Mahatma Education Society's

Pillai HOC College of Arts, Science & Commerce (Autonomous)
Rasayani

Affiliated to University of Mumbai
NAAC Accredited with "A+" Grade in cycle II
ISO 9001:2015 Certified

SYLLABUS

M.Sc. Organic Chemistry

As per National Education Policy 2020

Academic Year 2026-27

Mahatma Education Society's

Pillai HOC College of Arts , Science & Commerce,
Khalapur HOC Colony Rd, Rasayani
(Autonomous)
NAAC Accredited with "A+" Grade in Cycle II

Sr. No	Name	Category	Signature
1	Dr. Dinesh Navale	Expert nominated by the Vice-Chancellor	
2	Ms. Komal Kamble	Subject experts from outside the parent University	
3	Dr. Anand K Singh	Subject experts from outside the parent University	Dr. Anand Singh
4	Dr. Bapu Gawade	Industry representative	
5	Mr. Rushikesh Ghodvinde	College Alumnus	
6	Dr. Rinkoo Shantnu	Principal	
7	Mr. Binit Kumar	Vice principal	Mr. Binit Kumar
8	Dr. Richa Chauhan	Chairperson	
9	Ms. Remya MG	Member (Env. Sci.)	
10	Dr. Archana Bhagwat	Member (Chemistry)	
11	Dr. Sulochana Bhalekar	Member (Chemistry)	
12	Dr. Vineetha P	Member (Physics)	
13	Ms. Komal Gunjal	Member (Chemistry)	
14	Ms. Shruti C. Hogale	Member (Physics)	
15	Ms. Juilee Shirke	Member (Physics)	

INTRODUCTION TO MASTER OF SCIENCE IN ORGANIC CHEMISTRY (M.Sc. OC)

The Master of Science in Organic Chemistry is a postgraduate programme that equips students with advanced insight into organic molecules—how they are structured, how they react, how they are synthesized, and how they are characterized and applied. It builds upon the knowledge gained during an undergraduate degree in Chemistry or a related field, and deepens the study of carbon-containing compounds and their transformations, using both theoretical concepts and practical laboratory techniques.

AIMS AND OBJECTIVES

The programme aims to enable students to:

Understand fundamental & advanced concepts in organic chemistry — reaction mechanisms, stereochemistry, functional groups, aromaticity, etc.
Develop laboratory skills for synthesis, purification, analysis, and structural elucidation of organic compounds using modern instrumental techniques.
Gain experience in research and innovation via projects/thesis work, enabling them to design experiments, solve problems, and communicate results.
Learn specialized and emerging topics, such as green chemistry, natural products, heterocyclic compounds, organometallic chemistry, computational tools, etc.
Prepare for careers in academia, industry, or research — whether in pharmaceutical and chemical companies, government labs, quality control/assurance, teaching, or further higher studies.

PROGRAM OUTCOMES (PO)

Sr. No	PO Title	POs in brief
PO 1	Fundamental Knowledge Acquisition	Graduates will demonstrate a comprehensive and foundational knowledge of their chosen discipline along with an awareness of interdisciplinary connections.
PO 2	Critical Thinking and Analytical Reasoning	Graduates will be able to analyse complex problems, synthesize data from multiple sources (qualitative and quantitative), and employ logical reasoning to formulate well-supported conclusions and arguments.
PO 3	Effective Communication	Graduates will exhibit proficiency in both written and oral communication, articulating ideas clearly, persuasively, and ethically to diverse audiences
PO 4	Problem Solving	Graduates will possess the ability to identify, formulate, and design solutions for real-world problems in their professional or social contexts, applying relevant theoretical knowledge and practical skills.
PO 5	Information and Digital Literacy	Graduates will demonstrate the capability to locate, evaluate, and effectively use information from various sources, and utilize modern tools and Information and Communication Technology (ICT) for professional and academic tasks.
PO 6	Research Skills and Scientific Temperament	Graduates will develop a sense of inquiry and research methodology, including the ability to design experiments (where applicable), collect and analyse data, and interpret results while maintaining scientific rigor and intellectual honesty.
PO 7	Ethical Reasoning and Professional Integrity	Graduates will recognize ethical dilemmas, commit to professional and academic ethics, and demonstrate an understanding of moral and social responsibilities in their personal and professional conduct.
PO8	Employability and Professional Skills	Graduates will acquire the necessary job-ready skills, managerial competencies, and professional values to secure gainful employment or pursue advanced education in their respective fields.
PO 9	Environmental and Sustainability Consciousness	Graduates will understand the importance of environmental conservation and sustainable development, displaying responsibility toward ecological challenges and advocating for healthy environmental practices.
PO 10	Life-Long Learning	Graduates will develop the capacity for independent and self-directed learning to continuously upgrade their knowledge and skills, enabling them to adapt to rapid technological and societal changes.

PO 11	Civic and Social Responsibility	Graduates will act as responsible citizens with an informed awareness of constitutional values, engaging proactively in community development and addressing social needs.
PO 12	Empathy and Social Intelligence	Graduates will be able to cultivate and demonstrate affective, interpersonal, social and emotional intelligence.

PROGRAM SPECIFIC OUTCOMES (PSO)

PSO's No.	PSO in brief
PSO1	Gain knowledge of the advanced concepts in the branch of chemistry, scrutinize and accomplish a solution to problems encountered in the field of research and analysis.
PSO2	Apply the basic knowledge of chemistry to perform various tasks assigned to them at the workplace in industry and academia to meet the global standards.
PSO3	Deduce qualitative and quantitative information of chemical compounds using advanced spectroscopic methods which can further be analyzed using practical skills inculcated in them during the course.
PSO4	Design, analysis, synthesis and interpretation data to provide solutions to different industrial problems by working in the multi-disciplinary areas of chemical sciences.

