R.E. Society's
R.P. Gogate College of Arts & Science
&
R.V. Jogalekar College of Commerce
(Autonomous)
Ratnagiri

Syllabus For

M. Sc. I

Chemistry

Semester I and II

Under Choice Based Credit System

(CBCS)

As Per framework of NEP 2020

With effect from Academic Year 2023-2024

Name of Programme	**Masters of Science**
Level	PG
No of Semesters	04
Year of Implementation	**2023-24**
Programme Specific Outcomes (PSO)	At the end of the Programme, Learner will be able to 1. 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. 2. 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. 3. Deduce qualitative and quantitative information of chemical compounds using advanced spectroscopic methods which can further be analysed using practical skills inculcated in them during the course. 4. Imbibe the attitude as well as aptitude of a scientific approach along with analytical reasoning with respect to the novel techniques actually implemented in the Industry. 5. Use the subject knowledge, communication and ICT skills to become an effective team leader/team member in the interdisciplinary fields. 6. Understand, Manage and contribute to solve basic societal issues and environmental concerns ethically based on principles of scientific knowledge gained. 7. Exhibit professional work ethics and norms of scientific development 8. Conduct research projects, utilize appropriate methodologies, and effectively execute projects in the field of science.
Relevance of PSOs to the local, regional, national, and global developmental needs	Post Graduates with strong chemical knowledge and laboratory skills can support industries, research institutions, and local communities in solving local environmental issues, water purification, waste management, and sustainable resource utilization. Chemistry Post Graduates can foster economic growth by driving innovation and entrepreneurship. They can contribute to regional research and development initiatives, enhance product quality, and support industries in adopting green practices. Additionally, their expertise in chemical safety and ethics can promote responsible industrial practices and environmental protection, benefiting the region.

	Chemistry graduates can contribute to addressing pressing global challenges, such as climate change mitigation, renewable energy development, and pollution control. Their research and problem-solving abilities can lead to the discovery of new materials, technologies, and treatments with global applications.

Revised Scheme of Examination
Faculty of Science
(Post-graduate Programmes)
Choice Based Credit System (CBCS)
Scheme of Examination

Master of Science (M.Sc.) Programme

The performance of the learners shall be evaluated into two parts. The learner‟s performance shall be assessed by Internal Assessment with 40% marks and by conducting the Semester End Examinations with 60% marks. The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below-

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination:
1. Duration - These examinations shall be of two hours duration.
2. Theory question paper pattern:
a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units.
b. All questions shall be compulsory with internal choice within the questions.

Standard of Passing

The learner to pass a course shall have to obtain a minimum of 40% marks in aggregate for each course where the course consists of Internal Assessment and Semester End Examination. The learner shall obtain minimum of 40% marks (i.e. 16 out of 40) in the Internal Assessment and 40% marks in Semester End Examination (i.e. 24 out of 60) separately, to pass the course and minimum of Letter Grade “P” in the project component, wherever applicable to pass a particular semester. A learner will be said to have passed the course if the learner passes the Internal Assessment and Semester End Examination together.

Performance Grading:

Letter Grades and Grade Points

Semester GPA/ Program CGPA Semester/Program	**% of Marks**	**Alpha-Sign / Letter Grade Result**
9.00-10.00	90.0 -100	0 (Outstanding)
8.00 ≤ 9.00	80.0 ≤ 90.0	A+ (Excellent)
7.00 ≤ 8.00	70.0 ≤ 80.0	A (Very Good)
6.00 ≤ 7.00	60.0 ≤ 70.0	B+ (Good)
5.50 ≤ 6.00	55.0 ≤ 60.0	B (Above Average)
5.00 ≤ 5.50	50.0 ≤ 55.0	C (Average)
4.00 ≤ 5.00	40.0 ≤ 50.0	P (Pass)
Below 4.00	Below 40	F (Fail)
Ab (Absent)	-	Absent

Master of Science (M.Sc.) Programme
Under Choice Based Credit System
Course Structure

M.Sc. I

(with effect from Academic Year- 2023-24)

No. of Courses	Semester I	Credits		No. of Courses	Semester II	Credits	
	Major Mandatory				Major Mandatory		
PSCH 101	Inorganic Chemistry-I	04		PSCH 201	Inorganic Chemistry-II	04	
PSCH 102	Organic Chemistry-I	04		PSCH 202	Organic Chemistry-II	04	
PSCH 103	Analytical Chemistry-I	04		PSCH 203	Analytical Chemistry-II	04	
PSCH 104	Chemistry Practical-I (Organic Chemistry and Analytical Chemistry)	02		PSCH 204	Chemistry Practical- (Organic Chemistry and Analytical Chemistry)	02	
	Major Electives				Major Electives		
PSCH 105	Physical Chemistry I	02	04	PSCH 205	Physical Chemistry III	02	04
PSCH 106	Chemistry Practical E-I (Physical and Inorganic Chemistry)	02		PSCH 206	Chemistry Practical E-III (Physical and Inorganic Chemistry)	02	
	OR				OR		
PSCH 107	Physical Chemistry II	02	04	PSCH 207	Physical Chemistry IV	02	04
PSCH 108	Chemistry Practical E-II (Physical and Inorganic Chemistry)	02		PSCH 208	Chemistry Practical E-IV (Physical and Inorganic Chemistry)	02	
PSCH 109	Research Methodology	04		PSCH209	On Job Training/Internship Field Project/Extended Experiment	04	
Total Credits		22		Total Credits		22	

SMART Criteria for Course Outcomes:

Specific: Each course outcome is specific, outlining the knowledge and skills students are expected to acquire in relation to the specific topics covered.

Measurable: Each outcome can be measured through assessments, tests, or projects to determine the level of understanding and proficiency achieved by the students.

Achievable: The outcomes are achievable within the duration of the course, considering the number of lectures allocated to each topic.

Relevant: The outcomes are relevant to the subject of financial services and capital market, addressing important concepts, types, and mechanisms involved.

Time-bound: The outcomes are expected to be achieved by the end of the course, providing a clear timeline for assessment and evaluation.

No. of Courses	Semester I	Credits
	Major: Mandatory	
PSCH 101	Inorganic Chemistry-I	4
PSCH 102	Organic Chemistry-I	4
PSCH 103	Analytical Chemistry-I	4
PSCH 104	Chemistry Practical-I (Organic Chemistry and Analytical Chemistry)	2
	Major: Elective (Any One from below)	
PSCH 105	Physical Chemistry I	4
PSCH 106	Chemistry Practical E-I (Physical and Inorganic Chemistry)	
PSCH 107	Physical Chemistry II	4
PSCH 108	Chemistry Practical E-II (Physical and Inorganic Chemistry)	
PSCH 109	Research Methodology	4
Total Credits		22

Revised Syllabus of Courses of Master of Science (M.Sc.)
Programme atSemester I with Effect from the Academic Year
2023-2024

Name of the Course	Inorganic Chemistry-I
Course Code	PSCH101
Class	M.Sc.
Semester	I
No of Credits	4
Nature	Theory
Type	Major: Mandatory-1
Employability/ Entrepreneurship/ Skill Development	Inorganic chemistry plays a significant role in employability, entrepreneurship and skill development due to its wide ranging applications and relevance in various industries, such as material science, electronics, ceramics, pharmaceuticals, and environmental science. Entrepreneurs in fields like material science and nanotechnology rely on inorganic chemistry principles to innovate. Thus a course provides Post Graduates with analytical skills, problem solving skills, research capabilities which empower them to pursue a diverse path career.

Inorganic Chemistry-I

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1	Chemical Bonding	15
2	Molecular Symmetry and Group Theory	15
3	Materials Chemistry and Nanomaterials	15
4	Characterization of Coordination compounds	15
Total		**60**

Course Outcomes:

At the end of the Course, the Learner will be able to

1. The learner will know the important fundamental concept of Group Theory, which helps them in understanding the properties and bonding in polyatomic molecules.
2. The learner gets the knowledge about the various techniques used for Characterization coordination compounds.
3. The learners develop the skill in interpretation of the spectra.
4. The learners will get comprehensive idea about established instrumental techniques and significant characterization tools available to study inorganic complexes having wide applications in industries.

Curriculum:

Sr. No.	Modules / Units
1	**Chemical Bonding (15 Lectures)**
	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.
2	**Molecular Symmetry and Group Theory (15 Lectures)**
	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 AB_n (NH_3, CH_4) molecule.
3	**Materials Chemistry and Nanomaterials (15 Lectures)**
	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 and Applications **3.2 Nanomaterials :** **3.2.1** Preparative methods, Chemical methods, solvothermal, combustion synthesis, microwave, Co-precipitation, Langmuir-Blodgett (L-B) method, Biological methods, synthesis using microorganism. **3.2.2** Applications in the field of semiconductors, solar cells.
4	**Characterization of Coordination compounds (15 Lectures)**
	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 and 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.

References:

Unit I

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2. W. W. Porterfield, Inorganic Chemistry-A Unified Approach, 2nd Ed., Academic Press, 1993.
3. B. W. Pfennig, Principles of Inorganic Chemistry, Wiley, 2015.
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11. J. N. Murrell, S. F. A. Kettle and J. M. Tedder, The Chemical Bond, Wiley, 1978.
12. G. A. Jeffrey, an Introduction to Hydrogen Bonding, Oxford University Press, Inc., 1997.

Unit II

1. F. A. Cotton, Chemical Applications of Group Theory, 2nd Edition, Wiley Eastern Ltd., 1989.
2. H. H. Jaffe and M. Orchin, Symmetry in Chemistry, John Wiley and Sons, New York, 1996.
3. R. L. Carter, Molecular Symmetry and Group Theory, John Wiley and Sons, New York, 1998.
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5. A. Salahuddin Kunju and G. Krishnan, Group Theory and its Applications in Chemistry, PHI Learning, 2012.
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7. S. Swarnalakshmi, T. Saroja and R. M. Ezhilarasi, A Simple Approach to Group Theory in Chemistry, Universities Press, 2008.

Unit III

1. Lesley E. Smart, Elaine A. Moore, Solid State Chemistry Introduction, ISBN 0- 203-49635-3, Taylor and Francis Group, LLC.
2. Catherine Brechignac, Philippe Houdy, Marcel Lahmani, Nanomaterials and Nanochemistry, 2007, ISBN 978-3-540-72992-1 Springer Berlin Heidelberg New York.
3. A. Muller, and A.K. Cheetham, WILEY-VCH Verlag GmbH and Co. KGaA, Weinheim. Nanomaterials Chemistry, Recent Developments and New Directions C.N.R. Rao, ISBN 978-3-527-31664-9, 2007.
4. Morton Rosoff, Nano-Surface Chemistry, 2001, ISBN: 0-8247-0254-9, Marcel DekkerInc. New York.
5. Muller Cheetham, WILEY-VCH Verlag GmbH and Co. KGaA, Weinheim, The Chemistry of Nanomaterials, CNR Rao, 2004.
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8. M.N. Avadhanulu, P.S. Hemne, S. Chand publication, An introduction to Lasers Theory and Applications
9. M. Grishin, Advances in solid state lasers development and Applications.
10. Walter Koechner, Michael Bass, Springer, Solid state Lasers- A Graduate Text.
11. A.R. Jha, CRC Press, Rare earth materials-properties and applications.

Unit IV

1. J. E. Huheey, E. A. Keiter and R. L. Keiter; Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education, 2006.
2. D. Banerjea, Coordination Chemistry.
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6. B. Douglas, D. McDaniel and J. Alexander. Concepts and Models of InorganicChemistry (3rd Edn.), John Wiley and Sons (1994).

Evaluation Pattern

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination:
1. Duration - These examinations shall be of two hours duration.
2. Theory question paper pattern:
a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units.
b. All questions shall be compulsory with internal choice within the questions.

Revised Syllabus of Courses of Master of Science (M.Sc.)
Programme at Semester I with Effect from the Academic Year
2023-2024

Name of the Course	Organic Chemistry-I
Course Code	PSCH102
Class	M.Sc.
Semester	I
No of Credits	4
Nature	Theory
Type	Major: Mandatory-II
Relevance with Employability/ Entrepreneurship/ Skill development	Organic chemistry plays a significant role in employability, entrepreneurship and skill development due to its wide ranging applications and relevance in various industries, such as polymer, pharmaceuticals, petrochemicals, agrochemicals, cosmetics, and environmental science. Understanding Organic reactions and synthesis is essential for designing and creating new compound with specific properties. Learner can apply organic chemistry knowledge to develop innovative products such as specialty chemicals, natural based products to meet specific market demand.

