy, 2002.
8. D. M. Roundhill, Photochemistry and Photophysics of Metal complexes, Springer; Edition, 1994.
9. Lesley Smart and Elaine Moore, Solid State Chemistry-An Introduction by Chapman Hall, London, 1992.
10. A.R. West, Solid State Chemistry and its Applications , John Wiley & Sons.1989.
11. M. G. Arora, Solid State Chemistry by Anmol Publications, New Delhi, 2001.
12. P. K. Palanisamy, Materials Science, Scitech Publications, Chennai, 2003
13. Geoffrey A Ozin and Andre C Arsenault, Nanochemistry, A chemical approach to Nanomaterials, RSC, 2006.
14. Harry R Allcock, Introduction to materials chemistry, Wiley NY, 2008
15. Gurtu and Gurtu, Solid state Chemistry, Pragathiprakashan, 2015.
16. V. Raghavan, material Science and Engineering, Eastern Economic Edition, New Delhi, 2011.

17. Dr. Elangoven, Solid State Physics

Mapping of CO with PO and PSO

CO	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	Mean Scores of Cos
CO1	3	3	3	3	2	3	3	2	3	2	2	2.64
CO2	3	3	3	3	2	3	3	3	3	3	2	2.82
CO3	2	3	3	3	2	3	3	3	3	2	2	2.64
CO4	3	3	3	3	2	3	3	3	3	2	2	2.73
CO5	3	2	3	3	2	3	3	3	2	3	2	2.64
CO6	3	3	3	3	2	3	3	3	3	2	2	2.73
Mean Overall Score												2.70
Result												High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	20
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	10

CH921B – Polymer Chemistry

Course Code	Type	Total Hours	Lecture	Tutorial	Practical
CH921B	Theory	75	65	10	0
		Course Name		**Max Marks**	**Credits**
		POLYMER CHEMISTRY		100	4

Objectives

- To gain knowledge in the preparation, properties, characterization and uses of polymers.
- To appreciate the role and applications of polymer substances.

Course outcomes:

On successful completion of this Course, the students will be able to

S.No	Course outcome Statement	Cognitive Level
CO-1	Understand different types of polymers and learning the polymerization techniques	K1, K2
CO-2	Enumerate the reaction mechanism that takes place in the polymers	K3, K4
CO-3	Demonstrate the structural morphology of polymers	K2, K5
CO-4	Determining the molecular weights using different techniques.	K4
CO-5	Devise synthetic methodology for industrial polymers and assessing its importance	K4, K5

CO-6	Elucidate the synthetic methods of various novel polymers.	K4, K6

Course content:

Unit - I: Basic Concepts **15 Hours**

Classification: natural, synthetic, organic, inorganic, elastomers, fibers, resins, and plastics: thermoplastic and thermosetting. -Nomenclature and isomerism-polymerization-functionality-Molecular forces and chemical bonding in polymers-Molecular Weight-Linear, branched, and cross-linked polymers. Techniques of polymerization–emulsion, bulk, solution and suspension.

Unit - II: Reaction, Mechanism and Kinetics **15 Hours**

Reaction of polymers (Addition, Hydrogenation, Hydrolysis Cyclisation and Cross linking) Kinetics and Mechanism of polymerization-free radical, cationic, anionic and co-ordination polymerization (Ziegler-Natta Catalyst). Copolymerization-Kinetics (Detailed Study). General characterization–Kinetic chain length–degree of polymerization, chain transfer-initiators-inhibitors-retarders.

Unit - III: Structure, Properties, Polymer Characterization and Analysis **15 Hours**

Structure –Physical Property-Morphology (configurations-crystal structure-morphology-crystallization and melting)-Rheology (Viscoelasticity-glassy state and glass transition) Factors affecting Glass transition temperature-crystallinity and melting point-related to structure. Crystalline nature determination-X-Ray diffraction- Thermo Gravimetric Analysis-molecular weight determination-Osmometry(membrane), Ultra centrifuge, and Gel Permeation Chromatography.

Unit - IV: Industrial and Natural Polymers **15 Hours**

Important industrial polymers-preparation and application of polyethylene, polyvinylchloride, poly urethanes, polytetrafluro ethylene (TEFLON), Nafion and ion-exchange resins. Importance of natural polymers-application and structures of starch, cellulose, chitin and chitosan derivatives.

Unit - V: Novel Polymers **15 Hours**

Polymers in Medicine-Ionomers-Electronically conducting polymers-Interpenetrating polymer networks-Inorganic Polymers-Polymer liquid Crystals-High temperature and fire-retardant polymers-polymer nanocomposites- Electroluminescent polymers.

References

1. F. W. Bill Meyer. Text book of polymer science, III Edition, John Wiley and sons, New York, 1973.
2. V. R. Gowarikar, B. Viswanathan, J. Sridhar, Polymer Science, Wiley Eastern, 1986.
3. G. S. Misra, Introduction to Polymer Chemistry, New Age Publishers Ltd. 2008,
4. C. E. H. Brawn, The Chemistry of High Polymers, Butter worth & Co., London, 1948.
5. G. Odian, Principles of Polymerization, McGraw Hill Book Company, New York, 1973.
6. E. A. Coolins, J. Bares and E. W. Billmeyer, Experiments in Polymer Science, Wiley Interscience, New York, 1973.
7. Jagdamba Singh, R. C. Dubey, Organic Polymer Chemistry, PragathiPrakashan, 3rdEdn., 2011.
8. Rudin, The Elements of Polymer Science and Engineering. Academic Press, New York, 1973.
9. G. S. Krishenbaum, Polymer Science Study Guide, Gordon Breach Science publishing, New York, 1973.