Evaluation Pattern

Marking Code	Marking Scheme
A	50 Marks Semester End Exam, 50 Marks Continuous Assessment (distributed within 20 Marks Class Test, 20 Marks Research paper & Presentation and 10 Marks Assignment)
B	100 Marks research Project/OJT Examination (50 Marks Semester End Viva Exam, 50 Marks Continuous Assessment)
C	150 Marks Research Project Assessment (75 Marks Semester End Viva Exam, 75 Marks Continuous Assessment)
D	50 Marks of Continuous Assessment (20 Marks Class Test, 20 Marks Research paper & Presentation and 10 Marks Assignment)
E	100/50 Marks Practical Examination (distributed within 40 Marks Practical Module, 05 Marks Journal, 05 Marks Viva)

Course Structure

Semester I							
Course Code	**Course Type**	**Course Title**	**Theory/ Practical**	**Marks**	**Credits**	**Lectures/ Week**	**Evaluation Pattern**
HPSCY101	Major	Inorganic Chemistry I	Theory	100	4	4	A
HPSCY102	Major	Organic Chemistry I	Theory	100	4	4	A
HPSCY103	Major	Analytical Chemistry I	Theory	100	4	4	A
HPSCY108	Major	Research Methodology in Chemistry	Theory	100	4	4	A
HPSCY105	Elective	Physical Chemistry I	Theory	50	2	2	D
HPSCY106 P	Major-Practical	Organic & Analytical Chemistry Practical I	Practical	100	2	4	E
HPSCY107 P	Elective-Practical	Physical & Inorganic Chemistry Practical I	Practical	50	2	4	E
Total				600	22		**

Semester II							
Course Code	**Course Type**	**Course Title**	**Theory/ Practical**	**Marks**	**Credits**	**Lectures / Week**	**Evaluation Pattern**
HPSCY151	Major	Inorganic Chemistry II	Theory	100	4	4	A
HPSCY152	Major	Organic Chemistry II	Theory	100	4	4	A
HPSCY153	Major	Analytical Chemistry II	Theory	100	4	4	A
HPSCY154	Major	Physical Chemistry II	Theory	50	2	2	D
HPSCY155P	Major-Practical	Organic and Analytical Chemistry Practical II	Practical	100	2	8	E
HPSCY156P	Elective-Practical	Physical and Inorganic Chemistry Practical II	Practical	50	2	4	E
HPSCY157	On Job Training (OJT)	On Job Training (OJT)	OJT	100	4	8	B
Total				600	22		**

Semester I

BOS	**Natural and Physical Sciences**				
Course	**INORGANIC CHEMISTRY I**				
Course Code	**HPSCY102**	**Level**	**6.0**		
		Type	**Theory**	**Practical**	**Total**
Semester	**I**	**Credits**	**4**	**-**	**4**
Type	**Major: Mandatory**	**No. of Teaching hours**	**60**	**-**	**60**

Evaluation Pattern	**Total Marks**	**Semester End**	**Internal**	**Practical**
	100	**50**	**50**	**-**

Learning Objectives	
1	To develop the ability to correlate fundamental theories of spatial orientations of molecules based on wave mechanics with advanced concepts in chemical bonding
2	To gain knowledge of Molecular Symmetry and Group Theory.
3	To learn about diverse tools available for characterization of coordination compounds in order to enhance competency while applying for practical purposes.
4	To gain theoretical knowledge of cutting edge topics such as solid state lasers and contemporary Methods of preparation of nanomaterials.
5	Explain the concept of Coordination compounds.

Course Outcomes	
CO1	The learner will know the concept of chemical bonding.
CO2	The learner will know the important fundamental concept of Group Theory, which helps them in understanding the properties and bonding in polyatomic molecules.
CO3	The learners will get comprehensive ideas about established instrumental techniques and Significant characterization tools available to study inorganic complexes having wide applications in industries.
CO4	The learners develop the skill in interpretation of the spectra.
CO5	The learner gets the knowledge about the various techniques used for Characterization coordination compounds.

Modules at Glance

Module No.	Content	No. of Hours	CO Mapping
I	Chemical Bonding	15	CO1
II	Molecular Symmetry and Group Theory	15	CO2, CO3
III	Materials Chemistry and Nanomaterials	15	CO4
IV	Characterization of Coordination compounds	15	CO5

Syllabus

Module No.	Content	No. of Hours
I	**Chemical Bonding** 1.1 Recapitulation of hybridization Derivation of wave functions for *sp*, sp^2, sp^3 orbital hybridization types considering only sigma bonding. 1.2 Discussion of involvement of d orbitals in various types of hybridizations. Concept of resonance, resonance energy derivation expected. Formal charge with examples. 1.3 Molecular Orbital Theory for diatomic species of First transition Series. 1.4 Molecular Orbital Theory for Polyatomic species considering σ bonding for SF_6, CO_2, B_2H_6, I_3^- molecular species. 1.5 Weak forces of attraction: Hydrogen bonding – concept, types, properties, methods of detection and importance. Van der Waal‘s forces, ion-dipole, dipole-dipole, London forces.	15
II	**Molecular Symmetry and Group Theory** 2.1. Symmetry criterion of optical activity, symmetry restrictions on dipole moment. A systematic procedure for symmetry classification of molecules. 2.2. Concepts of Groups, Sub-groups, Classes of Symmetry operations, Group Multiplication Tables. Abelian and non-Abelian point groups. 2.3. a) Representation of Groups: Matrix representation of symmetry operations, reducible and irreducible representations. The Great Orthogonality Theorem and its application in construction of character tables for point groups C_{2v}, C_{3v} and C_{2h}, structure of character tables. b) Determination of symmetry species for translations and rotations. c) Mulliken"s notations for irreducible representations. d) Reduction of reducible representations using reduction formula. 2.4. Applications of Group Theory Symmetry adapted linear combinations (SALC), symmetry aspects of MO theory, sigma bonding in ABn (NH_3, CH_4) molecule.	15

III	**Materials Chemistry and Nanomaterials** 3.1 Solid State Chemistry – 3.1.1. Electronic structure of solids and band theory, Fermi level, K Space and Brillouin Zones. 3.1.2. Structures of Compounds of the type: AB [nickel arsenide (NiAs)], AB_2 [fluorite (CaF_2) and anti-fluorite structures, rutile (TiO_2) 3.1.3. Solid state lasers: Introduction, Types, Working & Applications 3.2 Nanomaterials 3.2.1 Preparative methods, Chemical methods, solvothermal, combustion synthesis, microwave, coprecipitation, Langmuir-Blodgett(LB) method, biological methods, synthesis using microorganism. 3.2.2 Applications in the field of semiconductors, solar cells.	15
IV	**Characterization of Coordination compounds** 4.1. Methods of Characterization: thermal studies, Conductivity measurements, electronic spectral and magnetic measurements, IR, NMR and ESR spectroscopic methods. 4.2. Introduction to Orgel& Tanabe Sugano Diagram, Terms, Splitting of terms in Octahedral weak field, Calculation of electron parameters Δ, β, C and Nephlauxetic ratio with suitable examples. 4.3. Determination of formation constants of metal complexes (Overall and Stepwise): Comparative studies of Potentiometric and spectrophotometric methods.	15