Organic Chemistry-I

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1	Physical Organic Chemistry	15
2	Stereochemistry	15
3	Nucleophilic substitution reactions and Aromaticity	15
4	Oxidation and Reduction	15
Total		**60**

Course Outcomes:

At the end of the Course, the Learner will be able to

1. Predict the reactivity of organic compound from its structure.
2. Understand different methods used for determination of Organic Reaction Mechanism.
3. Understand the fundamental concept in stereochemistry by applying various symmetry elements of organic molecule.
4. Acquire the knowledge of chirality by taking examples of symmetrical and unsymmetrical molecule.
5. Develop interest in stereochemistry by studying stereochemical features of different classes of organic compounds.
6. Identify the nomenclature of various stereochemical phenomena
7. Organize the techniques of aromatic nucleophilic substitution reactions for synthesizing/transforming molecules.
8. Understand the concept of aromaticity and to know the nature of bonds, electronic effects and other properties of molecules.
9. Understand the preparation of important oxidizing reagent and predict the selectivity of the reagents in organic reactions.
10. Explain the preparation and uses of important reducing reagents in various organic transformation reactions.

Curriculum:

Sr. No.	Modules / Units
1	**Physical Organic Chemistry (15 Lectures)**
	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.
2	**Stereochemistry (15 Lectures)**
	2.1. Concept of Chirality: Recognition of symmetry elements. **2.2.** Molecules with tri- and tetra-coordinate centers: Compounds with carbon, silicon, nitrogen, phosphorous 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 pseudoasymmetriccentres. R-S nomenclature for chiral centers in acyclic and cyclic compounds. **2.4. Axial and planar chirality:** Principles of axial and planar chirality. Stereo chemical features and configurational descriptors (R, S) for the following classes of compounds: allenes, alkylidene cycloalkanes, spirans, biaryls (buttressing effect) (including BINOLs and BINAPs), ansa compounds, cyclophanes, trans-cyclooctenes. **2.5. Prochirality:** Chiral and prochiral centres; 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 prochiralcentres ii) a chiral as well as a prochiralcentre, iii) a prochiral axis iv) a prochiral plane v) pro-pseudo-asymmetric centre. Symbols for enantiotopic and diastereotopic faces.
3	**Nucleophilic substitution reactions and Aromaticity (15 Lectures)**

	3.1. Nucleophilic substitution reactions: (9L) **3.1.1 Aliphatic nucleophilic substitution:** SN^1, SN^2, SN ^{i} reactions, mixed SN^1 and SN^2 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, SN^1 and SN^2 reactions. SN at sp2 (vinylic) carbon. **3.1.2 Aromatic nucleophilic substitution:** S_NAr, S_N1, 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: (6L)** **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).
4	**Oxidation and Reduction (15 Lectures)**
	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 $K_2Cr_2O_7/H_2SO_4$ (Jones reagent), CrO_3-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 HIO_4; cycloalkanones using CrO_3; carbon-carbon double bond using ozone, $KMnO_4$, CrO_3, $NaIO_4$ and OsO_4; aromatic rings using RuO_4 and $NaIO_4$. **4.1.4 Oxidation involving replacement of hydrogen by oxygen:** oxidation of CH_2 to CO by SeO_2, oxidation of arylmethanes by CrO_2Cl_2 (Etard oxidation). **4.1.5 Oxidation of aldehydes and ketones:** with H_2O_2 (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 CH_2 in aldehydes and ketones**-Clemmensen reduction, Wolff-Kishner reduction and Huang-Minlon modification. **4.2.2 Metal hydride reduction:** Boron reagents ($NaBH_4$, $NaCNBH_3$, diborane, 9-

	BBN, $Na(OAc)_3BH$, aluminium reagents ($LiAlH_4$, DIBAL-H, Red Al, L and K-selectrides). **4.2.3** N_2H_2 (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.

References:

1. NeilIsaacs, Physical Organic Chemistry.
2. Eric V. Anslynand Dennis A.Dougherty, Modern Physical Organic Chemistry.
3. Barton and Ollis, Comprehensive Organic chemistry, Vol-1.
4. J. Claydens, N. Greeves, S.Warren and P. Wothers, OxfordUniversity Press, Organic Chemistry,
5. F.A. Careyand R.J. Sundberg, Part A and B, Plenum Press, Advanced Organic Chemistry.
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11. R. Bruckner, Academic Press, Advanced Organic Chemistry: Reaction mechanisms.
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18. P.S. Kalsi, Organic reactions and their Mechanisms, New Age International Publishers.
19. R.O.C. Norman and J.M. Coxon, Nelson Thornes, Principles of Organic Synthesis.

Evaluation Pattern:

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60 Marks per paper Semester End Theory Examination:
1. Duration - These examinations shall be of two hours duration.
2. Theory question paper pattern:
a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units.
b. All questions shall be compulsory with internal choice within the questions.

Revised Syllabus of Courses of Master of Science (M.Sc.)
Programme at Semester I with Effect from the Academic Year
2023-2024

Name of the Course	Analytical Chemistry-I
Course Code	PSCH103
Class	M.Sc.
Semester	I
No of Credits	4
Nature	Theory
Type	Major: Mandatory-III
Relevance with Employability/ Entrepreneurship/ Skill development	Analytical chemistry plays a significant role in employability, entrepreneurship and skill development due to its wide ranging applications and relevance in various industries, such as polymer, pharmaceuticals, cement, ceramics, petrochemicals, agrochemicals, cosmetics, and environmental science. Learner can apply Analytical chemistry knowledge to develop and validate analytical method for particular pharmaceutical product. Learner can work as Quality control chemist in Laboratories of various chemical industry. Entrepreneurs can establish analytical testing laboratory that offer services to various industries including QC, environmental analysis.

Analytical Chemistry-I

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1.	Language of Analytical Chemistry and Quality in Analytical Chemistry	15
2.	Calculations based on Chemical Principles	15
3.	Optical Methods	15
4.	Instrumental Methods-I	15
Total		**60**

Course Outcomes:

At the end of the Course, the Learner will be able to

1. Understand various terms used in analytical chemistry.
2. Identify the different types of errors in analysis.
3. Sketch out the role and importance of total quality management, safety, accreditations and GLP in industries.
4. Understand the efficacy of automation in chemical analysis.
5. Design and specify applications of advanced analytical techniques in various fields.
6. Explore the applications of IR spectroscopy and thermal methods.
7. Perform basic calculations required in chemical analysis.
8. Interpret the experimental results of analytical technique

Curriculum:

Sr. No.	Modules / Units
1	**Language of Analytical Chemistry and Quality in Analytical Chemistry (15 Lectures)**
	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 [2 L] 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.
2	**Calculations based on Chemical Principles (15 Lectures)**
	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).
3	**Optical Methods (15 Lectures)**
	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 [6L]** **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.
4	**Instrumental Methods-I** **(15 Lectures)**
	4.1 Thermal Methods: [9L] **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. **4.2 Automation in chemical analysis: [6L]** **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 equipments. **4.2.4** Automatic titrators.

References:

Unit I

1. David Harvey, McGraw-Hill, Higher Education, Modern Analytical Chemistry ; (2000).
2. Skoog, Holler and Nieman, Principles of Instrumental Analysis ; 5th Edition, Ch: 1
3. Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch, Fundamentals of Analytical Chemistry, 9th Edition, 2004, Ch: 5.
4. J W Robinson, Marcel Dekker, Undergraduate Instrumental Analysis; 6th edition Ch:1.
5. David Hoyle, ISO 9000 Quality Systems Handbook; 4th edition (Chapter: 3 and 4) (Freedownload).
6. Elizabeth Pichard, Wiley India, Quality in the Analytical Laboratory ; Ch: 5, Ch: 6 andCh: 7.
7. Donna C S Summers, Prentice-Hall of India, Quality Management; Ch:3.
8. Parag Diwan, Deep and Deep Publications, Quality in Totality: A Manager‟s Guide To TQM and ISO 9000, 1st Edition, 2000.
9. P.L. Jain-Tata McGraw-Hill, Quality Control and Total Quality Management - ; (2006) Total Quality Management - Bester field - Pearson Education, Ch:5.
10. M H Fulekar, Industrial Hygiene and Chemical Safety,; Ch:9, Ch:11 and Ch:15.
11. M N Vyas, AtlanticPublisher, Safety and Hazards Management in Chemical Industries; Ch:4, Ch:5 and Ch:19.
12. World Health Organization (2009) Handbook: Good Laboratory Practice (GLP)
13. OECD Principles of Good Laboratory Practice (as revised in 1997)". OECD Environmental Health and Safety Publications. OECD. 1. 1998.

14. Klimisch, HJ; Andreae, M; Tillmann, U, "A systematic approach for evaluating the quality of experimental toxicological and eco-toxicological data".(1997). doi:10.1006/rtph.1996.1076. PMID 9056496.

Unit II

1. Chaums Solved problem series, ; David E.Goldbers, Mc Graw Hill international Editions, 3000 solved problems in chemistry, S Chapter 11,15,16,21,22.

Unit III

1. D. A. Skoog, F. J. Holler, T. A. Nieman, Principles of Instrumental Analysis,; 5th Edition, Harcourt Asia Publisher. Chapter 6, 7,8, 13, 14, 16,17
1. H. H. Willard, L. L. Merritt, J. A. Dean, F. A. Settle, Instrumental Methods of Analysis,; 6th Edition, CBS Publisher. Chapter 2.
2. R. D. Braun, McGraw Hill Publisher, Introduction to Instrumental Analysis, Chapter 5, 8, 12.
3. G. W. Ewing, McGraw Hill Publisher, Instrumental Methods of Chemical Analysis, 5th Edition, Chapter 3.
4. M. Ito, J. Mol. Spectrosc, The effect of temperature on ultraviolet absorption spectra and its relation to hydrogenbonding, 4 (1960) 106-124.
5. A. J. Somnessa, Spectrochim. Acta, The effect of temperature on the visible absorption band of iodine in several solvents;Part A: Molecular Spectroscopy, 33 (1977) 525-528.
6. Z. M. Khoshhesab (2012). Prof. TheophanidesTheophile (Ed.), Infrared Spectroscopy-Materials Science, Engineering and Technology. ISBN: 978-953- 51-0537-4, In Tech, (open access).

Unit IV

1. Robert D. Braun, Mc. Graw Hill,Introduction to instrumental methods of analysis; (1987): Chapter 27, 28.
2. R. T. Sane, Ghadge, Quest Publications, Thermal Analysis-theory and applications.
3. Willard, Merrit, Dean, Instrumental methods of analysis; 7 th Edition, Chapter 25, 264.
4. Skoog, Holler and Nieman, Instrumental Analysis, ; 5th Edition, Chapter 31,33
5. Vogel‟s Quantitative Chemical Analysis,; 6th Edition, Chapter 12.
6. James W. Dodd, W. Jamesand Kenneth H. Tonge, Analytical Chemistry - Open Learning: Thermal Methods.

Evaluation Pattern:

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination:

1. Duration - These examinations shall be of two hours duration.
2. Theory question paper pattern:

a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units.

b. All questions shall be compulsory with internal choice within the questions.

Revised Syllabus of Courses of Master of Science (M.Sc.)
Programme at Semester I with Effect from the Academic Year
2023-2024

Name of the Course	Chemistry Practical-I (Organic Chemistry and Analytical Chemistry)
Course Code	PSCH104
Class	M.Sc.
Semester	I
No of Credits	2
Nature	Practical
Type	Major: Mandatory- IV
Relevance with Employability/ Entrepreneurship/ Skill development	Practical Skills of organic and analytical chemistry experiments involve wide range of laboratory techniques Synthesis/preparation, distillation, extraction and purification., chromatography, Instrumental analysis Learner who have hands on experience with these techniques are highly sought in industries like pharmaceuticals, polymers, petrochemicals. Product development and analytical method development knowledge can be valuable for entrepreneurs looking for to develop new products and its analytical method development.

Chemistry Practical-I

(Organic Chemistry and Analytical Chemistry)

Course Outcomes:

At the end of the Course, the Learner will be able to

1. Learn determination of chemical types of different organic binary mixture
2. Learn to separate solid organic binary mixtures on the basis of solubility.
3. Learn to purify the separated organic compound by recrystallization technique.
4. Learn characterization steps of organic compounds.
5. Handle and get familiar with SOP's of instruments like potentiometer, conductivity meter, colorimeter and spectrophotometer.
6. Understand the concept of complexometric titrations and factors enhancing selectivity of EDTA as a titrant.
7. Apply the theory of FES to fertilizers analysis.
8. Develop scientific temperament and research-based skills accomplish to encountered in the field of research.