Online Source

1. https://hackr.io/tutorials/learn-polymer

Mapping of CO with PO and PSO

CO	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	Mean Scores of Cos
CO1	3	3	3	3	2	3	3	2	2	2	1	2.45
CO2	3	3	3	3	2	3	3	2	2	2	2	2.54
CO3	3	2	3	3	2	3	3	2	2	3	3	2.6
CO4	2	3	3	2	2	3	3	2	2	2	2	2.36
CO5	3	3	3	3	2	3	3	2	2	3	2	2.63
CO6	3	3	3	3	2	3	3	2	2	3	2	2.63
Mean Overall Score												2.53
Result												High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	20
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	10

CH921C – Chemoinformatics

Course Code	Type	Total Hours	Lecture	Tutorial	Practical
CH921C	Theory	75	65	10	0
		Course Name		**Max Marks**	**Credits**
		CHEMOINFORMATICS		100	4

Objectives

- To study the fundamentals principles of the various computational methods
- To interpret the various methods of representing molecules in a chemical database
- To learn to analyse the data available in various databases
- To learn to apply the datamining tools on datasets and interpret the results

Course Outcomes

- On successful completion of this Course, the students will be able to

S. NO	Course Outcomes Statement	Cognitive level
CO1	Describe the various methods of representing molecules in a chemical database and apply the various tools.	**K1 & K3**
CO2	Analyze the physicochemical data available in various databases	**K4**
CO3	Apply the data mining tools on datasets and interpret the results.	**K2 & K3**
CO4	Explain the fundamentals and apply the various computational methods in chemical calculations.	**K1 & K3**
CO5	Evaluate the chemical calculations using computer programs, construct the new molecule using molecular modelling tools	**K5 & K6**
CO6	Design the structure of the small molecules and integrate the docking process using the software	**K3 & K6**

Course content

Unit – I: Introduction to Chemoinformatics **15 Hours**

History and evolution of Chemoinformatics, Use of Chemoinformatics, Prospects of Chemoinformatics, Molecular modelling, and structure elucidation. Nomenclature: IUPAC names, trade names, common names., Representing the molecules: Older systems – Connection tables, Line notation – INCHI, SMILES, WLN canolications. (Activity – Create a SMILES notation of simple molecules using the software) Line notation versus connection tables. Query languages - SMARTS, SMILES coding, Matrix representations, Introduction to chemical structure file formats - Molfiles and Sdfiles

Unit – II: Structure Searching **15 Hours**

Structure searching:2D-Fingerprints-Structural Keys – Hashed fingerprints, Exact structure searching, Substructure search, Sub structure searching - screening methods- algorithms for sub graph isomorphism – practical aspects of structure searching - Ways to measure Similarity - 2D topology, 3D configuration, Tanimotto Coefficient – Euclidean distance – Dice Coefficient – Cosine Coefficient – Tversky similarity Coefficient.Basics of computation of physical and chemical data and structure descriptors, data visualization.

Unit – III: Databases and Datamining **15 Hours**

Introduction-Database concepts-**types**-chemical, proteomic, genomic and literature databases-source, content and design, applications.

Chemical databases-Chembank, ChemPDB, Combichem, NCI- Pubchem (Compounds, Substances, Bioassay), PubMed, Drug Bank, ChemSpider (Activity - Search the simple molecules and predict their physico – chemical properties using Pubchem database)
Introduction-Aspects of Data mining – Techniques of Data mining – Multi dimensional models – cube – star – snowflakes – classification techniques – K-nearest neighbour – Decision tree – – Baeysian classifier – Introduction to neural network- Applications of Data mining

Unit IV: Molecular Modelling and Docking: 15 Hours

Molecular descriptors – ID, 2D & 3D – Deriving a simple QSAR equation – Hansch analysis – Free Wilson analysis – Application of Hansch equation – Hydrophobic & Steric factors – Influence of electronic factors – Ionisation constants, QSPR - Toxicity relationship
Ligand based drug design – Structure based drug design – Docking & Scoring functions – Active site characterization, building a molecule and energy optimization using ARGUSLAB (Activity),Docking of small molecules using ARGUSLAB (Activity)

Unit V: Computational chemistry 15 Hours

Fundamental principles - Ab initio methods – HartreeFock approximations – semi empirical methods – density functional theory – Basic theory – Linear scaling techniques – molecular mechanics - Basic theory – existing force fields – molecular dynamics and Monte Carlo simulations.

Reference Books:

1. Andrew R. Leach, Valerie J. Gillet. An Introduction to Chemoinformatics, revised edition, Springer, Netherland, 2007.
2. Larsen et al (ed), Textbook of Drug Design and Discovery, 3rd edition, Taylor and Francis, London and NewYork, 2004.
3. Leach A.R, Molecular Modelling: Principles and applications, 2nd edition, Prentice Hall, New Delhi, 2001.
4. K.V. Raman, Computer Applications in Chemistry, Tata McGraw Hill, New Delhi, 2008.
5. Vikas Gupta, Computer Course Kit, Dream Tech Press, 2010

Web sources:

1. https://open-babel.readthedocs.io/en/latest/Cheminf101/index.html
2. https://open-babel.readthedocs.io/en/latest/Cheminf101/represent.html#iupac-names-trade-names-common-names
3. https://open-babel.readthedocs.io/en/latest/Cheminf101/similarity.html
4. http://insideinformatics.cambridgesoft.com/webinars/info/Default.aspx?webinarID=632
5. http://www.acdlabs.com/resources/freeware/chemsketch/
6. http://www.acdlabs.com/download/technotes/2016/technote_chemsketch_advanced.pdf
7. accelrys.com/products/pdf/**isis-draw**.pdf
8. http://www.originlab.com/doc/Tutorial
9. http://www.inflibnet.ac.in/
10. https://www.**khanacademy**.org/

Mapping of CO with PO and PSO

CO	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	Mean Scores of Cos
CO1	3	3	3	3	2	3	3	3	3	3	2	2.81
CO2	3	3	3	3	2	3	3	3	3	3	2	2.81
CO3	3	3	3	3	2	3	3	3	3	3	2	2.81
CO4	3	3	3	2	2	3	3	3	3	3	2	2.72

CO5	3	3	3	3	2	3	3	3	2	3	2	2.72
CO6	3	3	2	3	2	3	3	3	2	3	3	2.72
Mean Overall Score												2.76
Result												High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	20
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	10

CH1017 - Organic Chemistry-IV

Course Code	Type	Total Hours	Lecture	Tutorial	Practical
CH1017	Theory	60	55	5	0
		Course Name		**Max Marks**	**Credits**
		ORGANIC CHEMISTRY IV		100	4

Course Objectives

- To know modern synthetic methods and synthetic strategies. This help in planning the synthesis of any types of organic compounds.
- To learn the synthesis and bio-synthesis of heterocyclic products.