Case Study examples
A medical device company is developing a compact, high-precision surgical tool using a solid-state laser. The team is considering materials such as Nd:YAG, Ti:sapphire, and Er:YAG. They must decide the best active medium, understand how electronic band structure affects lasing, and optimize efficiency. (a) Explain how the electronic structure and band gaps of Nd:YAG and Ti:sapphire influence their suitability as solid-state laser materials. (b) How does the Fermi level position in these materials help determine their optical transition behavior?
A renewable-energy startup plans to improve the efficiency of next-generation solar cells using nanostructured TiO_2 and quantum dots. They must choose an appropriate synthesis technique and understand how nanomaterial properties affect semiconductor behavior. (a) Compare solvothermal, microwave, and Langmuir–Blodgett (LB) methods for synthesizing TiO_2 nanomaterials for solar cells. (b) Explain how the rutile TiO_2 structure influences charge transport in solar cells.

- **References Books**
  1. B. R. Puri, L. R. Sharma and K. C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, 2013-2014.
  2. W. W. Porterfield, Inorganic Chemistry-A Unified Approach, 2nd Ed., Academic Press, 1993.
  3. F. A. Cotton, Chemical Applications of Group Theory, 2nd Edition, Wiley Eastern Ltd., 1989.
  4. Solid State Chemistry Introduction, Lesley E. Smart, Elaine A. Moore, ISBN 0- 203- 49635-3, Taylor & Francis Group, LLC.
  5. J. E. Huheey, E. A. Keiter and R. L. Keiter; Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education, 2006.

Semester End Evaluation (50 Marks) **Time: 2 Hrs**

Paper Pattern

Question No.	Questions	Total Marks: 50
Q1	Attempt any three out of five (05M) Module I 4Q, Module IV 1Q	15
Q2	Attempt any three out of five (05M) Module II 4Q, Module IV 1Q	15
Q3	Attempt any three out of five (05M) Module III 4Q, Module IV 1Q	15
Q4	Case study/application based question Module IV 1Q	05
	Total	*50*

BOS	**Natural and Physical Sciences**				
Course	**ORGANIC CHEMISTRY I**				
Course Code	**HPSCY102**	**Level**	**6.0**		
		Type	**Theory**	**Practical**	**Total**
Semester	**I**	**Credits**	**4**	**-**	**4**
Type	**Major: Mandatory**	**No. of Teaching hours**	**60**	**-**	**60**
Evaluation Pattern	**Total Marks**	**Semester End**	**Continuous**	**Practical**	
	100	**50**	**50**	**-**	

Learning Objectives	
1	1.To enable learners to have comprehensive knowledge and understanding of the advanced concepts in reaction Mechanism, stereochemistry, different reactions and reagents.
2	To apply the basic knowledge of Organic chemistry to perform various tasks assigned to them at the workplace in industry and academia to meet the job requirements as per global standards.
3	Accomplish a solution to problems encountered in the field of research.

Course Outcomes	
CO1	Predict the reactivity of organic compounds from its structure.
CO2	Understand different methods used for determination of Organic Reaction Mechanism. Understand the fundamental concept in stereochemistry by applying various symmetry elements of organic molecules.
CO3	Organize the techniques of aromatic nucleophilic substitution reactions for synthesizing/transforming molecules. Understand the concept of aromaticity and to know the nature of bonds, electronic effects and other properties of molecules.
CO4	Understand the preparation of important oxidizing reagents and predict the selectivity of the reagents in organic reactions. Explain the preparation and uses of important reducing reagents in various organic transformation reactions.

Modules at Glance

Module No.	Content	No. of Hours	CO Mapping
I	Physical Organic Chemistry	15	CO1
II	Stereochemistry	15	CO2
III	Nucleophilic substitution reactions and Aromaticity	15	CO3
IV	Oxidation and Reduction	15	CO4
		60	

Syllabus

Module No.	Content	No. of Hours
I	**Physical Organic Chemistry: (15L)** 1.1. Thermodynamic and kinetic requirements of a reaction: rate and equilibrium constants, reaction coordinate diagram, transition state (activated complex), nature of activated complex, Hammond postulate, Reactivity vs selectivity, Curtin-Hammett Principle, Microscopic reversibility, Kinetic vs thermodynamic control of organic reactions. 1.2. Determining mechanism of a reaction: Product analysis, kinetic studies, use of isotopes (Kinetic isotope effect – primary and secondary kinetic isotope effect). Detection and trapping of intermediates, crossover experiments and stereochemical evidence. 1.3. Acids and Bases: Factors affecting acidity and basicity: Electronegativity and inductive effect, resonance, bond strength, electrostatic effects, hybridization, aromaticity and solvation. Comparative study of acidity and basicity of organic compounds on the basis of pKa values, leveling effect and non-aqueous solvents. Acid and base catalysis – general and specific catalysis with examples.	15
II	**Stereochemistry: (15 L)** 2.1. Concept of Chirality: Recognition of symmetry elements. 2.2. Molecules with tri- and tetra-coordinate centers: Compounds with carbon, silicon, nitrogen, phosphorus and sulphur chiral centers, relative configurational stabilities. 2.3. Molecules with two or more chiral centers: Constitutionally unsymmetrical molecules: erythro-threo and syn-anti systems of nomenclature. Interconversion of Fischer, Sawhorse, Newman and Flying wedge projections. Constitutionally symmetrical molecules with odd and even number of chiral centers: enantiomeric and meso forms, concept of stereogenic, chirotopic, and pseudoasymmetric centres. R-S nomenclature for chiral centres in acyclic and cyclic compounds. 2.4. Axial and planar chirality: Principles of axial and planar chirality. Stereochemical features and configurational descriptors (R,S) for the following classes of compounds: allenes, alkylidene cycloalkanes, spirans, biaryls (buttressing effect) (including BINOLs and BINAPs), ansa	15