Curriculum:

Course	Modules	No. of Credits
Organic Chemistry	**Preparation :** **One step preparations (1.0 g scale)** 1. Bromobenzene to p-nitrobromobenzene 2. Anthracene to anthraquinone 3. Benzoin to benzyl 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 **(Minimum 08 experiments are expected)**	01

Analytical Chemistry	**Non-Instrumental** 1. To carry out assay of the sodium chloride injection by Volhard‟s method. 2. To determine (a) the ion exchange capacity (b) exchange efficiency of the given cation exchange resin. 3. To determine amount of Cr (III) and Fe (II) individually in a mixture of the two by titration with EDTA. 4. To determine number of nitro groups in the given compound using$TiCl_3$. **Instrumental** 1. To determine percentage purity of sodium carbonate in washing soda pH metrically. 2. To determine amount of Ti (III) and Fe(II) in a mixtureby 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.	01
Total		**02**

References:

1. A. I.Vogels, Quantitative Inorganic Analysis including Elementary Instrumental Analysis, 3rd Ed. ELBS (1964).
2. Mendham, Denny, Barnes,Thomas, Pearson education, Vogel's textbook of quantitative chemical analysis, Sixth Ed.
3. F. J. Welcher, Standard methods of chemical analysis; 1975.
4. F. J. Welcher, Standard methods of chemical analysis: Instrumental methods of Analysis; vol. 3, 1966.
5. W. W. Scott, "Standard methods of Chemical Analysis"; Vol. I, Van NostrandCompany, Inc.,1939.
6. E. B. Sandell and H. Onishi, "Spectrophotometric Determination of Traces of Metals" Part II, 4th Ed., A Wiley Interscience Publication, New York, 1978.

Evaluation Pattern: Practical

Max. Marks 50

A) Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Assessment during practicals (Interaction / Performance) Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of journal	15
02	Overall performance (attendance, punctuality, interaction during Practical session throughout semester)	05
Total		**20**

B) Semester End Examination: 60% (30 Marks)

Sr. No.	Name of course	Method	Duration	Marks
1.	Analytical Chemistry	Experiment performance as per the practical slip	Three and half hours	25
2.	Organic Chemistry	Experiment performance as per the practical slip	Three and half hours	25
3.	Journal + Viva			5+5
Total				**60**

Practical examination will be of 60 marks at the end of semester which will be converted to 30 Marks.

CIE	Semester End	Total Marks
20	30	50

Revised Syllabus of Courses of Master of Science (M.Sc.)
Programme atSemester I with Effect from the Academic Year
2023-2024

Name of the Course	Physical Chemistry I
Course Code	PSCH105
Class	M.Sc.
Semester	I
No of Credits	2
Nature	Theory
Type	Major: Elective I
Relevance with Employability/ Entrepreneurship/ Skill development	Chemical kinetics plays a crucial role in optimizing industrial process by understanding reaction rates and able to design efficient reactors. Learner can apply concept of kinetics in drug stability studies, and understanding pathways drug synthesis. Electrochemistry offers entrepreneurs to create environmentally friendly and sustainable solutions such as water purification system and renewable energy technologies.

Physical Chemistry I

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1	Chemical Kinetics and Molecular Dynamics-I	15
2	Electrochemistry	15
Total		**30**

Course Outcomes:

1. The learners evaluate the different theories of chemical kinetics and effect of temperature on reaction rates.
2. The learners will understand the applications of chain reactions in the field of Polymer Chemistry.
3. The learners will evaluate the resting membrane potential by using the concept of bio electrochemistry.
4. The learners will try to accomplish a solution to problems encountered in the field of research.

Curriculum:

Sr. No.	Modules / Units
1	**Chemical Kinetics and Molecular Dynamics-I (15 Lectures)**
	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.
2	**Electrochemistry (15 Lectures)**
	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] **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) [Ref: 14 and 16, 17, 18] **[Note: Numerical and theoretical problems from each unit are expected]**

References:

1. Peter Atkins and Julio de Paula, Atkin‟s Physical Chemistry, 7th Edn., 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, 3rd Edn., John Wiley and Sons (Asia) Pte. Ltd., 2002.
4. Ira R. Levine, Physical Chemistry, 5th Edn., Tata McGraw-Hill New Delhi, 2002.
5. G.W. Castellan, Physical Chemistry, 3rdEdn.,Narosa Publishing House, New Delhi, 1983.
6. S. Glasstone, Text Book of Physical Chemistry, 2nd Edn., McMillan and Co. Ltd., London, 1962
7. B.K. Sen, Quantum Chemistry including Spectroscopy, Kalyani Publishers, 2003.
8. A.K. Chandra, Introductory Quantum Chemistry, Tata McGraw – Hill, 1994.
9. R.K. Prasad, Quantum Chemistry, 2nd Edn., New Age International Publishers, 2000.
10. S. Glasstone, Thermodynamics for Chemists, Affiliated East-West Press, New Delhi, 1964.
11. W.G. Davis, Introduction to Chemical Thermodynamics – A Non – Calculus Approach, Saunders, Philadelphia, 19772.
12. Peter A. Rock, Chemical Thermodynamics, University Science Books, Oxford University Press, 1983.
13. Ira N. Levine, Quantum Chemistry, 5th Edn., Pearson Education (Singapore) Pte. Ltd., Indian Branch, New Delhi, 2000.
14. Thomas Engel and Philip Reid, Physical Chemistry, 3rd Edn., Pearson EducationLimited 2013.
15. D.N. Bajpai, Advanced Physical Chemistry, S. Chand 1st Edn., 1992.
16. Bockris, John O'M., Reddy, Amulya K.N., Gamboa-Aldeco, Maria E., Modern Electrochemistry, 2A, Plenum Publishers, 1998.
17. Gurtu and Gurtu, Physical Chemistry.
18. Dr. Harichandra A Parbat and Dr. Damodar V Prabhu, Essence of Chemical Kinetics, Sara Publication, First Edition, Sept. 2022.
19. K L Kapoor, A Text book of Physical Chemistry by Vol 5, 2nd Edn.

Evaluation Pattern:

Max. Marks 50

A) Continuous assessment : 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester	15
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities.	05

B) Semester End Examination: 60% (30 Marks)

30 Marks per paper Semester End Theory Examination:
1. Duration - These examinations shall be of one hour duration.
2. Theory question paper pattern.
a. There shall be two questions each of 10 marks on each unit and one question of 10 marks on all units.
b. All questions shall be compulsory with internal choice within the questions.

Revised Syllabus of Courses of Master of Science (M.Sc.)
Programme at Semester I with Effect from the Academic Year
2023-2024

Name of the Course	Chemistry Practical-E-I (Physical and Inorganic)
Course Code	PSCH106
Class	M.Sc.
Semester	I
No of Credits	2
Nature	Practical
Type	Major: Elective
Relevance with Employability/ Entrepreneurship/ Skill development	Practical Skills of physical and inorganic chemistry experiments involve wide range of laboratory techniques like Synthesis/preparation, extraction and purification, Instrumental analysis. Learners who have hands on experience with these techniques are highly sought in industries like pharmaceuticals, fine chemicals, ceramics. Product development and analytical method development knowledge can be valuable for entrepreneurs looking for to develop new products and its analytical method development.

Course Outcomes:

At the end of the Course, the Learner will be able to

Physical Chemistry Practical:

1. To Gain knowledge of the advanced concepts in pH metry, quantum mechanics, potentiometry and conductometry experiments.
2. To understand advance concept of thermodynamics and chemical kinetics in the chemical reactions.
3. To develop scientific temper and research based skills accomplish to encountered in the field of research.
4. To usage of subject fundamentals-principles with practical knowledge to design experiments, analyze and interpret data so as to reach to proper conclusions.
5. Learner will train the handling of equipments like potentiometer, conductivity meter, colorimeter and spectrophotometer.
6. Learner will develop scientific temper and research based skills accomplish to encountered in the field of research.

Inorganic Chemistry Practical:

1. To apply basic concepts of separation and estimation of metals ions from constituent ores/alloys effectively using chemical analysis.
2. To gain knowledge of employing instrumental techniques for quantitative analysis.
3. The learner can able to analyze structure, reactivity and reaction mechanisms of coordination compounds.
4. It explains various methods, concepts, highlights on effect of environment on human beings.
5. Will able to understand Commercial applications of novel materials in synthesis of compounds.

Curriculum:

Course	Modules	No. of Credits
Physical Chemistry	**Non – Instrumental:** 1. To determine the heat of solution (ΔH) of a sparingly soluble acid (benzoic/salicylic acid) from solubility measurement at three different temperature. 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 electrode. 4. To verify Ostwald‟s dilution law and to determine the dissociation constant of a weak mono-basic acid conductometrically.	**01**
Inorganic Chemistry	**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** 1. Estimation of Fe (III)solution using Ce (IV) ions Potentiometrically 2. Estimation of Copper using Iodometric method Potentiometrically 3. Estimation of Na_2CO_3 in washing soda by pH metry 4. Estimation of Cl^- ion in NaCl / KCl by Conductometry.	**01**
	Total	**02**

References:

Physical Chemistry Practical:

1. B. Viswanathan and P.S. Raghavan, Viva Books Private Limited, Practical Physical Chemistry, 2005.
2. A.M. James and F.E. Prichard, Practical Physical Chemistry, 3rd Edn., Longman Group Ltd., 1974.
3. V.D. Athawale and P. Mathur, Experimental Physical Chemistry, New Age International Publishers, 2001.

Inorganic Chemistry Practical:

1. G. N. Mukherjee., Advanced experiments in Inorganic Chemistry., 1st Edn., 2010., U. N. Dhuri and Sons Pvt. Ltd.
2. William L. Jolly, The Synthesis and Characterization of Inorganic Compounds.
3. Dr. Deepak Pant, Inorganic Chemistry Practical Under UGC Syllabus for M.Sc. in all India Universities.

Evaluation Pattern: Practical

Max. Marks 50

A) Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Assessment during practicals (Interaction / Performance) Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of journal	15
02	Overall performance (attendance, punctuality, interaction during Practical session throughout semester)	05
Total		**20**

B) Semester End Examination: 60% (30 Marks)

Sr. No.	Name of course	Method	Duration	Marks
1.	Physical Chemistry	Experiment performance as per the practical slip	Three and half hours	25
2.	Inorganic Chemistry	Experiment performance as per the practical slip	Three and half hours	25
	Journal + Viva			5+5
Total				**60**

Practical examination will be of 60 marks at the end of semester which will be converted to 30 Marks.

CIE	Semester End	Total Marks
20	30	50

Revised Syllabus of Courses of Master of Science (M.Sc.)
Programme atSemester I with Effect from the Academic Year
2023-2024

Name of the Course	Physical Chemistry II
Course Code	PSCH107
Class	M.Sc.
Semester	I
No of Credits	2
Nature	Theory
Type	Major: Elective II
Relevance with Employability/ Entrepreneurship/ Skill development	Quantum chemistry plays a crucial role in computational chemistry which is used to predict mode of chemical reaction and molecular properties. Learner with knowledge of Chemical thermodynamics and Quantum chemistry are in demand in academia, industries and research institutes.

Physical Chemistry II

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1	Thermodynamics-I	15
2	Quantum Chemistry	15
Total		**30**

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

1. The learners will apply the advanced thermodynamics, Maxwell equation and its applications to ideal gasses.
2. The learners will implement the applications of chemical thermodynamics to real gases, solutions, surfaces and their energetics.
3. The learners will understand the applications of operators and Schrodinger equation in the field of quantum Chemistry.
4. The learners will try to accomplish a solution to problems encountered in the field of research.