Learning Outcomes:

- Any types of organic compounds synthesis were learned by the students, through modern synthetic methods and strategies.
- Synthesis and bio-synthesis of heterocyclic products were also learned by the students

Course Outcomes:

Sl. No.	Course Outcome Statements On successful completion of this Course, students will be able to	Knowledge level
CO1	Define the modern synthetic terminologies/methods and build the synthetic strategies incorporated in retrosynthesis of various types of organic molecules	**K1, K6**
CO2	Identify suitable protecting reagents for the protection of multifunctional organic molecules and predicting suitable deprotecting reagents after the completion of desired reaction.	**K1, K2**
CO3	Sketch various heterocyclic compounds structure with numbering and their interaction with various chemical reagents in detail.	**K3**
CO4	Illustrate the importance of environmentally benign solvents and their role in synthetic organic reactions.	**K4**
CO5	Validate the structure of various natural organic molecules and confirming their structure through total synthesis	**K5**
CO6	Build the synthetic route theoretically for a given target molecule in retrosynthetic way with theoretical justification.	**K6**

Course Content

Unit - I: Retrosynthetic Analysis-I **12 Hours**

Basic guidelines and terminology of retrosynthesis (synthons, FGI, disconnection approach), Important functional group interconversion synthesis of aromatic compounds-, one group C-X disconnections and two group C-X disconnections, one group C-C disconnections and two group C-C disconnections, important strategies of retrosynthesis.

Unit - II: Retrosynthetic Analysis-II and Protecting Functional Groups **12 Hours**

Amine and alkene synthesis, umpolung carbonyl group reactivity in synthesis, Protection and deprotection of hydroxy, carbonyl, amine and carbon-carbon multiple bonds; chemo- and

regioselective protection and deprotection; illustration of protection and deprotection in synthesis.

Unit - III: Chemistry of heterocyclic compounds **12 Hours**

Numbering of heterocyclic compounds, structure, preparation and reactions of heterocyclic compounds (pyrrole, furan, thiophene, 1,2- and 1,3-azoles, triazoles, pyridine, pyryliums, diazines, triazine), Fused heterocycles containing one or more heteroatoms (indoles, benzofurans, benzothiophene, benzenellated azoles, quinolines, isoquinolines, benzopyrones).

Unit - IV: Green chemistry and Natural Products Chemistry **12 Hours**

Green chemistry: Importance and synthetic reactions of green solvents as reaction medium (water, $ScCO_2$, Polyethylene glycol)- Ionic liquids (alkylation and coupling reactions)- microwave assisted organic synthesis.

Steroids: Sterols and bile acids, estrogens, androgens: **Alkaloids:** Structure, synthesis Reserpine, Morphine.**Terpenoids:**Zingiberene, Squalene. Natural Pigments: structural confirmations of flavones, flavanones, isoflavones, xanthones, quinones.

Unit - V: Bioorganic Molecules **12 Hours**

Molecular structure and numbering of Purines (Uric acid, Cytosine, Adenine, Guanine) &Pyrimidines (Uracil, thymine & Cytosine). Nucleic acids-Functions of nucleic acids-Structural features of nucleosides and nucleosides- structure and biological implications of DNA and RNA (m-RNA, t-RNA and r-RNA) - replication of DNA - Genetic code and informational theory. Proteins – standard amino acids - peptide synthesis-End group analysis (Sanger's method, Edmon's degradation) - primary, secondary, tertiary structure and quaternary structure of proteins and their determination.

References

1. William Caruthers and Iain coldham, Modern methods of organic synthesis, IV Edition, Cambridge university press, 2004.
2. Michael B Smith, Organic Synthesis, Tata Mc Graw Hill, 1994.
3. Stuart warren, Organic synthesis the disconnection approach,Wiley India edition, 2004.
4. V K Ahluwalia and Renuagarwal Organic synthesis special techniques, second edition, Narosa Publishing House, 2007.
5. J.March, Advanced Organic Chemistry, 4thEdn, Wiley Publications, 1992.
6. Gurdeep R Chatwal, Organic Chemistry of Natural Products, Vol 1 & 2, revised Edn., Himalaya Publications, 2009.
7. O.P Agarwal, Chemistry of Organic Natural Products, Vol 1 & 2, Goel Publications, 28thEdn., 2002.
8. S.P.Bhutani, Chemistry of Biomolecules, Ane Books, 2009.
9. George S. Zweifet, Michael H Nantz, Modern Organic Synthesis – an introduction, W.H.Freeman and Company, 2007.
10. Raj K Bansal, Heterocyclic chemistry, fourth edition, New Age International Publishers, 2005.