	compounds, cyclophanes, trans-cyclooctenes. 2.5. Prochirality: Chiral and prochiralcentres; prochiral axis and prochiral plane. Homotopic, heterotopic (enantiotopic and diastereotopic) ligands and faces.Identification using substitution and symmetry criteria. Nomenclature of stereoheterotopic ligands and faces. Symbols for stereoheterotopic ligands in molecules with i) one or more prochiral centres ii) a chiral as well as a prochiralcentre, iii) a prochiral axis iv) a prochiral plane v) pro-pseudoasymmetric centre. Symbols for enantiotopic and diastereotopic face.	
3	**3.1. Nucleophilic substitution reactions: (9 L)** 3.1.1 Aliphatic nucleophilic substitution: SN1, SN2, SNi reactions, mixed SN1 and SN2 and SET mechanisms. SN reactions involving NGP - participation by aryl rings, σ and pi-bonds. Factors affecting these reactions: substrate, nucleophilicity, solvent, steric effect, hard-soft interaction, leaving group. Ambident nucleophiles. SNcA, SN1‟ and SN2‟ reactions. SN at sp2 (vinylic) carbon. 3.1.2 Aromatic nucleophilic substitution: SNAr, SN1, benzyne mechanisms. Ipso, cine, tele and vicarious substitution. 3.1.3 Ester hydrolysis: Classification, nomenclature and study of all eight mechanisms of acid and base catalyzed hydrolysis with suitable examples. 3.2. Aromaticity: (6 L) 3.2.1. Huckel‘s (4n+2) and 4n rules, structural, thermochemical, and magnetic criteria for aromaticity, including NMR characteristics of aromatic systems. Delocalization and aromaticity. 3.2.2. Aromatic and antiaromatic compounds up-to 18 carbon atoms. Homoaromatic compounds. Aromaticity of all benzenoid systems, heterocycles, metallocenes, azulenes, annulenes, aromatic ions and Fullerene (C60).	15
4	**Oxidation and Reduction: (15L)** 4.1. Oxidation: General mechanism, selectivity, and important applications of the following: 4.1.1. Dehydrogenation: Dehydrogenation of C-C bonds including aromatization of six membered rings using metal (Pt, Pd, Ni) and organic reagents (chloranil, DDQ). 4.1.2. Oxidation of alcohols to aldehydes and ketones: Chromium reagents such as K2Cr2O7/H2SO4 (Jones reagent), CrO3-pyridine (Collin‘s reagent), PCC (Corey‘s reagent) and PDC (Cornforth reagent), hypervalent iodine reagents (IBX, Dess-Martin periodinane). DMSO based reagents (Swern oxidation), Corey-Kim oxidation - advantages over Swern and limitations; and Pfitzner-Moffatt oxidation-DCC and DMSO and Oppenauer oxidation. 4.1.3. Oxidation involving C-C bonds cleavage: Glycols using HIO4; cycloalkanones using CrO3; carbon-carbon double bond using ozone, KMnO4, CrO3, NaIO4 and OsO4; aromatic rings using RuO4 and NaIO4. 4.1.4. Oxidation involving replacement of hydrogen by oxygen: oxidation of CH2 to CO by SeO2, oxidation of arylmethanes by CrO2Cl2 (Etard	15

	oxidation). 4.1.5. Oxidation of aldehydes and ketones: with H2O2 (Dakin reaction), with peroxy acid (Baeyer-Villiger oxidation) 4.2. Reduction: General mechanism, selectivity, and important applications of the following reducing reagents: 4.2.1. Reduction of CO to CH2 in aldehydes and ketones-Clemmensen reduction, Wolff-Kishner reduction and Huang-Minlon modification. 4.2.2. Metal hydride reduction: Boron reagents (NaBH4, NaCNBH3, diborane, 9-BBN, Na(OAc)3BH, aluminium reagents (LiAlH4, DIBAL- H, Red Al, L and K- selectrides). 4.2.3. N2H2 (diimide reduction) and other non-metal based agents including organic reducing agents (Hantzschdihydropyridine). 4.2.4. Dissolving metal reductions: using Zn, Li, Na, and Mg under neutral and acidic conditions, Li/Na-liquid NH3 mediated reduction of aromatic compounds (Birch reduction) and Alkynes.	

Case study examples
A pharmaceutical company is synthesizing an intermediate that contains a p- hydroxybenzaldehyde unit. They need to convert it into a p-hydroxyphenol derivative without affecting the phenolic –OH group. 1. Which oxidation method—Dakin oxidation (H_2O_2/base) or Baeyer–Villiger oxidation (peroxy acid)—is more suitable for this transformation, and why? 2. Briefly explain the key mechanistic difference between the Dakin reaction and Baeyer–Villiger oxidation.
A chemist must reduce a ketone group in a molecule that also contains a nitro group, an alkyne, and an ester. The goal is to convert C=O → CH_2 *without altering* the nitro or alkyne functionality. 1. Which reduction method—Clemmensen, Wolff–Kishner/Huang–Minlon, metal hydrides, diimide, or dissolving-metal reductions—is most appropriate for this selective conversion? Give a brief justification. 2. Why would Clemmensen reduction or Birch reduction be unsuitable for this substrate?

References Books

1. Physical Organic Chemistry, NeilIsaacs
2. Modern Physical Organic Chemistry, Eric V. Anslyn and Dennis A.Dougherty
3. Organic Chemistry, J. Claydens, N. Greeves, S.Warren and P. Wothers, Oxford University Press.
4. Advanced Organic Chemistry, F.A. Carey and R.J. Sundberg, Part A and B, Plenum Press.
5. Stereochemistry: Conformation and mechamism, P.S. Kalsi, New Age International, New Delhi.

Semester End Evaluation (50 Marks)

Paper Pattern ***Time: 2 Hr.***

Question No.	Questions	Total Marks: 50
Q1	Attempt any three out of five (05M) Module I 4Q, Module IV 1Q	15
Q2	Attempt any three out of five (05M) Module II 4Q, Module IV 1Q	15
Q3	Attempt any three out of five (05M) Module III 4Q, Module IV 1Q	15
Q4	Case study/application based question Module IV 1Q	05
	Total	*50*

Continuous Evaluation: Internal (50 marks)

	Assessment/ Evaluation	Marks
1	Class Test • Attempt any 4 questions out of 5 (05 marks)	20
2	Research paper and presentation	20
3	Assignments	10

BOS	**Natural and Physical Sciences**					
Course	**ANALYTICAL CHEMISTRY I**					
Course Code	**HPSCY103**	**Level**	**6.0**			
		Type	**Theory**	**Practical**	**Total**	
Semester	**I**	**Credits**	**4**	**-**	**4**	
Type	**Major: Mandatory**	**No. of Teaching hours**	**60**	**-**	**60**	
Evaluation Pattern	**Total Marks**	**Semester End**	**Continuous**	**Practical**		
	100	**50**	**50**	**-**		

Learning Objectives	
1	To enable learners to have comprehensive knowledge, understanding of the types of instruments with operations and automated methods of analysis.
2	To apply the basic knowledge of quality systems, quality audit and quality management.
3	To enable learners to perform various tasks assigned to them at the workplace in industry and academia to meet the job requirements as per global standards.
4	To provide solutions to problems encountered in the field of analysis and research.