Curriculum:

Sr. No.	Modules / Units
1	**Thermodynamics-I (15 Lectures)**
	1.1 State function and exact differentials. Maxwell equations, Maxwell thermodynamic Relations; it‟s significance and applications to ideal gases, Joule Thomson experiment, Joule Thomson coefficient, inversion temperature, Joule Thomson coefficient in terms of van der Waals constants. **[8L]** **1.2** Third law of Thermodynamics, Entropy change for a phase transition, absolute entropies, determination of absolute entropies in terms of heat capacity, standard molar entropies and their dependence on molecular mass and molecular structure, residual entropy. **[7L] [Ref 2 and 1,10,11,12 17]**
2	**Quantum Chemistry (15 Lectures)**
	2.1 Classical Mechanics, failure of classical mechanics: Need for Quantum Mechanics. **2.2** Particle waves and Schrödinger wave equation, wave functions, properties of wave functions, Normalization of wave functions, orthogonality of wave functions. **2.3** Operators and their algebra, linear and Hermitian operators, operators for the

	dynamic variables of a system such as, position, linear momentum, angular momentum, total energy, eigen functions, eigen values and eigen value equation, Schrödinger wave equation as the eigen value equation of the Hamiltonian operator, average value and the expectation value of a dynamic variable of the system, Postulates of Quantum Mechanics, Schrodinger‟s Time independent wave equation from Schrodinger‟s time dependent wave equation. **2.4.** Application of quantum mechanics to the following systems: a) Free particle, wave function and energy of a free particle. b) Particle in a one, two and three dimensional box, separation of variables, Expression for the wave function of the system, expression for the energy of the system, concept of quantization, introduction of quantum number, degeneracy of the energy levels. c) Harmonic oscillator, approximate solution of the equation, Hermite polynomials, expression for wave function, expression for energy, use of the recursion formula. **[Ref 7, 8 and 9]**

References:

1. Peter Atkins and Julio de Paula, Atkin's Physical Chemistry, 7th Edn., OxfordUniversity 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, 3rd Edn., John Wiley and Sons (Asia) Pte. Ltd., 2002.
4. Ira R. Levine, Physical Chemistry, 5th Edn., Tata McGraw-Hill New Delhi, 2002.
5. G.W. Castellan, Physical Chemistry, 3rd Edn., Narosa Publishing House, New Delhi, 1983.
6. S. Glasstone, Text Book of Physical Chemistry, 2nd Edn., McMillan and Co. Ltd., London, 1962
7. B.K. Sen, Quantum Chemistry including Spectroscopy, Kalyani Publishers, 2003.
8. A.K. Chandra, Introductory Quantum Chemistry, Tata McGraw – Hill, 1994.
9. R.K. Prasad, Quantum Chemistry, 2nd Edn., New Age International Publishers, 2000.
10. S. Glasstone, Thermodynamics for Chemists, Affiliated East-West Press, New Delhi, 1964.
11. W.G. Davis, Introduction to Chemical Thermodynamics – A Non – Calculus Approach, Saunders, Philadelphia, 1972.
12. Peter A. Rock, Chemical Thermodynamics, University Science Books, Oxford University Press, 1983.
13. Ira N. Levine, Quantum Chemistry, 5th Edn., Pearson Education (Singapore) Pte. Ltd., Indian Branch, New Delhi, 2000.
14. Thomas Engel and Philip Reid, Physical Chemistry, 3rd Edn., Pearson Education Limited 2013.
15. D.N. Bajpai, Advanced Physical Chemistry, S. Chand 1st Edn., 1992.
16. Bockris, John O'M., Reddy, Amulya K.N., Gamboa-Aldeco, Maria E., Modern Electrochemistry, 2A, Plenum Publishers, 1998.

17. Gurtu and Gurtu, Physical Chemistry.
18. Dr. Harichandra A Parbat and Dr. Damodar V Prabhu, Essence of Chemical Kinetics, Sara Publication, First Edition, Sept. 2022.
19. K L Kapoor, A Text book of Physical Chemistry by Vol 5, 2nd Edn.

Evaluation Pattern:

Max. Marks 50

A) Continuous assessment : 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester.	15
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities.	05

B) Semester End Examination: 60% (30 Marks)

30 Marks per paper Semester End Theory Examination:
1. Duration - These examinations shall be of one hour duration.
2. Theory question paper pattern:
a. There shall be two questions each of 10 marks on each unit and one question of 10 marks on all units.
b. All questions shall be compulsory with internal choice within the questions.

Revised Syllabus of Courses of Master of Science (M.Sc.)
Programme at Semester I with Effect from the Academic Year
2023-2024

Name of the Course	Physical and Inorganic Chemistry Practical-II
Course Code	PSCH108
Class	M.Sc.
Semester	I
No of Credits	2
Nature	Practical
Type	Major: Elective II
Relevance with Employability/ Entrepreneurship/ Skill development	Physical chemistry experiments require precise laboratory skills, such as handling of sensitive instruments. Measuring accurately and executing complex procedures. It enhances ability to design and execute experiments and analyze data. By conducting advance Inorganic chemistry experiments at PG level hones laboratory techniques and analytical skills, making learner suitable for research and industry.

Course Outcomes:

At the end of the Course, the Learner will be able to

Physical Chemistry Practical:

1. To Gain knowledge of the advanced concepts in pH metry, quantum mechanics, potentiometry and conductometry experiments.
2. To understand advance concept of thermodynamics and chemical kinetics in the chemical reactions.
3. To develop scientific temper and research based skills accomplish to encountered in the field of research.
4. To usage of subject fundamentals-principles with practical knowledge to design experiments, analyze and interpret data so as to reach to proper conclusions.
5. Learner will train the handling of equipments like potentiometer, conductivity meter, colorimeter and spectrophotometer.
6. Learner will develop scientific temper and research based skills accomplish to encounteredin the field of research.

Inorganic Chemistry Practical:

1. To apply basic concepts of separation and estimation of metals ions from constituent ores/alloys effectively using chemical analysis
2. To gain knowledge of employing instrumental techniques for quantitative analysis.
3. The learner can able to analyze structure, reactivity and reaction mechanisms of coordination compounds.
4. It explains various methods, concepts, highlights on effect of environment on human beings.
5. Will able to understand Commercial applications of novel materials in synthesis of compounds.

Course	Modules	No. of Credits
Physical Chemistry	**Non – Instrumental:** 1. To determine the heat of solution (ΔH) of a sparingly soluble acid (benzoic/salicylic acid) from solubility measurement at three different temperature. 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:** 5. To determine the mean ionic activity coefficient of an electrolyte by e.m.f. measurement. 6. To study the effect of substituent on the dissociation constant of acetic acid conductometrically. 7. To determine pKa values of phosphoric acid by potentiometric titration with sodium hydroxide using glass electrode. 8. To verify Ostwald‟s dilution law and to determine the dissociation constant of a weak mono-basic acid conductometrically.	01
Inorganic Chemistry	**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 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.	01
Total		**02**

References:

Physical Chemistry Practical:

1. B. Viswanathan and P.S. Raghavan, Viva Books Private Limited, Practical Physical Chemistry, 2005.
2. A.M. James and F.E. Prichard, Practical Physical Chemistry, 3rdEdn., LongmanGroup Ltd., 1974.
3. E V.D. Athawale and P. Mathur, New Age International Publishers, experimental Physical Chemistry, 2001.

Inorganic Chemistry Practical:

1. G. N. Mukherjee., U.N. Dhuri and Sons Pvt Ltd. Advanced experiments in Inorganic Chemistry., 1st Edn., 2010.,
2. William L. Jolly, The Synthesis and Characterization of Inorganic Compounds.
3. Dr. Deepak Pant, Inorganic Chemistry Practical Under UGC Syllabus for M.Sc. in all India Universities.

Evaluation Pattern: Practical Max. Marks 50

A) Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Assessment during practicals (Interaction / Performance) Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of Journal.	15
04	Overall performance (attendance, punctuality, interaction during Practical session throughout semester).	05
Total		**20**

B) Semester End Examination: 60% (30 Marks)

Sr. No.	Name of course	Method	Duration	Marks
1.	Physical Chemistry	Experiment performance as per the practical slip	Three and half hours	25
2.	Inorganic Chemistry	Experiment performance as per the practical slip	Three and half hours	25
	Journal + Viva			5+5
Total				**60**

Practical examination will be of 60 marks at the end of semester which will be converted to 30 Marks.

CIE/ Internal	Semester End	Total Marks
20	30	50

Revised Syllabus of Courses of Master of Science (M.Sc.)
Programme at Semester I with Effect from the Academic Year
2023-2024

Name of the Course	Research Methodology
Course Code	PSCH109
Class	M.Sc.
Semester	I
No of Credits	4
Nature	Theory
Type	Research Methodology
Relevance with Employability/ Entrepreneurship/ Skill development	Learner will gain the knowledge of Research Methodology in Chemistry. Further, the learner will be benefited in the form of increase in research aptitude, analytical and decision- making skills. Acquisition of the knowledge in the field of research will increase the chances of employability and will offer better prospects in industry.

Research Methodology

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1	Fundamentals of Research Methods	15
2	Research Design and Measurement Concepts and LiteratureSearching	15
3	Documentation, scientific writing and Academic Integrity	15
4	Hypothesis Testing and Communication Skills in Research	15
Total		**60**

Course Outcomes:

Student will able to: -

1. Understand fundamentals of research methods
2. Learn design and measurement concepts of research
3. Know data collection and analysis tools
4. Test the hypothesis and communicate the research findings effectively
5. Write research report, research proposal, research paper etc. and get acquainted with ethicalconsiderations in research tools.

Curriculum:

Sr. No.	Modules / Units
1	**Fundamental of Research Methods (15 Lectures)**
	Definition of research, Role and objectives of research, importance of research, Applications and types of research, Creativity and innovation, Critical thinking, Research process and steps in it, Collecting and reviewing the literature, Conceptualization and Formulation of: research problem, identifying variables, constructing hypothesis and Synopsis. Interpretation of resultsand discussion

2	**Research Design and Measurement Concept and Literature Searching (15 Lectures)**
	Selecting and defining a research problem, Need forresearch design, Features of a good research design, Different research designs, Scales of measurements,Nominal, Ordinal, Internal and ratio scales, Errors in measurements, Validity and Reliability in measurement, Scale Construction Techniques. Digital: Web sources, E-journals, Journal access,Citation Index, Impact factor, H-index, E- consortium, UGC info net, eBooks, Internet discussion groups and communities, Blogs, preprint servers, Search engines, Google Scholar,Scopus.
3	**Documentation, scientific writing and Academic Integrity (15 Lectures)**
	Documentation and scientific writing: Results and Conclusions, Preparation of manuscript for Publication of Research paper, Presenting a paper in scientific seminar, Thesis writing. Structure and Components of Research Report, Types of Report: research papers, thesis, Research Project Reports, Pictures and Graphs, citation styles, writing a review of paper, Bibliography. for illustration, style,publications of scientific work, Research and Academic Integrity: Intellectual property rights (IPRs). Plagiarism, Copyright issues,Ethics in research, and case studies.
4	**Hypothesis Testing and Communication Skills in Research (15 Lectures)**
	Hypotheses, Meaning, Nature of hypothesis, Functions of Hypothesis, Importance of Hypothesis, Kinds of Hypothesis, Characteristics of good hypothesis Hypothesis testing**:** Null and alternate hypothesis, Type I and Type II errors, Level of significance, Power of test, p-value Communication skills: Importance communication through English, The process of communication and factors that influence communication. Sender, receiver, channel, code, topic, message, context, feedback, noise, filters, and barriers. Verbal and Non verbal communication, Comparison of general communication andbusiness communication. Presentation skills: Structure of presentation, Types of presentation, oral power Presentation Handling, power point slides, organization, content, bodylanguage geasture and voice, modulation

References:

1. Kothari C.R., “Research Methodology, Methods and Techniques” (Second revised edition,New Age International Publication, 2004).
2. Saravanavel P., “Research Methodology” (Kitab Mahal, Sixteenth edition, 2007).
3. Ranjit Kumar, “Research Methodology, a step-by-step guide for beginners” (Pearsoneducation Australia, Second edition 2005).
4. Mark Saunders, Philip Lewis, Adrain Thornhiu, “Research Methods for BusinessStudents”(Pearson Education ltd, Seventh edition, 2016)
5. Research Methodology and Scientific Writing by C. George Thomas 2nd Ed. Springer
6. Thesis & Assignment Writing–J Anderson, B.H.Dursten & M.Poole, Wiley Eastern, 1977
7. A Hand Book of Methodology of Research – P. Rajammal and P. Devadoss, R. M. M. Vidya Press,1976.
8. The Craft of Scientific Writing by Michael Alley, (Springer).
9. Research Methodology by R. Panneerselvam, PHI, New Delhi 2005
10. Research Methodology- A step by step Guide for Beginners, (2nd ed.) Kumar Ranjit,2005, Pearson Education.
11. How to write and publish by Robert A. Day and Barbara Gastel, (Cambridge University Press).
12. S. Gupta, (2005). Research Methodology and Statistical techniques, Deep and Deep Publications (P) Ltd. New Delhi, India.
13. R. Kothari, (2008). Research Methodology, New Age International, New Delhi, India.