Mapping of CO with PO and PSO

CO	Programme Specific Outcomes (PSO)						Programme Outcomes (PO)					Mean Scores of COs
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	

CO1	3	3	3	2	2	2	3	3	2	2	2	2.4545455
CO 2	3	3	2	2	2	2	3	2	2	2	2	2.2727273
CO 3	3	3	3	3	2	3	3	3	3	2	2	2.7272727
CO 4	3	2	3	3	3	3	3	2	3	3	1	2.6363636
CO 5	3	2	3	2	2	3	2	2	3	3	1	2.3636364
CO 6	3	3	3	3	2	2	3	3	3	3	1	2.6363636
										Mean Overall Score		2.515152
										Result		

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	20
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	10

CH1018 - Inorganic Chemistry-IV

Course Code	**Type**	**Total Hours**	**Lecture**	**Tutorial**	**Practical**
CH1018	Theory	60	55	5	0
		Course Name		**Max Marks**	**Credits**
		INORGANIC CHEMISTRY IV		100	4

Course Objectives:

- To illustrate the structure and bonding nature of Organometallic compounds and their reactions.
- To study the various industrial importance and applications of organometallic compounds.
- To study the fundamentals of nuclear chemistry and learn about the working principle of nuclear reactor.
- To learn the MO theory and spectral behaviour in coordination compounds.
- To learn the structure and function of bio – inorganic compounds.
- To study the application of metals in medical field.

Course Outcomes

At the end of the course, the students will be able to:

S. NO	Course Outcomes Statement	Cognitive level
CO1	Students can explain the bonding in organometallic compounds and illustrate the different types of reactions of complexes	**K1, K2 & K3**
CO2	Students can analyse the catalytic properties of organometallic compounds and to integrate the application of these compounds in catalysis.	**K4 & K6**
CO3	Students will be able to discuss the aspects of nuclear chemistry and applications of nuclear fission and fusion reactions	**K2 & K3**
CO4	Students can understand and apply the MO theory and construct the Orgel and Sugano - Tanabe diagrams for coordination complexes	**K1, K3 & K6**
CO5	Students can analyse the electronic spectra of complexes and can able to evaluate the Δ_0 and β	**K4 & K5**
CO6	Students can review the importance of metallo biochemistry and conclude the role of metals in medicine	**K4 & K5**

Course Content

Unit - I: Organometallic Chemistry – I **12 Hours**

Carbon donors: Alkyls and aryls metalation, bonding in carbonyls and nitrosyls, chain and cyclic donors, olefins, acetylene and allyl system synthesis structure and bonding Metallocenes. Reactions: Association substitution, addition and elimination ligand promotion, electrophilic and nucleophilic attack on ligands. Carbonylation.Decorboxylation, oxidative addition and fluxionality.

Unit - II: Organometallic Chemistry – II **12 Hours**

Catalysis: Hydrogenation of olefins (Wilkinson's catalyst), hydroformylation of olefins using cobalt or rhodium catalysts (oxo process), oxidation of olefins to aldehydes and ketones (Wacker process) polymerization (Zeigler – Natta Catalyst); cyclooligomerisation of acetylene using nickel catalyst (Repee's catalyst); polymer-bound catalysts.

Unit - III: Nuclear Chemistry – I **12 Hours**

Nuclear Reactions: Types, reactions, cross section, Q-value, threshold energy, compound nucleus theory: high energy nuclear reactions, nuclear fission and fusion reactions as energy sources - comparison between nuclear fission and fusion - Liquid drop and the shell models of the nucleus. photonuclear and thermo nuclear reactions.

Stellar energy: synthesis of elements, hydrogen burning, carbon burning. Nuclear Reactors: fast breeder reactors, particle accelerators, linear accelerators, cyclotron and synchrotron. Radiation chemistry - interaction of radiation with matter - linear energy transfer (LET) - Bethe's equation - Chernkov radiation - absorption coefficient - linear and mass absorption coefficient.

Unit - IV: Coordination Chemistry **12 Hours**

Molecular orbital theory and energy level diagrams, Evidence for metal-ligand orbital overlap, Jahn-Teller distortion, charge - transfer spectra.

Term states for "d" - ions, energy diagrams, concept of weak and strong field ligands d-d transitions, Orgel and Sugano - Tanabe diagrams, spin orbit coupling, nephelauxetic effect, spectral and magnetic characteristics of transition metal complexes.

Unit - V: Bio-Inorganic Chemistry – II **12 Hours**

Characterization of O_2 bound species by Raman and infrared spectroscopic methods; representative synthetic models of heme and non-heme systems.Electron transfer proteins - active site structure and functions of ferredoxin, rubridoxin and cytochromes, and their comparisons.Vitamin B_{12} and cytochrome P_{450} and their mechanisms of action.Metals in medicine - therapeutic applications of cis-platin, radio-isotopes (e.g., Tc& I_2) and MRI agents.

Text Books

References

1. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, John Wiley and Sons 5^{th} Edition, 1988.
2. K.F. Purcel and J.C. Kotz, Inorganic Chemistry, W.Saunders Co., 1977.
3. EAV. Epsworth, D.W.H. Rankin and S. Cradock, Structural methods in Inorganic Chemistry, Blackwell Scientific Publ. 1987.
4. G. Coates M.I. Green and K. Wade. Principles of Organo metallic chemistry, Methven Co., London 1988.
5. R.B. Jordon, Reaction mechanism of Inorganic and Organo metallic system, OUP, 1991.
6. P. Powell, Principles of Organo metallic chemistry, Chappmanan Han. 1998.
7. R.C. Mehrothra, A. Singh, Organo Metallic Chemistry, Wiley Eastern Co., 1992.
8. R.B. Heslop and K. Jones, Inorganic Chemistry, Elsevier Scientific Publ. 1976.
9. H.A. O Hill and P. Day, Practical methods in advanced inorganic chemistry, John Wiley, 1968.
10. G. Frielander, J.w. Kennedy and J.M. Miller, Nuclear and Radiochemistry, John Wiley and Sons, 1981.
11. HariJeevanArnikar , Essentials of Nuclear Chemistry, New Age International (P) Ltd., 2005.
12. S. J. Lippard and J. M. Berg, Principles of Bioinorganic Chemistry, Univ. Science Books, 1994.
13. W. Kaim and B. Schwederski, Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life (An introduction and Guide), John Wiley & Sons, 1994.