Course Outcomes	
CO1	Understand various terms used in analytical chemistry and identify the different types of errors in analysis.
CO2	Sketch out the role and importance of total quality management, safety, accreditations and GLP in industries.
CO3	Understand the efficacy of automation in chemical analysis and design and specify applications of advanced analytical techniques in various fields.
CO4	Explore the applications of IR spectroscopy and thermal methods.
CO5	Perform basic calculations required in chemical analysis and interpret the experimental results of analytical techniques & transformation reactions.

Modules at Glance

Module No.	Content	No. of Hours	CO Mapping
I	Language of Analytical Chemistry	15	CO1,CO2
II	Calculations based on Chemical Principles	15	CO3
III	Optical Methods	15	CO5
IV	Instrumental methods-I	15	CO4
		60	

Syllabus

Module No.	Content	No. of Hours
I	1.1 Language of Analytical Chemistry [8L] 1.1.1 Analytical perspective [3L] Analytical approach, common analytical problems. Terms involved in analytical chemistry - Analysis, Analyte, Matrix, Determination, Measurement, Techniques, Methods, Procedures and protocol. 1.1.2 An overview of analytical methods [3L] Analytical methods - Types, classification and selection. Quantitative method of Analysis- Calibration method, Method of Standard addition, Internal standard method. Performance Characteristics of analytical method- Accuracy, Precision, Selectivity, Sensitivity, Detection limit (LOD, LOQ, LOL) ,Dynamic range and Robustness and Ruggedness. 1.1.3 Errors [2L] Types of errors .Absolute error, Relative error, Constant error and Proportionate errors. Minimization of errors. 1.2 Quality in Analytical Chemistry [7L] 1.2.1 Total Quality Management- TQM [3L] Definition, Principles, Importance and benefits. Philosophy of implementation of TQM - Process steps, Advantages and Limitations i) Kaizen -Six steps ii) Six Sigma approach iii) 5S and 5S audit check for laboratories. 1.2.2 Safety in laboratories [2L] Basic concept of safety in laboratory- The Industrial Hygiene Principles. Personal protection equipment (PPE).Occupational Safety and Health Administration (OSHA). 1.2.3 Accreditations [2L] Accreditation of laboratories, NABL, Indian Government standards (ISI, HALLMARK, AGMARK).- Meaning and significance.	15

II	2.1 Calculations based on Chemical Principles [15 L] (The following topics are to be covered in the form of numerical problems only) 2.1.1 Concentration of a solution based on volume and mass units. 2.1.2 Calculations of ppm, ppb and dilution of the solutions, concept of mmol. 2.1.3 Stoichiometry of chemical reactions, concept of kg /mol, limiting reactant, theoretical and practical yield. 2.1.4 Solubility and solubility equilibria, effect of presence of common ion in solution. 2.1.5 Calculations of pH of acids, bases, acidic and basic buffers. 2.1.6 Concept of formation constants, stability and instability constants, stepwise formation constants. 2.1.7 Oxidation number, rules for assigning oxidation number, redox reaction in term of oxidation number, oxidizing and reducing agents, equivalent weight of Oxidizing and reducing agents, stoichiometry of redox titration (Normality of a solution of an oxidizing / reducing agent and its relationship with molarity).	15
III	Unit III -Optical Methods [15 L] 3.1 Infrared Absorption Spectroscopy [6L] 3.1.1 Instrumentation: Sources, Sample handling, Transducers, Dispersive, non- dispersive instrument. 3.1.2 Applications of IR [Mid IR, Near IR, Far IR]: Qualitative with emphasis on ―Finger print‖ and Quantitative analysis. 3.1.3 Advantages and Limitations of IR. 3.2 FT Technique [3 L] 3.2.1 Introduction of Fourier Transform. 3.2.2 Laser as a source of radiation, sample containers. 3.2.3 Detectors, Fiber optics. 3.2.4 FTIR and its advantages. 3.3 Molecular Ultraviolet and Visible Spectroscopy [6 L] 3.3.1 Factors affecting molecular absorption: pH, temperature, solvent and effect of substituents, types of transitions [emphasis on charge transfer absorption]. 3.3.2 Applications of Ultraviolet and Visible spectroscopy: i) On charge transfer absorption ii) Simultaneous spectroscopy iii) Derivative Spectroscopy 3.3.3 Dual spectrometry – Introduction, Principle, Instrumentation and Applications.	15
IV	Unit - IV Instrumental methods-I [15L] 4.1 Thermal Methods: [9 L] 4.1.1 Introduction: Types of thermal methods, comparison between TGA and DTA. 4.1.2 Differential Scanning Calorimetry-Principle, comparison of DTA and DSC. 4.1.3 Instrumentation, Block diagram, Nature of DSC Curve, Factors affecting DSC Curves. 4.1.4 Applications - Heat of reaction, Safety screening, Polymers, liquid crystals, Drug analysis.	15

	4.2 Automation in chemical analysis: [6 L] 4.2.1 Need for automation, Objectives of automation. 4.2.2 An overview of automated instruments. 4.2.3 Process control analysis, flow injection analysis, discrete automated systems, automatic analysis based on multi-layered films, gas monitoring equipment. 4.2.4 Automatic titrators.	

Case study examples
1. A pharmaceutical company is analyzing a hydrated drug sample. During heating, the sample shows a clear mass loss event around 120 °C and an accompanying endothermic peak. Case Question: How would TGA and DTA together help determine whether the event corresponds to dehydration or decomposition of the drug? Discuss what each technique would reveal.
2. A polymer manufacturer wants to verify whether a newly synthesized polymer batch is semi-crystalline or completely amorphous. A DSC run shows a glass transition at 65 °C, a crystallization exotherm at 120 °C, and a melting endotherm at 165 °C. Case Question: Interpret the DSC curve and explain what it reveals about the polymer structure and thermal behavior.