Evaluation Pattern:

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester.	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities.	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination:
1. Duration - These examinations shall be of two hours duration.
2. Theory question paper pattern:
a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units.
b. All questions shall be compulsory with internal choice within the questions.

Revised Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester II with Effect from the Academic Year 2023-2024

No. of Courses	Semester II	Credits
	Major: Mandatory	
PSCH 201	Inorganic Chemistry-II	4
PSCH 202	Organic Chemistry-II	4
PSCH 203	Analytical Chemistry-II	4
PSCH 204	Chemistry Practical-II (Organic Chemistry and Analytical Chemistry)	2
	Major: Elective (Any One from below)	
PSCH 205	Physical Chemistry III	4
PSCH 206	Chemistry Practical E-III (Physical and Inorganic Chemistry)	
PSCH 207	Physical Chemistry IV	4
PSCH 208	Chemistry Practical E-IV (Physical and Inorganic Chemistry)	
PSCH 209	On the Job Training/ Field Projects	4
Total Credits		22

Revised Syllabus of Courses of Master of Science (M.Sc.)
Programme at Semester II with Effect from the Academic Year
2023-2024

Name of the Course	Inorganic Chemistry-II
Course Code	PSCH201
Class	M.Sc.
Semester	II
No of Credits	4
Nature	Theory
Type	Major: Mandatory-II
Employability/ Entrepreneurship/ Skill Development	Inorganic chemistry plays a significant role in employability, entrepreneurship and skill development due to its wide ranging applications and relevance in various industries, such as material science, electronics, ceramics, pharmaceuticals, and environmental science. Entrepreneurs in fields like material science and nanotechnology rely on inorganic chemistry principles to innovate. Thus a course provides Post Graduates with analytical skills, problem solving skills, research capabilities which empower them to pursue a diverse path career.

Inorganic Chemistry-II

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1	Inorganic Reaction Mechanism	15
2	Organometallic Chemistry of Transition metals	15
3	Environmental Chemistry	15
4	Bioinorganic Chemistry	15
Total		**60**

Course Outcomes:

The learners will be able to study rates of reactions and the factors affecting them and understand the different techniques used to study the rate of the reaction.

1. The learners will be able to learn ligand substitution reactions of Octahedral and Square planar complexes, Trans effect and factors affecting these substitution reactions.
2. The learners will be able to understand the 18 and 16 electron square planar complexes by studying different examples. They will also learn the preparation and properties of a few selected compounds including sandwich compounds of Fe, Cr
3. The learners will understand the structure and bonding of a few inorganic compounds like Ziese‟s salt, ferrocene and bis(arene)chromium(0)
4. The learners will understand the occurrence and effect of toxic metals like Pb, As, Cu, Cd, and Hg on the environment, the different diseases caused by poisoning of metals and the impact these metals have on the living organism.
5. The learners will be familiar with the role of Inorganic chemistry in Biological systems, understand the structure of various biological oxygen carriers and molecules involved in electron storage and transport.

Curriculum:

Sr. No.	Modules / Units
1	**Inorganic Reaction Mechanism (15 Lectures)**
	1.1 Rate of reactions, factors affecting the rate of reactions, techniques for determination of rate of reaction (Direct chemical analysis, spectrophotometric method, electrochemical and flow methods). **1.2 Ligand substitution reactions of:** a) Octahedral complexes without breaking of metal-ligand bond (Use of isotopic labelling method). b) Square planar complexes, trans-effect, its theories and applications. Mechanism and factors affecting these substitution reactions. **1.3 Redox reactions:** inner and outer sphere mechanisms, complimentary and non-complimentary reactions. **1.4** Isomerization and racemization reactions.
2	**Organometallic Chemistry of Transition metals (15 Lectures)**
	2.1 Eighteen electron rule and electron counting with examples, sixteen electronSquare Planar complexes. **2.2** Preparation and properties of the following compounds (a) Alkyl and aryl derivatives of Pd and Pt complexes (b) Carbenes and carbynes of Cr, Mo and W (c) Alkene derivatives of Pd and Pt (d) Alkyne derivatives of Pd and Pt (e) Allyl derivatives of nickel (f) Sandwich compounds of Fe, Cr and Half Sandwich compounds of Cr, Mo. **2.3** Structure and bonding on the basis of VBT and MOT in the following organometallic compounds: Zeise‟s salt, bis(triphenylphosphine)diphenylacetylene platinum (0) $[Pt(PPh_3)_2(HC{\equiv}CPh)_2]$, diallylnickel(diallylnickel(II), ferrocene and bis(arene)chromium(0), tricarbonyl (η^2-butadiene) iron(0).
3	**Environmental Chemistry (15 Lectures)**
	3.1. Conception of Heavy Metals: Critical discussion on heavy metals **3.2. Toxicity of metallic species:** a) Mercury, lead, cadmium, arsenic, copper and chromium, with respect to their sources, distribution, speciation, biochemical effects and toxicology, control and treatment. b) Itai-itai disease for Cadmium toxicity, c) Arsenic Poisoning in the Indo-Bangladesh region. **3.3. Interaction of radiation in context with the environment:** Sources and biological implication of radioactive materials. Effect of low-level radiation on cells- Its applications in diagnosis and treatment, Effect of radiation on cell proliferation and cancer.

4	**Bioinorganic Chemistry** **(15 Lectures)**
	4.1 Biological oxygen carriers; hemoglobin, hemerythrene and hemocyanine-structure of metal active center and differences in mechanism of oxygen binding, Differences between hemoglobin and myoglobin: Cooperativity of oxygen binding in hemoglobin and Hill equation, pH dependence of oxygen affinity in hemoglobin and myoglobin and its implications. **4.2** Activation of oxygen in biological system with examples of mono-oxygenases. **4.3** Copper containing enzymes- superoxide dismutase, **4.4** Nitrogen fixation-nitrogenase, hydrogenases. **4.5** Metal ion transport and storage: Ionophores, transferrin, ferritin and metallothionins. **4.6** Medicinal applications of cis-platin and related compounds.

References:

Unit I

1. P. Atkins, T. Overton, J. Rourke, M. Weller and F. Armstrong, Inorganic Chemistry, 5th Ed., Oxford University Press, 2010.
2. D. Banerjea, Coordination Chemistry, Tata McGraw Hill, 1993.
3. W. H. Malik, G. D./Tuli and R. D. Madan, S. Chand and Company ltd, Selected Topics in Inorganic Chemistry,8th Ed.
4. M. L. Tobe and J. Burgess, Inorganic Reaction Mechanism, Longman, 1999.
5. S. Asperger, Chemical kinetics and Inorganic Reaction Mechanism, 2nd Ed., Kluwer Academic/ Plenum Publishers, 2002.
6. Gurdeep Raj, Advanced Inorganic Chemistry-Vol.II, 12th Edition, Goel publishing house.
7. B. R. Puri, L. R. Sharma and K. C. Kalia, Principles of Inorganic Chemistry,Milestone Publishers, 2013-2014.
8. F. Basalo and R. G. Pearson, Wiley, Mechanism of Inorganic Reactions, 2nd Ed., 1967.
9. R. Gopalan and V. Ramlingam, Vikas Publishing house Pvt Ltd., Concise Coordination chemistry, 2001.
10. Robert B. Jordan, Reaction Mechanisms of Inorganic and Organometallic Systems, 3rd Ed., Oxford University Press 2008.

Unit II

1. D. Banerjea, Coordination chemistry. Tata McGrew Hill, New Delhi, 1993.
2. R.C Mehrotra and A.Singh, Organometallic Chemistry- A unified Approach, 2nded, New Age International Pvt Ltd, 2000.
3. R.H Crabtree, The Organometallic Chemistry of the Transition Metals, 5th edition, Wiley International Pvt, Ltd 2000.
4. B.Doughlas, D.H McDaniel and J.J Alexander. Concepts and Models of Inorganic Chemistry, 2nd edition, John Wiley and Sons. 1983.
5. G.S Sodhi. Ane Books Pvt Ltd., Organometallic Chemistry.

Unit III

1. Colin Baird Michael Cann, W. H. Freeman and Company, Environmental Chemistry 5th edition, New York, 2012.
2. Stanley E. Manahan, CRC Press Publishers, Environmental Chemistry 7th edition.
3. Daniel A. Vallero, Environmental Contaminants, ISBN: 0-12-710057-1, Elsevier Inc., 2004.
4. G. Tyler Miller Jr. and Scott E. Spoolman, Environmental Science 13th edition, ISBN-10: 0-495-56016-2, Brooks/Cole, Cengage Learning, 2010.
5. Stanley E. Manahan, Fundamentals of Environmental and Toxicological Chemistry 4th edition, ISBN: 978-1-4665-5317-0, CRC Press Taylor and Francis Group, 2013.
6. G. Tyler Miller Jr. and Scott E. Spoolman, Living in the Environment 17th edition, ISBN10: 0-538-49414-X, Brooks/Cole, Cengage Learning, 2011.
7. Jerrold B. Leikin, Frank P. Paloucek, Poisoning and Toxicology Handbook, ISBN: 1-4200-4479-6, Informa Healthcare USA, Inc.
8. Casarett and Doull‟s Toxicology- The Basic Science of Poisons 6th edition, McGraw-Hill, 2001.

Unit IV

1. R. W. Hay, Bioinorganic Chemistry, Ellis Harwood, England, 1984.
2. I. Bertini, H.B.Gray, S. J. Lippard and J.S. Valentine, Bioinorganic Chemistry, First South Indian Edition, Viva Books, New Delhi, 1998.
3. J. A. Cowan, Inorganic Biochemistry-An introduction, VCH Publication, 1993.
4. S. J. Lippard and J. M. Berg, Principles of Bioinorganic Chemistry, University Science Publications, Mill Valley, Caligronic, 1994.
5. G.N. Mukherjee and A. Das, Elements of Bioinorganic Chemistry, Dhuriand Sons, Calcutta, 1988.
6. J.Chem. Educ. (Special issue), Nov, 1985.
7. E.Frienden, J.Chem. Educ., 1985, 62.
8. Robert R.Crechton, Biological Inorganic Chemistry – An Introduction, Elsevier
9. J. R. Frausto da Silva and R. J. P. Williams The Biological Chemistry of the Elements, Clarendon Press, Oxford, 1991.
10. JM. D. Yudkin and R. E. Offord A Guidebook to Biochemistry, Cambridge University Press, 1980.

Evaluation Pattern

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given Semester.	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination:
1. Duration - These examinations shall be of two and half hours duration.
2. Theory question paper pattern:
a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units.
b. All questions shall be compulsory with internal choice within the questions.

Revised Syllabus of Courses of Master of Science (M.Sc.)

Programme at Semester II with Effect from the Academic Year

2023-2024

Name of the Course	Organic Chemistry-II
Course Code	PSCH202
Class	M.Sc.
Semester	II
No of Credits	4
Nature	Theory
Type	Major: Mandatory-II
Relevance with Employability/ Entrepreneurship/ Skill development	Organic chemistry plays a significant role in employability, entrepreneurship and skill development due to its wide ranging applications and relevance in various industries, such as polymer, pharmaceuticals, petrochemicals, agrochemicals, cosmetics, and environmental science. Learner can apply organic chemistry knowledge to develop innovative products such as specialty chemicals, natural based products to meet specific market demand. Learners will be able to interoperate spectra using 13C NMR and Mass spectrometry.

Organic Chemistry-II

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1	Alkylation of Nucleophilic Carbon Intermediates and Reaction of carbonnucleophiles with carbonyl groups	15
2	Introduction to Molecular Orbital Theory for Organic Chemistry andApplications of UV and IR spectroscopy	15
3	Reactions and Rearrangements	15
4	^{1}H and ^{13}C NMR spectroscopy and Mass spectrometry	15
Total		**60**

Course Outcomes:

At the end of the Course, the Learner will be able to

1. Recognize the type of mechanism and intermediates involved in the given organic reaction and to prove mechanism for the reaction.
2. Identify the ways to modify aliphatic and aromatic compounds via Nucleophilc substitution reactions.
3. Predict the mechanism and stereochemistry of important organic reactions.
4. Understand and write the mechanism of rearrangement reactions with stereochemistry and its applications.
5. Understand the HOMO-LUMO concept and it significance in organic chemistry.
6. Understand the basic principle and concepts in UV and IR spectroscopy
7. Understand the basic concepts of ^{1}H, ^{13}C NMR, and mass spectroscopy.
8. Understand how ^{1}H, ^{13}C NMR and Mass spectroscopy are important for the structure determination of organic compounds.