Online Resources

1. http://nptel.ac.in/courses/104101079/
2. http://eacharya.inflibnet.ac.in/ Inorganic Chemistry (I/II/III)

Mapping of CO with PO and PSO

CO	Programme Specific Outcomes (PSO)						Programme Outcomes (PO)					Mean Scores of COs
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	
1	3	3	3	3	2	2	3	3	3	2	3	2.7
2	3	3	3	3	3	3	3	3	3	3	2	2.9
3	3	3	3	3	2	2	3	3	3	2	3	2.7
4	3	3	3	3	2	2	3	3	3	2	3	2.7
5	3	3	3	3	3	2	3	3	3	2	3	2.8

6	3	3	3	3	3	3	3	3	3	3	2	2.9
											Mean Overall Score	2.8
											Result	**High**

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	20
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	10

CH1019 – PHYSICAL CHEMISTRY III

Course Code	Type	Total Hours	Lecture	Tutorial	Practical
CH1019	Theory	75	65	10	0
		Course Name		**Max Marks**	**Credits**
		PHYSICAL CHEMISTRY III		100	4

Objectives:

- To study the importance and theory of ionic conductance.
- To learn the concepts of electrode - electrolytic interface and structure of the double layer.
- To learn the mechanism of electrode reactions and electron transfer process.
- To illustrate the importance and industrial applications of different types of fuel cells.
- To understand the concepts of various methods of energy calculation in many electron systems.
- To apply the VB, MO and HMO theory to simple many electrons system.

Course Outcomes

At the end of this course, the students will be able to

CO. No.	Course Outcome Statement	Cognitive Level
CO 1	Comprehend the concept of activity coefficient and ionic strength of electrolytes and to evaluate and relate the mean ionic activity coefficient of electrolytes.	**K3 &K5**
CO 2	Describe the structure of the electrified interface, and define and describe mathematically the capacitance of various model of double layer	**K1 & K2**
CO 3	Calculate and analyse the electron transport and kinetic overpotential for electrodes at which a one-step and multi-step electron reaction takes place.	**K3 & K4**
CO 4	Know about the behaviour of ions in solution phase under different conditions and its application towards different energy storage devices	**K1 & K3**
CO 5	Describe many-electron atoms with the various approximation methods and evaluate the energy and construct wave function of many electron atoms with suitable methods	**K2, K5 & K6**
CO 6	Describe the chemical bonding quantum mechanically with VB, MO and HMO theory and able to calculate the pi electron energy to simple systems.	**K2 & K3**

Course Content

Unit - I: Electro Chemistry – I **15 Hours**

The nature of electrolytes –ion-ion and ion-solvent interactions. The Debye- Huckel theory of ion -ion interaction. Mean ionic activity and mean ionic activity coefficient - activity coefficient of strong electrolytes - determination of activity coefficient by electrochemical method.

Debye Huckel limiting law derivation and verification - limitation of Debye Huckel limiting law at appreciable concentrations of electrolytes - Debye - Huckel – Onsager equation

derivation and validity. Conductivity at high frequency (Debye-Falkenhagen effect) and at high field strength (Wien effect).

Unit - II: Electro Chemistry – II **15 Hours**

Electrode - electrolyte interface - adsorption at electrified interface - electrical double layer - electro capillary phenomenon - Lippmann equation - Structure of double layers - Helmholtz - Perrin, Guoy - Chapman and Stern model of electrical double layers.

Mechanism of electrode reactions - polarization and over-potential - the Butler-Volmer equation for one step and multistep electron transfer reactions - significance of electron exchange current density and symmetry factors - transfer coefficient and its significance.

Unit - III: Electro Chemistry – III **15 Hours**

Mechanism of the hydrogen and oxygen evolution reactions. Diffusion - Fick's law of diffusion - Effect of ionic association on conductance- Electro-kinetic phenomena – Electro-osmosis. Streaming potential – electrophoresis.

Corrosion and passivation of metals - Pourbaix diagram - Evan's diagram - Modern Batteries – Nickel-metal hydride batteries, lithium secondary batteries. Fuel cells – History – Types of fuel cells – H_2 / O_2 fuel cells – Direct methanol fuel cells– Alkaline fuel cells – phosphoric acid fuel cells - Molten carbonate fuel cells (High temperature fuel cell) – Proton exchange membrane fuel cells (PEM Cells). electrodeposition - principle and applications.

Unit - IV: Applications of Quantum Chemistry – III **15 Hours**

Approximation methods - Need for approximation – Perturbation Theory – Time independent Perturbation (First order only) - Application of Perturbation theory to particle in one dimensional box, anharmonic oscillator and helium atom – Variation method – principle – methodology and its applications to hydrogen and helium atoms. Semi - empirical methods - Slater orbital and HFSCF methods.

Unit - V: Applications of Quantum Chemistry – IV **15 Hours**

The Born - Oppenheimer approximation – VB and MO theories as applied to hydrogen molecular ion (H_2^+) and hydrogen molecule – coulomb integral an exchange integral and an overlap integral. Construction of sp, sp2 and sp3 hybrid orbitals - Huckel molecular orbital theory – principles and applications to ethylene, butadiene and benzene. Huckel calculation of pi- electron energies.

TEXT BOOKS

1. J.O.M. Bokris and A. K. N. Reddy, Electrochemistry, Vol. 1, 2A and 2B, Plenum, New York, 1977
2. Donald A McQuarrie, Quantum chemistry, Indian Edition, Viva Books Private Limited 2005.

REFERENCES

1. S. Glasstone, Introduction to Electrochemistry, Affiliated East West Press, New Delhi 1960.
2. D.R.Crow, Principles and Applications to Electrochemistry, Chapman and Hall 1991
3. ViswanathanB.,M.AuliceScibioh, Fuel Cells-Principles and Applications**,** Universities Press, Hyderabad, India, 2006
4. J. Robbins, Ions in Solution - An Introduction of Electrochemistry, Clarendon Press, Oxford, 1972
5. B.K.Sharma, Electrochemistry, Krishna Education publication, 2019.
6. R.K. Prasad, Quantum Chemistry, 1st Edition, New Delhi, Wiley Eastern Ltd, 1992.