- **References Books**

1. Modern Analytical Chemistry ; David Harvey, McGraw-Hill,Higher Education,(2000)
2. Principles of Instrumental Analysis ; Skoog, Holler and Nieman, 5th Edition, Ch: 1
3. Fundamentals of Analytical Chemistry, Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch, 9
4. 3000 solved problems in chemistry, Schaums Solved problem series, ; David E.
5. Principles of Instrumental Analysis,; D. A. Skoog, F. J. Holler, T. A. Nieman, 5thEdition, Harcourt Asia Publisher. Chapter 6, 7,8, 13, 14, 16,17

Semester End Evaluation (50 Marks)

Paper Pattern

Time: 2 Hr.

Question No.	Questions	Total Marks: 50
Q1	Attempt any three out of five (05M) Module I 4Q, Module IV 1Q	15
Q2	Attempt any three out of five (05M) Module II 4Q, Module IV 1Q	15
Q3	Attempt any three out of five (05M) Module III 4Q, Module IV 1Q	15
Q4	Case study/application based question Module IV 1Q	05
	Total	*50*

Continuous Evaluation: Internal (50 marks)

	Assessment/ Evaluation	Marks
1	Class Test • Attempt any 4 questions out of 5 (05 marks)	20
2	Research paper and presentation	20
3	Assignments	10

<table>
<tr><td>BOS</td><td colspan="6">Natural and Physical Sciences</td></tr>
<tr><td>Course</td><td colspan="6">RESEARCH METHODOLOGY IN CHEMISTRY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">HPSCY108</td><td>Level</td><td colspan="4">6.0</td></tr>
<tr><td>Type</td><td>Theory</td><td>Practical</td><td colspan="2">Total</td></tr>
<tr><td>Semester</td><td>I</td><td>Credits</td><td>4</td><td>-</td><td colspan="2">4</td></tr>
<tr><td>Type</td><td>Major: Mandatory</td><td>No. of Teaching hours</td><td>60</td><td>-</td><td colspan="2">60</td></tr>
<tr><td rowspan="2">Evaluation pattern</td><td>Total Marks</td><td>Semester End</td><td colspan="2">Continuous</td><td colspan="2">Practical</td></tr>
<tr><td>100</td><td>50</td><td colspan="2">50</td><td colspan="2">-</td></tr>
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Learning Objectives	
1	To create awareness and understanding of terms like intellectual property, patents, copyright, Industrial designs, trademarks, geographical indications etc.
2	To know trade secrets, IP infringement issues, economic value of intellectual property and study of various related international agreements.
3	To explore cheminformatics to facilitate molecular modeling and structure elucidations.
4	To apply the knowledge gained about various chemistry principles, techniques and tools in drug designing, target identification and validation, lead finding and optimization..

Course Outcomes	
CO1	To enable the student to be able to extract information from journals and digital resources.
CO2	Describe research, identification of research problems, and preparation of proposals.
CO3	Concept of Intellectual Property and identify different types of IP with their relevance in academic and industrial research
CO4	Safe working procedure And ethical handling of chemicals.

Modules at Glance

Module No.	Content	No. of Hours	CO Mapping
I	Literature survey	15	CO1
II	Methods of scientific research and writing scientific papers	15	CO2
III	Introduction to intellectual property rights	15	CO3
IV	Chemical safety and ethical handling of chemicals	15	CO4
		60	

Syllabus

Module No.	Content	No. of Hours
I	**Literature survey** 1.1 Print: Primary, Secondary and Tertiary sources. Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, textbooks, current contents, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples Digital: 1.2 Web sources, E-journals, Journal access, TOC alerts, Hot articles, Citation Index, Impact factor, H-index, E-consortium, UGC infonet, E-books, Internet discussion groups and communities, Blogs, preprint servers, Search engines, Scirus, Google Scholar, ChemIndustry, Wiki-databases, ChemSpider, Science Direct, SciFinder, Scopus. 1.3 Information Technology and Library Resources: The Internet and World wide web, Internet resources for Chemistry, finding and citing published information	15
II	**Methods of scientific research and writing scientific papers** Reporting practical and project work, writing literature surveys and reviews, organizing a poster display, giving an oral presentation. Writing Scientific Papers: Justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work, writing ethics, avoiding plagiarism.	15

III	**Introduction to Intellectual Property Rights (IPR)** Concept and Importance of Intellectual Property (IP). Types of Intellectual Property: Patents, Copyrights, Trademarks, Trade Secrets, Geographical Indications, Industrial Designs, Need for IPR in Research and Innovation, International Treaties and Agreements: TRIPS (Trade-Related Aspects of Intellectual Property Rights), WIPO (World Intellectual Property Organization), Indian IPR Regime: Overview and Legal Framework, Role of IPR in Academic and Industrial Research, Ethical Issues in IPR and Research**.**	15
IV	**Chemical safety and ethical handling of chemicals** Safe working procedure and protective environment, protective apparel, emergency procedure, first aid, laboratory ventilation, safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric pressure, safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, procedure for laboratory disposal of explosives, identification, verification and segregation of laboratory waste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals.	15

Case study example
1. A laboratory technician stores nitric acid and ethanol bottles on the same shelf due to lack of space. One bottle leaks slightly overnight, resulting in fumes and a small fire. Question: Identify the safety mistakes made in storage and handling. What safe-working procedures, ventilation practices, and emergency responses should have been followed to prevent this incident?
2. A researcher is using a compressed hydrogen gas cylinder for an experiment. The cylinder was not properly secured, and the pressure regulator had not been checked for leaks. During operation, the cylinder tips over and a fast gas release occurs. Case Question: Discuss what safety protocols for handling high-pressure gases, personal protective equipment (PPE), and emergency procedures were violated. What should be the correct method for storing, operating, and inspecting gas cylinders to avo*id such hazards?*

References Books

1. Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J., & Jones, A., (2011), Practical skills in Chemistry, 2nd Ed., Prentice Hall, Harlow.

2. Hibbert, D. B. & Gooding, J. J. (2006) Data Analysis for Chemistry Oxford University Press.

3. Topping, J., (1984) Errors of Observation and their Treatment 4 th Ed., Chapman Hill, London.

4. Harris, D. C. (2007) Quantitative Chemical Analysis 6th Ed., Freeman Chapters 3-5

5. Levie, R. De. (2001) How to use Excel in Analytical Chemistry and in general scientific data analysis Cambridge University Press.

Semester End Evaluation (50 Marks)
Paper Pattern

Time: 2 Hr.