Curriculum:

Sr. No.	Modules / Units
1	**Alkylation of Nucleophilic Carbon Intermediates and Reaction of carbon nucleophiles with carbonyl groups (15 Lectures)**
	1.1 Alkylation of Nucleophilic Carbon Intermediates: **1.1.1** Generation of carbanion, kinetic and thermodynamic enolate formation, Regioselectivity in enolate formation, alkylation of enolates. **1.1.2** Generation and alkylation of dianion, medium effects in the alkylation of enolates, oxygen versus carbon as the site of alkylation. **1.1.3** Alkylation of aldehydes, ketones, esters, amides and nitriles.

	1.1.4 Nitrogen analogs of enols and enolates- Enamines and Imines anions, alkylation of enamines and imines. **1.1.5** Alkylation of carbon nucleophiles by conjugate addition (Michael reaction). **1.2. Reaction of carbon nucleophiles with carbonyl groups:** **1.2.1** Mechanism of Acid and base catalyzed Aldol condensation, Mixed Aldol condensation with aromatic aldehydes, regiochemistry in mixed reactions of aliphatic aldehydes and ketones, intramolecular Aldol reaction and Robinson annulation. **1.2.2** Addition reactions with amines and iminium ions; Mannich reaction. **1.2.3** Amine catalyzed condensation reaction: Knoevenagel reaction. **1.2.4** Acylation of carbanions.
2	**Introduction to Molecular Orbital Theory for Organic Chemistry and Applications of UV and IR spectroscopy (15 Lectures)**
	2.1. Introduction to Molecular Orbital Theory for Organic Chemistry: (7L) **2.1.1** Molecular orbitals: Formation of σ- and π-MOs by using LCAO method. Formation of π MOs of ethylene, butadiene, 1, 3, 5-hexatriene, allyl cation, anion and radical. Concept of nodal planes and energies of π-MOs **2.1.2** Introduction to FMOs: HOMO and LUMO and significance of HOMO LUMO gap in absorption spectra as well as chemical reactions. MOs of formaldehyde: The effect of electronegativity perturbation and orbital polarization in formaldehyde. HOMO and LUMO (π and π* orbitals) of formaldehyde. A brief description of MOs of nucleophiles and electrophiles. Concept of „donor-acceptor" interactions in nucleophilic addition reactions on formaldehyde. Connection of this HOMO-LUMO interaction with „curved arrows" used in reaction mechanisms. The concept of hardness and softness and its application to electrophiles and nucleophiles. Examples of hard and soft nucleophiles/ electrophiles. Identification of hard and soft reactive sites on the basis of MOs. **2.1.3** Application of FMO concepts in (a) SN^2reaction, (b) Lewis acid base adducts (BF3-NH3 complex), (c) ethylene dimerization to Cyclobutane, (d) Diels-Alder cycloaddition, (e) regioselective reaction of allyl cation with allyl anion (f) addition of hydride to formaldehyde. **2.2. Applications of UV and IR spectroscopy: (8L)** **2.2.1 Ultraviolet spectroscopy:** Recapitulation, UV spectra of dienes, conjugated polyenes (cyclic and acyclic), carbonyl and unsaturated carbonyl compounds, substituted aromatic compounds. Factors affecting the position and intensity of UV bands – effect of conjugation, steric factor, pH, and solvent polarity. Calculation of absorption maxima for above classes of compounds by Woodward-Fieser rules (using Woodward-Fieser tables for values for substituents). **2.2.2 Infrared spectroscopy:** Fundamental, overtone and combination bands, vibrational coupling, factors affecting vibrational frequency (atomic weight, conjugation, ring size, solvent and hydrogen bonding). Characteristic vibrational frequencies for alkanes, alkenes, alkynes, aromatics, alcohols, ethers, phenols,

	amines, nitriles and nitro compounds. Detailed study of vibrational frequencies of carbonyl compounds, aldehydes, ketones, esters, amides, acids, acid halides, anhydrides, lactones, lactams and conjugated carbonyl compounds.
3	**Reactions and Rearrangements (15 Lectures)**
	Mechanisms, stereochemistry (if applicable) and applications of the following: **3.1. Reactions:** Baylis-Hillman reaction, McMurry Coupling, Corey-Fuchs reaction, Nef reaction, Passerini reaction. **3.2. Concerted rearrangements:** Hofmann, Curtius, Lossen, Schmidt, Wolff, BoultonKatritzky. **3.3. Cationic rearrangements:** Tiffeneau-Demjanov, Pummerer, Dienone-phenol, Rupe, Wagner-Meerwein. **3.4. Anionic rearrangements:** Brook, Neber, Von Richter, Wittig, Gabriel–Colman, Baker-Venkataraman.
4	**^{1}H and ^{13}C NMR spectroscopy and Mass spectrometry (15 Lectures)**
	4.1. Proton magnetic resonance spectroscopy: Principle, Chemical shift, Factors affecting on chemical shift (Electronegativity, H-bonding, Anisotropy effects). Chemical and magnetic equivalence, Chemical shift values and correlation for protons bonded to carbon and other nuclei as in alcohols, phenols, enols, carboxylic acids, amines, amides. Spin-spin coupling, Coupling constant (J), Factors affecting J, geminal, vicinal, Karplusequation, long range coupling (allylic and aromatic). **4.2. 13C NMR spectroscopy:** Theory and comparison with proton NMR, proton coupled and decoupled spectra, off-resonance decoupling. Factors influencing carbon shifts, correlation of chemical shifts of aliphatic, olefin, alkyne, aromatic and carbonyl carbons. **4.3. Mass spectrometry:** Basic Principle, Molecular ion peak, base peak, isotopic abundance, metastable ions. Nitrogen rule, Determination of molecular formula of organic compounds based on isotopic abundance and HRMS.Fragmentation pattern in various classes of organic compounds (including compounds containing hetero atoms), McLafferty rearrangement, Retro-Diels-Alder reaction, ortho effect. **4.4.** Structure determination involving individual or combined use of the above spectral techniques.

References:

1. J. Claydens, N.Greeves, S.Warrenand, P.Wothers, Oxford University Press., Organic Chemistry.
2. F.A. Carey and R.J. Sundberg, Advanced Organic Chemistry, Part A, page no.713-769,and B, Plenum Press.
3. Michael, B.Smith, Jerry March, Wiley. March‟s Advanced Organic Chemistry: Reactions, Mechanisms and Structure.

4. R.T. Morrison, R.N. Boydand, S.K. Bhattacharjee, Pearson Publication Organic Chemistry, (7^{th} Edition).
5. B. Millerand R. Prasad,Pearson Education., Advanced Organic Chemistry: Reactions and mechanism.
6. R.Bruckner, Academic Press., Advanced Organic Chemistry: Reaction mechanisms.
7. Adams Jacobs, Cambridge University Press., Understanding Organic Reaction Mechanisms.
8. A. Miller, P. H. Solomons, Academic Press., Writing Reaction Mechanism in organic chemistry.
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11. Mechanism in Organic Chemistry, eter Sykes,6^{th}.
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15. William Kemp, W. H. Freeman andCompany., Organic Spectroscopy.
16. Jagmohan, Narosa Publication., Organic Spectroscopy-Principlesand Applications.
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19. V.K. Ahluwalia, R. K. Parashar, Alpha Science International, Organic Reaction Mechanisms, 2011.
20. Jie Jack Li, Springer, Name Reactions.
21. V.K. Ahluwalia, R.K Parasher, Alpha Science International, Organic Reaction Mechanisms, 2011.
22. S.N. Sanyal, Reactions, Rearrangements and Reagents.
23. Bradford P. Mundy, M.G. Ellerd and F.G. Favaloro, John Wiley and Sons., Name reactions and Reagents in Organic Synthesis.
24. P.S. Kalsi, New Age International Publishers., Organic reactions and their Mechanisms.
25. Y. R. Sharma, (S. Chand Publications), Elementary Organic Spectroscopy.

Evaluation Pattern:

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given Semester.	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities.	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination:
1. Duration - These examinations shall be of two hours duration.
2. Theory question paper pattern:
a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units.
b. All questions shall be compulsory with internal choice within the questions.

Revised Syllabus of Courses of Master of Science (M.Sc.)

Programme at Semester II with Effect from the Academic Year

2023-2024

Name of the Course	Analytical Chemistry-II
Course Code	PSCH203
Class	M.Sc.
Semester	II
No of Credits	4
Nature	Theory
Type	Major: Mandatory-III
Relevance with Employability/ Entrepreneurship/ Skill development	Analytical chemistry plays a significant role in employability, entrepreneurship and skill development due to its wide ranging applications and relevance in various industries, such as polymer, pharmaceuticals, cement, ceramics, petrochemicals, agrochemicals, cosmetics, and environmental science. Learner can apply Analytical chemistry knowledge to develop and validate analytical method for particular pharmaceutical product. Learner can work as Quality control chemist in Laboratories of various chemical industry. Entrepreneurs can establish analytical testing laboratory that offer services to various industries including QC, environmental analysis.

Analytical Chemistry-II

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1	Chromatography	15
2	Instrumental methods – II	15
3	Instrumental methods – III	15
4	Electro analytical Methods	15
Total		**60**

Course Outcomes:

At the end of the Course, the Learner will be able to

1. Able to compare the advantages/disadvantages of SEM, STM and TEM.
2. Able to develop different techniques to separate the components of mixture.
3. Conversant with basic principles and theories of mass spectrometry.
4. Able to apply the electro analytical methods to sample under consideration.
5. Able to elaborate on electrogravimetry and coulometry techniques.

Curriculum:

Sr. No.	Modules / Units
1	**Chromatography (15 Lectures)**
	1.1 Basic concepts and theories of chromatography: [5L] **1.1.1** Introduction and Classification of chromatographic methods. **1.1.2** Concept of plate and rate theories in chromatography, efficiency, resolution, selectivity and separation capability. **1.1.3** Van Deemter equation and broadening of chromatographic peaks. Optimization of chromatographic conditions. **1.2 Gas Chromatography: [5 L]** **1.2.1** Instrumentation –sample injection systems (split/split less), column types (solid/ liquid stationary phases), column switching techniques, temperature programming. **1.2.2** Requirements of an ideal detector and types of detectors in GLC and GSC. **1.2.3** Applications -Qualitative and quantitative analysis. **1.3 High Performance Liquid Chromatography (HPLC):[5 L]** **1.3.1** Normal phase and reversed phase with special reference to types of

	commercially available columns (Use of C8 and C18 columns). **1.3.2** Diode array type and fluorescence detector. **1.3.3** Applications of HPLC.
2	**Instrumental methods - II** **(15 Lectures)**
	2.1 X-ray spectroscopy: [6L] Principle, instrumentation, applications, advantages and limitations of **2.1.1** X-ray absorption spectroscopy. (XAS) **2.1.2** X-ray fluorescence spectroscopy (XRF) **2.1.3** X-ray diffraction spectroscopy. (XRD) **2.2 Mass spectrometry: [6L]** **2.2.1 Instrumentation:** i) Ion sources - electron impact, field ionization, field absorption, chemical ionization and fast atom bombardment sources. ii) Mass analyzers: Quadrupole, time of flight and ion trap. **2.2.2 Applications:** **2.3 Radio analytical Methods –[3 L]** **2.3.1** Neutron Activation Analysis (NAA)- Introduction, Principle, Theory and Applications. **2.3.2** Advantages and Limitations of NAA.
3	**Instrumental methods - III** **(15 Lectures)**
	3.1 Surface Analytical Techniques – [9L] Principle, Instrumentation and Applications of: **3.1.1** Scanning Electron Microscopy (SEM) **3.1.2** Scanning Tunneling Microscopy (STM) **3.1.3** Transmission Electron Microscopy (TEM) **3.2 Atomic Spectroscopy [6L]** **3.2.1** Atomic Spectroscopy based on plasma sources – Introduction, Principle, Instrumentation and Applications. **3.2.2** Advantages and Limitations of AAS.
4	**Electroanalytical Methods** **(15 Lectures)**
	4.1 Ion selective potentiometry and Polarography: [10L] **(Numericals are Expected)** **4.1.1** Ion selective electrodes: Applications of - solid state, precipitate, liquid – liquid, enzyme, gas sensing, bio-catalytic membrane and enzyme-based biosensors electrodes. **4.1.2 Polarography:** Ilkovic equation, Cottrell equation, effect of complex formation on the polarographic waves. **4.2 Electrogravimetry: [2L]** **4.2.1** Introduction, Principle and Instrumentation. **4.2.2** Factors affecting the nature of the deposit. **4.2.3** Applications.