7. Anderson J. M. Mathematics of Quantum Chemistry, I Edition, Massachusetts, A.Benjamine Inc.,1966

Online resource:

1. http://eacharya.inflibnet.ac.in/ Physical Chemistry-I (Quantum Chemistry) [32 lectures]

Mapping of CO with PO and PSO

CO	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)						
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**Mean Scores of COs**
CO1	3	3	3	2	2	3	3	3	3	3	2	2.7
CO2	3	2	3	3	2	3	3	2	3	3	2	2.6
CO3	3	3	2	2	2	3	3	3	3	2	3	2.7
CO4	3	3	3	2	3	3	3	3	3	3	3	2.9
CO5	3	3	2	3	2	2	3	3	3	3	2	2.5
CO6	3	2	3	3	2	3	3	3	3	3	3	2.7
Mean Overall Score												2.6
Result												High

Assessment Pattern

Bloom's Category	CA Tests (Marks Allotment)		Term End Exam (100) Marks Allotment
	I CA (50)	II CA (50)	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	20
Analyze	10	10	10
Evaluate	5	5	10
Create	5	5	10

PCH1013 - Organic Chemistry Practical – II

Course Code	Type	Total Hours	Lecture	Tutorial	Practical
PCH1013	PRACTICAL	60	4	-	56
		Course Name		**Max Marks**	**Credits**
		ORGANIC CHEMISTRY PRACTICALS - II		100	4

Course Objectives

- To learn practical skills about the estimation of some organic compounds using chemical procedures

Course Outcomes:

Sl. No.	Course Outcome Statements	Knowledge level
	On successful completion of this Course, students will be able to	
CO1	Analyze the unknown concentration of the given substance	K3
CO2	Synthesis and prepare simple organic compounds using a two stage process	K3, K6
CO3	Relate and articulate the fundamental principles of volumetric estimations	K5
CO4	Examine and evaluate data collected to determine the identity, purity, and yield of products	K5
CO5	Develop methods for the estimation of organic substances volumetrically	K6
CO6	Investigate and interpret simple organic compounds using IR, UV, Mass and NMR spectroscopic data	K2

Course Content

Estimations

- Estimation of phenol
- Estimation of Aniline
- Estimation of Ketone
- Estimation of Glucose
- Saponification value of oil
- Iodination value of oil

Preparations (double stage)

- Sym. tribromo benzene from Aniline
- Benzanilide from benzophenone
- m-nitro benzoic acid from methyl benzoate
- 2,4- dinitro phenyl hydrazine from p-nitro chlorobenzene

SPECIAL INTERPRETATION OF ORGANIC COMPOUNDS UV, IR, PMR AND MASS SPECTRA OF THE FOLLOWING 15 COMPOUNDS (**any 10 may be chosen**)

- 1,3,5- Trimethyl benzene
- Pinacolane
- n-Propylamine
- p-Methoxy benzyl alcohol

- Benzyl bromide
- Phenylacetone
- 2-Methoxyethyl acetate
- Acetone
- Isoopropyl alcohol
- Acetaldehyde diacetate
- 2-N,N-Dimethylamino ethanol
- Pyridine
- 4-Picoline
- 1,3-dibromo - 1, 1- dichloropropene
- Cinnamaldehyde

References

1. N.S. Gnanapragasam and B. Ramamoorthy, "Organic Chemistry Lab Manual", S. Visvanathan Printers & Publishers,2006.
2. Arthur I. Vogel, "A Textbook of Practical Organic Chemistry", ELBS, 1985.

Mapping of CO with PO and PSO

CO	Programme Specific Outcomes (PSO)						Programme Outcomes (PO)					Mean Scores of COs
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	
CO1	3	2	3	3	3	1	3	3	2	3	1	2.4545455
CO 2	3	2	2	3	2	2	3	2	3	3	2	2.4545455
CO 3	3	3	3	3	2	1	3	3	2	3	2	2.5454545
CO 4	3	3	3	3	3	1	3	2	2	3	2	2.5454545
CO 5	3	2	2	3	3	1	3	2	2	2	2	2.2727273
CO 6	3	2	3	3	2	1	3	2	2	2	3	2.3636364
										Mean Overall Score		2.439394
										Result		

Scheme of Valuation

External Component: 50 Marks

S. No	Components	Mark Distribution
1	Estimation	20
2	Preparation	15
3	Interpretation of Spectra	05
4	Viva-Voce	05
5.	Record	05
	Total Marks	**50 Marks**

Mark distribution for components one and two in External

i) Estimation error percentage for estimation

<2% - 20 marks

2-3% - 20-15 marks

3-4% - 15-10 marks
>4% - 05 marks

ii) Two stage preparation:

Stage -1 crude = 06 Marks
Stage -2 crude = 06 Marks
Re-crystallization = 03 Marks

Internal Component: 50 Marks

S. No	Components	Mark Distribution
1	Estimation	15
2	Two stage Preparation	15
3	Viva-voce	05
4	Theory of Practicals	05
5	Model practical examination	10
	Total Marks	**50 Marks**

Conditions for Internal Component:

For Component **1** & **2,** 60% of the work done has to be taken in account
One Viva and one TOP per semester has to be conducted and taken into account

<u>Mark distribution for components one and two in Internal</u>

i) Estimation error percentage for estimation

<2% - 15 marks
2-3% - 15-10 marks
3-4% - 10-05 marks
>4% - 05 marks

ii) Two stage preparation:

Stage -1 crude = 06 Marks
Stage -2 crude = 06 Marks
Re-crystallization = 03 Marks

PCH1014 - Inorganic Chemistry Practicals – II

Course Code	Type	Total Hours	Lecture	Tutorial	Practical
PCH1014	PRACTICAL	60	4	-	56
		Course Name		**Max Marks**	**Credits**
		INORGANIC CHEMISTRY PRACTICALS - II		100	4

Course Objectives:

3. To learn the methods and techniques to estimate inorganic metals.

Course Outcomes

At the end of the course, the students will be able to:

S. NO	Course Outcomes Statement	Cognitive level
CO1	Gain knowledge about the methods and techniques to estimate inorganic metals	**K1, K2**
CO2	Analyse the complex materials, alloys or ores and ions	**K5**
CO3	Detecting the amount of mixtures of iron -magnesium, iron – nickel, copper - nickel and copper – zinc by Gravimetric and Volumetric	**K4**
CO4	Understand Photoelectric method	**K2**
CO5	**S**olve the spectra and interpreting it	**K2, K6**

Course Content

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

Complexometric Titrations (EDTA) - Estimation of Ca, Mg and Zn.