Question No.	**Questions**	**Total Marks: 50**
Q1	Attempt any three out of five (05M) Module I 4Q, Module IV 1Q	15
Q2	Attempt any three out of five (05M) Module II 4Q, Module IV 1Q	15
Q3	Attempt any three out of five (05M) Module III 4Q, Module IV 1Q	15
Q4	Case study/application based question Module IV 1Q	05
	Total	*50*

BOS	**Natural and Physical Sciences**					
Course	**PHYSICAL CHEMISTRY I**					
Course Code	**HPSCY105**	**Level**	**6.0**			
		Type	**Theory**	**Practical**	**Total**	
Semester	**I**	**Credits**	**2**	**-**	**2**	
Type	**Elective**	**No. of Teaching hours**	**30**	**-**	**30**	
Evaluation pattern	**Total Marks**	**Semester End**	**Internal**	**Practical**		
	50	**NA**	**50**	**-**		

Learning Objectives	
1	To enable learners to have comprehensive knowledge and understanding of the advanced concepts in reaction kinetics, molecular dynamics and chemical thermodynamics.
2	To apply the basic knowledge of Physical chemistry to perform various tasks assigned to them at the workplace in industry and academia to meet the job requirements as per global standards.
3	Accomplish a solution to problems encountered in the field of research.

Course Outcomes	
CO1	The learners evaluate the different theories of chemical kinetics and effect of temperature on reaction rates.
CO2	The learners will understand the applications of chain reactions in the field of Polymer Chemistry.
CO3	The learners will evaluate the resting membrane potential by using the concept of bio electrochemistry.

Modules at Glance

Module No.	Content	No. of Hours	CO Mapping
I	Chemical Kinetics and Molecular Dynamics-I	15	CO1
II	Electrochemistry	15	CO2, CO3

Syllabus

Module No.	Content	No. of Hours
I	**Chemical Kinetics and Molecular Dynamics-I** 1.1. Composite Reactions: Recapitulation: Rate laws, Differential rate equations Consecutive reactions, Steady state Approximation, rate determining steps, Microscopic Reversibility and Detailed Balanced Chain reactions-chain initiation processes. Some inorganic mechanisms: formation and decomposition of phosgene, decomposition of ozone, Reaction between Hydrogen and Bromine and some general examples Organic Decompositions: Decomposition of ethane, decomposition of acetaldehyde Gas phase combustion: Reaction between hydrogen and oxygen, Semenov – Hinshelwood and Thompson mechanism, Explosion limits and factors affecting explosion limits. 1.2. Polymerization reactions: Kinetics of stepwise polymerization, Calculation of degree of polymerization for stepwise reaction. Kinetics of free radical chain polymerization, Kinetic chain length and estimation of average no. of monomer units in the polymer produced by chain polymerization. 1.3 Reaction in Gas Phase Unimolecular Reactions: Lindeman- Hinshelwood theory, Kassel Rice-Ramsperger- Kasssel (RRK) theory, Rice-Ramsperger-Kassel Marcus (RRKM) theory.	15
II	**Electrochemistry** Recapitulation – basics of electrochemistry. 2.1. Debye-Hückel theory of activity coefficient, Debye-Hückel limiting law and its extension to higher concentration (derivations are expected). 2.2. Electrolytic conductance and ionic interaction, relaxation effect,. Debye-Hückel- Onsager equation (derivation expected). Validity of this equation for aqueous and non- aqueous solution, deviations from Onsager equation, Debye - Falkenhagen effect (dispersion of conductance at high frequencies), Wien effect. 2.3. Batteries: Alkaline fuel cells, Phosphoric acid fuel cells, High temperature fuel cells [Solid –Oxide Fuel Cells (SOFC) and Molten Carbonate Fuel Cells]	15
	2.4. Bio-electrochemistry: Introduction, cells and membranes, membrane potentials, theory of membrane potentials, interfacial electron transfer in biological systems, adsorption of proteins onto metals from solution, electron transfer from modified metals to dissolved protein in solution, enzymes as electrodes, electrochemical enzyme-catalysed oxidation of styrene. Goldmann equation. (derivations are expected) [Note: Numerical and theoretical problems from each unit are expected]	

Case study examples
1. A researcher is studying nerve cells exposed to a high external K^+ concentration. After exposure, the measured membrane potential becomes less negative than normal. Question: Using the Goldman equation, explain why the membrane potential shifts. How do ion permeabilities and concentration gradients contribute to the observed change?
2. An enzyme solution is introduced onto a gold electrode modified with a thiol-based self-assembled monolayer (SAM). After adsorption, the electrode shows increased current during the electrochemical oxidation of styrene. Question: How does protein adsorption influence interfacial electron-transfer processes? Explain how the modified metal surface facilitates electron transfer between the enzyme and substrate.

- **References Books**

1. Peter Atkins and Julio de Paula, Atkin‟sPhysical Chemistry, 7thEdn., Oxford University Press, 2002.
2. K.J. Laidler and J.H. Meiser, Physical Chemistry, 2nd Ed., CBS Publishers and Distributors, New Delhi, 1999.
3. Robert J. Silby and Robert A. Alberty, Physical Chemistry, 3rdEdn., John Wiley and Sons (Asia) Pte. Ltd., 2002.
4. Ira R. Levine, Physical Chemistry, 5thEdn., Tata McGraw-Hill New Delhi, 2002.
5. G.W. Castellan, Physical Chemistry, 3rdEdn.,Narosa Publishing House, New Delhi, 1983.
6. Ira N. Levine, Quantum Chemistry, 5thEdn., Pearson Education (Singapore) Pte. Ltd., Indian Branch, New Delhi, 2000

BOS	**Natural and Physical Sciences**				
Course	**ORGANIC CHEMISTRY AND ANALYTICAL CHEMISTRY I**				
Course Code	**HPSCY106P**	**Level**	**6.0**		
		Type	**Theory**	**Practical**	**Total**
Semester	**I**	**Credits**	**-**	**2**	**2**

Type	**Mandatory**	**No. of Teaching hours**	**-**	**60**	**60**

Evaluation Patterns	**Total Marks**	**Semester End**	**Continuous**	**Practical**
	100	**-**	**-**	**100**

Learning Objectives
Planning of synthesis, effect of reaction parameters including stoichiometry, and safety aspects including MSDS should be learnt.
Purify the product by crystallization. Formation and purity of the product should be checked by TLC
To gain knowledge and hands-on experience in instrumental and non-instrumental analysis.

Course Outcomes	
CO1	Carry out one step preparation in laboratory with basic understanding of stoichiometry
CO2	Evaluate the process and outcomes of an experiment quantitatively and qualitatively
CO3	Handle and get familiar with SOP's of instruments like potentiometer, conductivity meter, colorimeter and spectrophotometer.
CO4	Apply the theory of redox reactions to experimental systems.