	4.3 Coulometry: [3L] **4.3.1** Introduction, Principle and Instrumentation. **4.3.2** Coulometry at controlled potential and controlled current.

References:

Unit I

1. Skoog, Holler and Crouch, Instrumental Analysis, 7th edition.
2. E.B.Sandell and H.Onishi, HPLC Practical and Industrial Applications; 2 nd Ed., CRC Press.

Unit II

1. H J Arnikar, New Age Publishers, Essentials of Nuclear Chemistry; (2005).
2. D. D. Sood A. V. R. Reddy and N. Ramamoorthy, IANCAS Fundamentals of Radiochemistry; 4th edition, 2010.
3. Skoog, Holler and Nieman, Principles of Instrumental Analysis - 5th Edition, Ch: 12, 20

Unit III

1. Douglas A. Skoog - F. James Holler - Crouch, Publisher:Cengage; Instrumental Analysis; Edition, (2003), ISBN-10: 8131505421, ISBN-13: 978-8131505427.
2. Ray F. Egerton, Physical Principles of Electron Microscopy, An Introduction to TEM, SEM, andAEM ; ISBN: 978-0- 387-25800- 3 (Print) 978-0- 387-26016- 7 (Online).
3. D.P. Woodruff and T.A. Delchar, Cambridge Univ. Press, Modern techniques of surface science; 1994.
4. C. J. Chen, Oxford University Press, Introduction to Scanning Tunneling Microscopy ; New York, 1993.
5. T David BWilliams and C., Barry Carter, Springer, ransmission Electron Microscopy: A text book for Material Science; 2009.
6. J.M. Hollas, , John Wiley, New York, Modern Spectroscopy,; 3rd Edition (1996).
7. Skoog, Holler, Nieman, Harcourt College Publishers, Principles of Instrumental Analysis; 5th ed., 1998.

Unit IV

1. Skoog, Holler, Nieman, Harcourt College Publishers, Principles of Instrumental Analysis – ; 5th Edition, 1998. Chapters - 23, 24, 25.
2. John H Kennnedy, Saunders College Publishing, Analytical Chemistry Principles, 2nd edition, (1990).
3. David Harvey; McGraw Hill Higher education publishers, Modern Analytical Chemistry; (2000).
4. Vogel's Text book of quantitative chemical analysis; Pearson Education Limited, 6th edition, (2007).

5. Allen J Bard and Larry R Faulkner, John Wiley and Sons, Electrochemical Methods Fundamentals and Applications; (1980).
6. Willard, Merrit, Dean and Settle, CBS publishers, Instrumental Methods of Analysis; 7th edition.

Evaluation Pattern:

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given Semester.	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities.	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination:
1. Duration - These examinations shall be of two hours duration.
2. Theory question paper pattern:
a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units.
b. All questions shall be compulsory with internal choice within the questions.

Revised Syllabus of Courses of Master of Science (M.Sc.)
Programme at Semester II with Effect from the Academic Year
2023-2024

Name of the Course	Chemistry Practical-II (Organic Chemistry and Analytical Chemistry)
Course Code	PSCH204
Class	M.Sc.
Semester	II
No of Credits	2
Nature	Practical
Type	Major: Mandatory- II
Relevance with Employability/ Entrepreneurship/ Skill development	Practical Skills of organic and analytical chemistry experiments involve wide range of laboratory techniques Synthesis/preparation, distillation, extraction and purification., chromatography, Instrumental analysis Learner who have hands on experience with these techniques are highly sought in industries like pharmaceuticals, polymers, petrochemicals. Product development and analytical method development knowledge can be valuable for entrepreneurs looking for to develop new products and its analytical method development.

Course Outcomes:

At the end of the Course, the Learner will be able to

1. Learn determination of chemical types of different organic binary mixture.
2. Learn to separate solid organic binary mixtures on the basis of solubility.
3. Learn to purify the separated organic compound by recrystallization technique.
4. Learn characterization steps of organic compounds.
5. Handle and get familiar with SOP's of instruments like potentiometer, conductivity meter, colorimeter and spectrophotometer.
6. Understand the concept of complexometric titrations and factors enhancing selectivity of EDTA as a titrant.
7. Apply the theory of FES to fertilizers analysis.
8. Develop scientific temperament and research-based skills accomplish to encountered in the field of research.

Chemistry Practical-II
(Organic Chemistry and Analytical Chemistry)
Modules at a Glance

Course	Modules	No. of Credits
Organic Chemistry	**Separation of Binary mixture using micro-scale technique** 1. Separation of binary mixture using physical and chemical methods. 2. Characterization of one of the components with the help of chemical analysis and confirmation of the structure with the help of derivative preparation and its physical constant. 3. Purification and determination of mass and physical constant of the second component. The following types are expected: (i) Water soluble/water insoluble solid and water insoluble solid, (ii) (ii) Non-volatile liquid-Non-volatile liquid (chemical separation) (iii) Water-insoluble solid-Non-volatile liquid. **(Minimum two mixtures from each type and a total of eight mixtures are expected.)**	01
Analytical Chemistry	**Instrumental Experiments** 1. To determine the amount of Fe (II) and Fe (III) in a mixture using 1,10-phenanthroline spectrophotometrically. 2. Simultaneous determination of Cr(VI) and Mn(VII) in a mixture spectrophotometrically. 3. To determine the percentage composition of HCl and H_2SO_4 on weight basis in a mixture of two by conductometric titration with NaOH and $BaCl_2$. 4. To determine amount of potassium in the given sample of fertilizers using flame photometer by standard addition method. **Non-Instrumental Experiments** 5. To determine the lead and tin content of a solder alloy by titration with EDTA. 6. To determine amount of Cu (II) present in the given solution containing a mixture of Cu (II) and Fe (II). 7. To determine the break through capacity of a cation exchange resin. 8. Estimation of a mixture of Hydrochloric acid and boric acid by acid base titration.	01
Total		**02**

References:

1. A. I. Vogels, Quantitative Inorganic Analysis including Elementary Instrumental Analysis by ; 3rd Ed. ELBS (1964).
2. Mendham, Denny, Barnes, Thomas, Pearson education, Vogel's textbook of quantitative chemical analysis, Sixth Ed.
3. F. J. Welcher, Standard methods of chemical analysis ; 1975.
4. F. J. Welcher, Standard methods of chemical analysis: Instrumental methods of Analysis; vol. 3, 1966.
5. W. W. Scott, Vol. I, Van Nostrand , Company, "Standard methods of Chemical Analysis"; Inc.,1939.
6. E.B.Sandell and H.Onishi, "Spectrophotometric Determination of Traces of Metals"; ,Part II,4th Ed. ,A Wiley Interscience Publication, New York,1978.

Evaluation Pattern: Practical

Max. Marks: 50

A) Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Performance during practical session, Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of journal.	15
04	Overall performance (attendance, punctuality, interaction during Practical session throughout semester	05
Total		**20**

B) Semester End Examination: 60% (30 Marks)

Sr. No.	Name of course	Method	Duration	Marks
1.	Analytical Chemistry	Experiment performance as per the practical slip	Three and half hours	25
2.	Organic Chemistry	Experiment performance as per the practical slip	Three and half hours	25
	Journal + Viva			5+5
Total				**60**

Practical examination will be of 60 marks at the end of semester which will be converted to 30 Marks

CIE	Semester End	Total Marks
20	30	50

Revised Syllabus of Courses of Master of Science (M.Sc.)

Programme at Semester II with Effect from the Academic Year 2023-2024

Name of the Course	Physical Chemistry III
Course Code	PSCH205
Class	M.Sc.
Semester	II
No of Credits	2
Nature	Theory
Type	Major: Elective-III
Relevance with Employability/ Entrepreneurship/ Skill development	Understanding photochemistry and chemical kinetics is essential for chemist working in various industries such as pharmaceuticals, material science. These fields often rely on reactions that are influenced by light (photochemical reaction) or reaction rates (Chemical kinetics). Entrepreneurs with a background in photochemistry and chemical kinetics have opportunities to develop and commercialize innovative technologies.

Physical Chemistry III

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1	Photochemistry	15
2	Chemical Kinetics and Molecular Reaction Dynamics-II	15
Total		**30**

Course Outcomes:

1. To develop the skill to solve the problems based on molecular dynamics and quantum Chemistry.
2. Learners will able to distinguish between competitive, Noncompetitive and Uncompetitive Inhibition in enzyme-catalyzed reactions.
3. Learners will get knowledge of advanced chemical kinetics and molecular dynamics.
4. Leathers will able to use advanced concepts of chemical thermodynamics in chemical reactions.

Curriculum:

Sr. No.	Modules / Units
1	**Photochemistry (15 Lectures)**
	2.1 Absorption of light, laws of photochemistry, electronic structure of molecules, molecular orbital, electronically excited singlet states, designation based on multiplicity rule, construction of Jablonski diagram, electronic transition, Frank Condon principle, selection rules, intensity of absorption bands, nature of electronic spectra and primary process, photo-dissociation, predissociation. **2.2 Photo physical phenomena:** physical pathways of excited molecular system (radiative and non-radiative), prompt fluorescence, delayed fluorescence, and phosphorescence, fluorescence quenching: concentration quenching, collisional quenching, quenching by excimer and exciplex emission, fluorescence resonance energy transfer between photo-excited donor and acceptor systems. **2.3.** Stern-Volmer relation, critical energy transfer distances, energy transfer efficiency, examples and applications in chemical analysis. Photochemical reactions, photo-oxidation, photoreduction, photo-dimerization, photoisomerization and photosensitized reactions. Photochemistry of environment: Greenhouse effect. **(Ref: 17 and 18)**

2	**Chemical Kinetics and Molecular Reaction Dynamics-II (15 Lectures)**
	2.1. Elementary Reactions in Solution:-Solvent Effects on reaction rates, Reactions between ions- influence of solvent Dielectric constant, influence of ionic strength, Linear free energy relationships Enzyme action **2.2.** Kinetics of reactions catalyzed by enzymes -Michaelis-Menten analysis, Lineweaver-Burk and Eadie Analyses. **2.3.** Inhibition of Enzyme action: Competitive, Noncompetitive and Uncompetitive Inhibition. Effect of pH, Enzyme activation by metal ions, Regulatory enzymes. **2.4.** Kinetics of reactions in the Solid State:-Factors affecting reactions in solids Rate laws for reactions in solid: The parabolic rate law, The first order rate Law, the contracting sphere rate law, Contracting area rate law, some examples of kinetic studies. **(Ref: 7 and 2, 22)**

References:

1. Peter Atkins and Julio de Paula, Atkin's Physical Chemistry, 7th Edn., 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, John Wiley and Sons (Asia) Pte. Ltd., Physical Chemistry, 3rd Edn., 2002.
4. Ira R. Levine, Physical Chemistry, 5th Edn., Tata McGraw-Hill New Delhi, 2002.
5. G.W. Castellan, Physical Chemistry, 3rd Edn.,Narosa Publishing House, New Delhi, 1983.
6. S. Glasstone, Text Book of Physical Chemistry, 2nd Edn., McMillan and Co. Ltd., London, 1962.
7. Principles of Chemical Kinetics, 2nd Ed., James E. House, ELSEVIER, 2007.
8. B.K. Sen, Kalyani Publishers, Quantum Chemistry including Spectroscopy, 2003.
9. A.K. Chandra, Tata McGraw – Hill, Introductory Quantum Chemistry, 1994.
10. R.K. Prasad, Quantum Chemistry, 2nd Edn., New Age International Publishers, 2000.
11. S. Glasstone, Thermodynamics for Chemists, Affiliated East-West Press, New Delhi, 1964.
12. W.G. Davis, Introduction to Chemical Thermodynamics – A Non – Calculus Approach, Saunders, Philadelphia, 1972.
13. Peter A. Rock, Chemical Thermodynamics, University Science Books, Oxford University Press, 1983.
14. Ira N. Levine, Quantum Chemistry, 5th Edn., Pearson Education (Singapore) Pte. Ltd., Indian Branch, New Delhi, 2000.
15. Thomas Engel and Philip Reid, Physical Chemistry, 3rd Edn., Pearson Education Limited 2013.
16. D.N. Bajpai, Advanced Physical Chemistry, S. Chand 1st Edn., 1992.
17. C. H. DePuy, O. L. Chapman, Molecular reactions and photochemistry, Prentice hall of India PVT. LTD. 1988.