- Preparation of the followings:
- Potassium tris (oxalate) aluminate (III) trihydrate
- Tris (thiourea) copper (I) chloride
- Potassium tris (oxalaato) chromate (III) trihydrate
- Sodium bis(thiosulphato) cuprate (I)
- Tris (thiourea) copper (I) sulphate
- Sodium hexanitrocobaltate (III)
- Chloropentammine cobalt (III) chloride
- Bis (acetylacetonato) copper (II)
- Hexamminenickel (II) chloride
- Bis (thiocyanato) pyridine manganese (II)

Text Books

1. V. V. Ramanujam, Inorganic Semimicro Qualitative Analysis; 3rd ed., The National Publishing Company, Chennai, 1974.
2. Vogel’s Text book of Inorganic Qualitative Analysis, 4 th Ed, ELBS, London, 1974.

Mapping of CO with PO and PSO

CO	Programme Specific Outcomes (PSO)						Programme Outcomes (PO)					Mean Scores of COs
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	
1	3	2	3	2	3	3	3	2	3	3	1	2.5
2	3	2	2	3	3	3	3	3	3	3	1	2.6
3	3	2	2	2	3	3	3	2	2	3	1	2.4
4	3	2	3	3	3	2	3	3	3	3	1	2.6
5	3	3	2	2	3	2	3	3	2	3	1	2.5
6	3	2	3	2	3	3	3	2	3	3	1	2.5
Mean Overall Score												2.5
Result												**High**

Scheme of Valuation

External Component:

Components	Marks
Volumetric and Gravimetric	20+20
Colorimetric analysis	20
Spectral interpretation & short procedure	10+10
Viva	10
Record	10
Total	**100 Marks**

Total Marks 100 is converted in to 50 marks

Internal Component:

Components	Marks
Volumetric and Gravimetric	10+10
Colorimetric analysis	10
Model exam	10
Theory of practical	05
Viva	05
Total	**50 Marks**

Error Analysis

Volumetric analysis

< 2 - 20 marks
2-3 - 20 - 10 marks
3-4 -10 - 05 marks
>4 - 05 marks

Gravimetric analysis

< 2 - 20 marks
2-3 - 20 - 10 marks
3-4 -10 - 05 marks
>4 - 05 marks

Colorimetric Analysis

< 2 - 20 marks
2-3 - 20 - 10 marks
3-4 -10 - 05 marks

>4 - 05 marks

PCH1015 – PHYSICAL CHEMISTRY PRACTICALS II

Course Code	Type	Total Hours	Lecture	Tutorial	Practical
PCH1015	PRACTICAL	60	4	-	56
		Course Name		**Max Marks**	**Credits**
		PHYSICAL CHEMISTRY PRACTICALS - II		100	4

Objectives:

- To understand the principles that govern the basic electrochemical experiments
- To learn the physical methods used in determination of parameters such as pH, conductance and EMF etc.

Course Outcomes

At the end of this course, the students will be able to

CO. No.	Course Outcome Statement	Cognitive Level
CO 1	**Define** the principle of conductometric and potentiometric titration.	K1
CO 2	**Explain** the conductometric titration of strong acid, weak acid and mixture of acids with strong Base.	K2
CO 3	**Determine** the equivalent conductance of strong electrolytes at infinite dilution and dissociation constant of weak electrolyte	K3
CO 4	**Calculate** the pH of a buffer solution using emf measurements	K4
CO 5	**Prepare** a salt bridge for potentiometric experiments.	K5
CO 6	Verify the various laws like Ostwald's dilution law and Kohlrausch's law conductometrically and design working electrodes	K6

Course Content

Conductivity Measurements

1. Determination of equivalent conductance of a strong electrolyte and verification of Debye - Huckel - Onsager Equation
2. Verification of Debye-Huckel limiting law
3. Verification of Ostwald's Dilution law for a weak electrolyte. Determination of PK values of weak acids and weak bases.
4. Conductometric titrations between acid (simple and mixture of strong and weak acids) - base, precipitation titrations including mixture of halides.

E.M.F Measurements

5. Determination of standard potentials (Copper & Zinc)
6. Determination of thermodynamic quantities from EMF measurements - potentiometric titrations.
7. Determination of pH and calculation of pKa.
8. Determination of stability constant of a complex.
9. Determination of solubility product of a sparingly soluble salt. Redox titrations.

10. Precipitation titration of mixture of halides by EMF measurements.

Spectroscopy

11. Experiments given only to familiarize the interpretation of spectra provided. Interpretation of simple UV-Visible spectra of simple molecules for the calculation of molecular data and identification of functional groups (5 typical spectra will be provided).
12. IR and NMR spectral calculations of force constant - identification and interpretation of a Compound.

List of Experiments Suggested for Physical Chemistry Practical - II

Typical list of possible experiments is given. Experiments of similar nature and other experiments may also be given. The list given is only a guideline. Any 15 experiments have to be performed in a year.