Modules At Glance

Module No.	Content	No. of Hours	CO Mapping
I	Organic Chemistry Practical	30	CO1, CO2
II	Analytical Chemistry practical	30	CO3, CO4
		60	

Syllabus

Module No.	Content	No. of Hours	Mapping with CO
I	Organic Chemistry Practicals One step preparations (1.0 g scale) 1. Bromobenzene to p-nitrobromobenzene 2. Anthracene to anthraquinone 3. Benzoin to benzil 4. Anthracene to Anthracene maleic anhydride adduct 5. 2-Naphthol to BINOL 6. p-Benzoquinone to 1,2,4-triacetoxybenzene 7. Ethyl acetoacetate to 3-methyl-phenylpyrazol-5-one 8. o-Phenylenediamine to 2-methylbenzimidazole 9. o-Phenylenediamine to 2,3-diphenylqunooxaline 10. Urea and benzil to 5,5-diphenylhydantoin	30	CO1, CO2
II	Analytical Chemistry Practicals Instrumental Experiments 1. To determine percentage purity of sodium carbonate in washing soda pH metrically. 2. To determine the amount of Ti(III) and Fe(II) in a mixture by titration with Ce(IV)potentiometrically. 3. To determine the percentage purity of a sample (glycine/sodium benzoate/primary amine) by titration with perchloric acid in a non-aqueous medium using glass calomel system potentiometrically. 4. To determine the amount of nitrite present in the given water sample colorimetrically. Non-Instrumental Experiments 1. To carry out assay of the sodium chloride injection by Volhard‘s method. 2. To determine (a) the ion exchange capacity (b)	30	CO3, CO4

	exchange efficiency of the given cation exchange resin. 3. To determine the amount of Cr(III) and Fe(II) individually in a mixture of the two by titration with EDTA. 4. To determine the number of nitro groups in the given compound using$TiCl_3$.		

References:

1. Quantitative Inorganic Analysis including Elementary Instrumental Analysis by ; A. I.

Vogels, 3rd Ed. ELBS (1964)

2. Vogel's textbook of quantitative chemical analysis, Mendham, Denny, Barnes, Thomas, Pearson education, Sixth Ed.

3. Standard methods of chemical analysis; F. J. Welcher, 1975

4. Standard methods of chemical analysis :Instrumental methods of Analysis ; F.

J. Welcher, Vol. 3, 1966

5. "Standard methods of Chemical Analysis"; W. W. Scott, Vol. I, Van Nostrand Company, Inc.,1939.

Practical Evaluation (100 Marks)

	Assessment/ Evaluation	**Marks**
1	Practical	80
2	Journal & Viva	20

BOS	**Natural and Physical Sciences**				
Course	**PHYSICAL AND INORGANIC CHEMISTRY I**				
Course Code	**HPSCY407P**	**Level**	**6.0**		
		Type	**Theory**	**Practical**	**Total**
Semester	**I**	**Credits**	**-**	**2**	**2**
Type	**Major: Elective**	**No of Teaching hours**	**-**	**60**	**60**
Evaluation Pattern	**Total Marks**	**Semester End**	**Continuous**	**Practical**	
	50	**-**	**-**	**50**	

Learning Objectives	
1	To Gain knowledge of the advanced concepts
2	To usage of subject fundamentals-principles with practical knowledge to design experiments, analyze and interpret data so as to reach to proper conclusions
3	To develop scientific temper and research based skills to encounter in the field of research.
4	To gain knowledge of employing instrumental techniques for quantitative analysis.
5	Learners will develop scientific temper and research based skills to be encountered in the field of research.

Course Outcomes	
CO1	To understand advanced concepts of thermodynamics and chemical kinetics in the chemical reactions.
CO2	Learners will train the handling of equipment like potentiometer, conductivity meter, colorimeter and spectrophotometer.
CO3	To apply basic concepts of separation and estimation of metals ions from constituent ores/alloys effectively using chemical analysis

Modules at Glance

Module No.	Content	No. of Hours	CO Mapping
I	Physical Chemistry practical	30	CO1, CO2
II	Inorganic Chemistry practical	30	CO3

Syllabus

Module No.	Content	No. of Hours
I	Non – Instrumental: 1. To determine the heat of solution (ΔH) of a sparingly soluble acid (benzoic/salicylic acid) from solubility measurement at three different temperatures. 2. To study the variation of calcium sulphate with ionic strength and hence determine the thermodynamic solubility product of $CaSO_4$ at room temperature. 3. To investigate the reaction between acetone and iodine. 4. Graph Plotting of mathematical functions –linear, exponential and trigonometry and identify whether functions are acceptable or non-acceptable. Instrumental: 1. To determine the mean ionic activity coefficient of an electrolyte by e.m.f. measurement. 2.To study the effect of substituent on the dissociation constant of acetic acid conductometrically. 3. To determine pKa values of phosphoric acid by potentiometric titration with sodium hydroxide using glass electrodes. 4. To verify Ostwald‘s dilution law and to determine the dissociation constant of a weak mono-basic acid conductometrically.	30
II	Ores and Alloys 1) Analysis of Devarda‘s alloy 2) Analysis of Cu – Ni alloy 3) Analysis of Limestone. 4) Analysis of Tin Solder alloy Instrumentation 5) Estimation of Fe (III)solution using Ce (IV) ions Potentiometrically	30

	6) Estimation of Copper using Iodometric method Potentiometrically 7) Estimation of Na_2CO_3 in washing soda by pH metry 8) Estimation of Cl^- ion in NaCl/KCl by Conductometry.	

References

1. Practical Physical Chemistry, B. Viswanathan and P.S. Raghavan, Viva Books Private Limited, 2005.

2. Practical Physical Chemistry, A.M. James and F.E. Prichard, 3rdEdn., Longman Group Ltd., 1974.

3. Experimental Physical Chemistry, V.D. Athawale and P. Mathur, New Age International Publishers, 2001.

4. Advanced experiments in Inorganic Chemistry., G. N. Mukherjee., 1st Edn., 2010.,

U. N. Dhur& Sons Pvt Ltd

5. The Synthesis and Characterization of Inorganic Compounds by William L. Jolly

Practical Evaluation (50 Marks)

	Assessment/ Evaluation	Marks
1	Practical	40
2	Journal and viva	10