1. Determination of the equivalent conductance of a weak acid at different concentrations and verify Ostwald's dilution law and calculate the dissociation constant of the acid.
2. Determination of equivalent conductance of a strong electrolyte at different concentrations and examine the validity of the Onsager 's theory as limiting law at high dilutions.
3. Determination of the activity co-efficient of Zinc ions in the solution of 0.002M Zinc sulphate using Debye-Huckel limiting law.
4. Determination of the solubility product of silver bromate and calculate its solubility in water and in 0.01 M $KBrO_3$ using Debye-Huckel limiting law.
5. Conductometric titrations of a mixture of HCl, CH_3COOH and NaOH.
6. Determination of the dissociation constant of an acid at different dilution.
7. Determination of the solubility of the lead iodide in water, 0.04 M KI and 0.04 M Pb $(NO_3)_2$ at 298 K
8. Determination of the solubility product of lead iodide at 298 K and 308 K and calculate the molar heat of solution of lead iodide.
9. Compare the relative strength of acetic acid and mono chloroacetic acid by conductance method.
10. Determine the basicity of organic acids (oxalic /benzoic).
11. Determine the electrode potentials of Zn and Ag electrodes in 0.1M and 0.001M solutions at 298 K and fine the standard potentials for these electrodes and test the validity of Nernst equation.
12. Determine the activity co-efficient of an electrolyte at different molalities by EMF measurements.
13. Determine the dissociation constant of acetic acid titrating it with sodium hydroxide using quinhydrone as an indicator electrode and calomel as a reference electrode.
14. Study of the electrolytic separation of metals (Ag, Cu, Cd and Zn)
15. Determine the strength of a given solution of KCl using differential potentiometric titration technique.
16. Determine the dissociation constant of acetic acid in DMSO, DMF, acetone and dioxane by titrating it with KOH.
17. Determine the transport number of Ag ions and nitrate ions by Hittorf's method.
18. Determine the transport number of cadmium ions and sulphate ions by measuring emf of concentration cells with and without transference.
19. Determine the dissociation constant of monobasic or dibasic acid by all the Alber-Serjeant method.
20. Determine the pH of the given solution with the help of indicators using buffer solutions and by colorimetric method.
21. Perform acid-base titration in a non-aqueous medium.

22. Determine the pH of a given solution by EMF method using glass and calomel electrodes and evaluate pKa value of an acid.
23. Determine the pH of a given solution by emf methods using hydrogen electrode and quinhydrone electrode.
24. Estimate the concentration of cadmium and lead ions by successive reduction in polarography.
25. Verify Illkovic equation.
26. Determine lead ion by amperometric titrations with potassium dichromate.
27. Determine ferric ion by amperometric titration.
28. Determine pH value of an acid-base indicator (methyl red) by colorimetry.
29. Determine the composition and instability constant of a complex by mole ratio method.
30. By colorimetry, determine simultaneously Mn and Cr in solution.
31. Study the effect of solvent on the conductivity of $AgNO_3$/acetic acid and determine the degree of dissociation and equilibrium constant in different degree of dissociation and mixtures (DMSO, DMF, dioxane, acetone, water) and test the validity of Debye-Huckel Onsager's equation.
32. Determine the solubility of $Ca(TiO_3)_2$ in deionized water and in dilute solution of KCl at 298 K. Determine the solubility product graphically.
33. Determine the equivalent conductivity of a Ca electrolyte and dissociation constant of the electrolyte.
34. Determine the equivalent dissociation constant of a polybasic acid.
35. Calculate the thermodynamic parameters for the reaction Zn + H_2SO_4 -------ZnSO4 + H2 by EMF method.
36. Determine the formation constant of silver-ammonia complex and stoichiometry of the complex potentiometrically.
37. Determine the stability constant of a complex by polarographic method.
38. Determine the g value from a given ESR spectrum.

Text books

1. B. Viswanathan and P.S. Raghavan, Practical Physical Chemistry, Viva Books, New Delhi,2009.
2. K. Sundaram, Practical Chemistry, S. Viswanathan Co. Pvt., 1996.

Mapping of CO with PO and PSO

CO	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)						
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**Mean Scores of COs**
CO1	3	3	2	2	2	3	2	3	3	2	1	2.36
CO2	3	3	2	2	2	3	2	3	3	2	1	2.36
CO3	3	3	3	2	2	3	3	3	3	2	1	2.55
CO4	3	3	3	3	2	3	2	3	3	3	1	2.64
CO5	3	3	3	3	2	3	2	3	3	3	1	2.64
CO6	3	3	3	3	3	3	2	3	3	3	1	2.73
Mean Overall Score												2.55
Result												High

Scheme of Valuation

External Component (50 Marks):

Name of the component	Marks
Spectral Interpretation	10
Experiment	30
Record	05
Viva – Voce	05
Total	**50**

Internal Component (50 Marks):

Name of the component	Marks
Regular practical (Average of best 70%)	30
Theroy of practical (2)	05
Viva – Voce (2)	05
Model exam	10
Total	**50**

Marks distribution for Experiment / Regular Practical – 30 marks

Name of the component	Marks
Short procedure, formula and model graph	05
Calculation and graph	05
Result & accuracy	20
Total	**30**

Marks for results & accuracy for all experiments:

Error	Marks
≤5%	20
5.1-10%	20-10
>10%	5

Mark distribution PG – 2021 onwards
CA Components (PG)

Component	Marks
I CA	15
II CA	15
MCQ	10
Assignment/Seminar/Quiz Snap Test / problem solving/ Notes preparation / Journal paper reference (minimum any two)	10
Total	**50**

Question paper pattern
Pattern of CA Question Paper (PG)

Section – A
Answer ALL the questions 6 x 2 = 12 Marks

Section – B
Answer ALL the questions. Either or Type 3 x 6 = 18 Marks

Section – C
Answer ANY TWO questions out of Three Questions 2 x 10 = 20 Marks

Question paper pattern
Pattern of Semester Question Paper (PG)

Section – A
Answer ALL the questions 10 x 2 = 20 Marks

Section – B
Answer ALL the questions. Either or Type 5 x 7 = 35 Marks

Section – C
Answer Any THREE Questions out of FIVE Questions 3 x 15 = 45 Marks