18. K. K. Rohatgi-Mukherjee. Fundamentals of Photochemistry. Reprint 2002. New Age International Publisher, 1978.
19. Marrown and Prutton, Principles of physical Chemistry, 5th edition.
20. Arun Bahl, B. S Bahl, G. D.Tulli, S Chand and Co. Ltd, Essentials of Physical Chemistry, 2012 Edition.
21. L.V Azaroff , Tata McGraw Hill, Introduction of Solids.
22. Dr. Hari chandra A Parbat and Dr. Damodar V. Prabhu, Essence of Chemical Kinetics,Sara Publication, First Edition, Sept. 2022.
23. MacMillan Publishers India Ltd, A Text book of physical Chemistry; Applications of thermodynamics vol III, 2011.
24. C.N.R. Rao and J Gopal Krishnan, Cambridge University Press., New directions in solid state Chemistry.

Evaluation Pattern:

Max. Marks 50

A) Continuous assessment : 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given Semester.	15
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities.	05

B) Semester End Examination: 60% (30 Marks)

30 Marks per paper Semester End Theory Examination:
1. Duration - These examinations shall be of one hour duration.
2. Theory question paper pattern:
a. There shall be two questions each of 10 marks on each unit and one question of 10 marks on all units.
b. All questions shall be compulsory with internal choice within the questions.

Revised Syllabus of Courses of Master of Science (M.Sc.)

Programme at Semester II with Effect from the Academic Year

2023-2024

Name of the Course	Chemistry Practical-III (Physical and Inorganic)
Course Code	PSCH206
Class	M.Sc.
Semester	II
No of Credits	2
Nature	Practical
Type	Major: Elective III
Relevance with Employability/ Entrepreneurship/ Skill development	Physical chemistry experiments require precise laboratory skills, such as handling of sensitive instruments. Measuring accurately and executing complex procedures. It enhances ability to design and execute experiments and analyze data. By conducting advance Inorganic chemistry experiments at PG level hones laboratory techniques and analytical skills, making learner suitable for research and industry.

Course Outcomes:

At the end of the Course, the Learner will be able to

Physical Chemistry Practical

1. To use the concept of quantum chemistry to interprete the shape and information about the orbitals like 1s, 2pz and $3dz^2$.
2. To apply the subject fundamentals-principles with practical knowledge to design experiments, analyze and interpret data so as to reach to proper conclusions
3. Learner will train to handle the sophisticated instrument like digital potentiometer, conductivity meter, spectrophotometer.

Inorganic Chemistry Practical

1. The learners will characterize different coordination compounds with the help of conductivity measurements, electronic and magnetic measurements and spectroscopic measurements.
2. Able to calculating the equilibrium constant for Fe^{3-}/SCN^{1-} by slope intercept method
3. Able to determine the electrolytic nature of some inorganic compounds by conductance measurements.

Course	Modules	No. of Credits
Physical Chemistry	**Non – Instrumental:** 1. Polar plots of atomic orbitals such as 1s, Pz and $3dz^2$ orbitals by using angular part of hydrogen atom wave functions. 2. To study the influence of ionic strength on the base catalysed hydrolysis of ethyl acetate. 3. To study phase diagram of three component system water – chloroform/ toluene - acetic acid. 4. To determine the rate constant of decomposition reaction of diacetone alcohol by dialtometric method. **Instrumental:** 5. To determine the formula of silver ammonia complex by potentiometric method. 6. To determine CMC of sodium Lauryl Sulphate from measurement of conductivities at different concentrations. To determine Hammette constant of m- and p- amino benzoic acid/nitro benzoic acid by pH measurement. 7. To determine the Michaelis – Menten‟s constant value (Km) of the enzyme Beta Amylase spectrophotometrically.	01
Inorganic Chemistry	**Inorganic Preparations (Synthesis and Characterization)** 1. Bis-(tetramethylammonium) tetrachloroCuprate (II) $(Me_4N)_2[CuCl_4]$ 2. Bis-(tetramethylammonium) tetrachloroNickelate (II) $(Me_4N)_2[NiCl_4]$ 3. Bis (ethylenediammine) Copper (II) Sulphate $[Cu(en)_2]SO_4$ 4. HexaaamineNi(II) Sulfate $[Ni(NH_3)_6]SO_4$ 5. Potassiumtrioxalato Chromate(III) $K_3[Cr(C_2O_4)_3]$ 6. Tetramminemonocarbanato Cobalt (III) Nitrate $[Co(NH_3)_4CO_3]NO_3$ **Instrumentation :** 1. Determination of equilibrium constant by Slope intercepts method for Fe^{+3}/ SCN system. 2. Determination of Electrolytic nature of inorganic compounds by Conductance measurement.	01
Total		**02**

References:

Physical Chemistry Practical:

1. B. Viswanathan and P.S. Raghavan, Viva Books Private Limited, Practical Physical Chemistry, 2005.
2. A.M. James and F.E. Prichard, Practical Physical Chemistry, 3rd Edn., Longman Group Ltd., 1974.
3. V.D. Athawale and P. Mathur, New Age International Publishers, Experimental Physical Chemistry, 2001.

Inorganic Chemistry Practicals:

1. G. N. Mukherjee., Advanced experiments in Inorganic Chemistry., 1st Edn., 2010., U.N. Dhuri and Sons Pvt. Ltd.
2. William L. Jolly, The Synthesis and Characterization of Inorganic Compounds.
3. Dr. Deepak Pant., Inorganic Chemistry Practical Under UGC Syllabus for M.Sc. in all India Universities.

Evaluation Pattern: Practical Max. Marks 50

A) Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Assessment during practicals (Interaction / Performance) Skill, Accuracy, precision of measurement, Record of observation, Calculations, graph, result and conclusion. Timely submission of journal.	15
04	Overall performance (attendance, punctuality, interaction during Practical session throughout semester).	05
Total		**20**

B) Semester End Examination: 60% (30 Marks)

Sr. No.	Name of course	Method	Duration	Marks
1.	Physical Chemistry	Experiment performance as per the practical slip	Three and half hours	25
2.	Inorganic Chemistry	Experiment performance as per the practical slip	Three and half hours	25
	Journal + Viva			5+5
Total				**60**

Practical examination will be of 60 marks at the end of semester which will be converted to 30 Marks.

CIE	Semester End	Total Marks
20	30	50

Revised Syllabus of Courses of Master of Science (M.Sc.)

Programme at Semester II with Effect from the Academic Year 2023-2024

Name of the Course	Physical Chemistry IV
Course Code	PSCH207
Class	M.Sc.
Semester	II
No of Credits	2
Nature	Theory
Type	Major: Elective IV
Relevance with Employability/ Entrepreneurship/ Skill development	Quantum chemistry plays a crucial role in computational chemistry which is used to predict mode of chemical reaction and molecular properties. Learner with knowledge of Chemical thermodynamics and Quantum chemistry are in demand in academia, industries and research institutes.

Physical Chemistry IV

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1	Chemical Thermodynamics II	15
2	Quantum Chemistry II	15
Total		**30**

Course Outcomes:

At the end of the Course, the Learner will be able to

1. To learn the concept of quantum chemistry and able to solve problems related to 1D box, 2D box, 3D box and to explain the role of operators in quantum chemistry.
2. To understand the use of Schrodinger wave equation in one and two electron systems along with applications of HMO.
3. To develop the skill to solve the problems based on chemical thermodynamics, molecular dynamics and quantum Chemistry.
4. To apply the concept of Jabolonski mechanism in photochemical reactions.

Curriculum:

Sr. No.	Modules / Units
1	**Chemical Thermodynamics II (15 Lectures)**
	1.1. Fugacity of real gases, Determination of fugacity of real gases using graphical method and from equation of state. Equilibrium constant for real gases in terms of fugacity. Gibbs energy of mixing, entropy and enthalpy of mixing. **1.2. Real solutions:** Chemical potential in non-ideal solutions excess functions of non-ideal solutions calculation of partial molar volume and partial molar enthalpy, Gibbs Duhem Margules equation. **1.3.** Thermodynamics of surfaces, Pressure difference across curved surface (Laplace equation), vapour pressure of droplets (Kelvin equation), Gibbs adsorption isotherm, BET isotherm (derivations expected). **1.4. Bioenergetics:** standard free energy change in biochemical reactions, exergonic, endergonic. Hydrolysis of ATP, synthesis of ATP from ADP. **[Ref 2 and 1,10,11,12]**

2	**Quantum Chemistry II** **(15 Lectures)**
	1.1 Rigid rotor, spherical coordinates Schrödinger wave equation in spherical coordinates, separation of the variables, the phi equation, wave function, quantum number, the theta equation, wave function, quantization of rotational energy, spherical harmonics. **1.2.** Hydrogen atom, the two particle problem, separation of the energy as translational and potential, separation of variables, the Radial (R), Zenith (theta) and Azimuthal (Phi) equations, solution of the equation, introduction of the four quantum numbers and their interdependence on the basis of the solutions of the three equations, total wave function, expression for the energy, probability density function, distances and energies in atomic units, radial and angular plots, points of maximum probability. **1.3.** Application of the Schrödinger equation to two electron system, limitations of the equation, need for the approximate solutions, methods of obtaining the approximate solution of the Schrödinger wave equation. **1.4.** Hückel Molecular Orbitals theory for ethylene, 1,3-butadiene, cyclobutadiene and benzene. **(Derivation expected) [Ref 7, 8 and 9]**

References:

1. Peter Atkins and Julio de Paula, Atkin's Physical Chemistry, 7th Edn., 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, 3rd Edn., John Wiley and Sons (Asia) Pte. Ltd., 2002.
4. Ira R. Levine, Physical Chemistry, 5th Edn., Tata McGraw-Hill New Delhi, 2002.
5. G.W. Castellan, Physical Chemistry, 3rd Edn., Narosa Publishing House, New Delhi,1983.
6. S. Glasstone, Text Book of Physical Chemistry, 2nd Edn., McMillan and Co. Ltd., London, 1962.
7. Principles of Chemical Kinetics, 2nd Ed., James E. House, ELSEVIER, 2007.
8. B.K. Sen, Quantum Chemistry including Spectroscopy, Kalyani Publishers, 2003.
9. A.K. Chandra, Introductory Quantum Chemistry, Tata McGraw – Hill, 1994.
10. R.K. Prasad, Quantum Chemistry, 2nd Edn., New Age International Publishers, 2000.
11. S. Glasstone, Thermodynamics for Chemists, Affiliated East-West Press, New Delhi, 1964.
12. W.G. Davis, Introduction to Chemical Thermodynamics – A Non – Calculus Approach, Saunders, Philadelphia, 1972.
13. Peter A. Rock, Chemical Thermodynamics, University Science Books, Oxford University Press, 1983.
14. Ira N. Levine, Quantum Chemistry, 5th Edn., Pearson Education (Singapore) Pte. Ltd., Indian Branch, New Delhi, 2000.

15. Thomas Engel and Philip Reid, Physical Chemistry, 3rd Edn., Pearson Education Limited 2013.
16. D.N. Bajpai, Advanced Physical Chemistry, S. Chand 1st Edn., 1992.
17. C. H. DePuy, O. L. Chapman, Molecular reactions and photochemistry, Prentice hall of India PVT. LTD. 1988.
18. K. K. Rohatgi-Mukherjee. Fundamentals of Photochemistry. Reprint 2002. New Age International Publisher, 1978.
19. Marrown and Prutton, Principles of physical Chemistry, 5th edition.
20. Arun Bahl, B. S Bahl, G. D.Tulli, S Chand and Co. Ltd, Essentials of Physical Chemistry, 2012 Edition.
21. L.V Azaroff , Tata McGraw Hill., Introduction of Solids.
22. Dr. Harichandra A Parbat and Dr. Damodar V Prabhu, Essence of Chemical Kinetics, Sara Publication, First Edition, Sept. 2022.
23. MacMillan Publishers India Ltd, A Text book of physical Chemistry; Applications of thermodynamics vol III, 2011.
24. C.N.R. Rao and J Gopal krishnan, Cambridge University Press., New directions in solid state Chemistry.

Evaluation Pattern:

Max. Marks 50

A) Continuous assessment : 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester.	15
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities.	05

B) Semester End Examination: 60% (30 Marks)

30 Marks per paper Semester End Theory Examination:
1. Duration - These examinations shall be of one hour duration.
2. Theory question paper pattern:
a. There shall be two questions each of 10 marks on each unit and one question of 10 marks on all units.
b. All questions shall be compulsory with internal choice within the questions.

Revised Syllabus of Courses of Master of Science (M.Sc.)

Programme at Semester II with Effect from the Academic Year 2023-2024

Name of the Course	Chemistry Practical-IV(Physical and Inorganic)
Course Code	PSCH208
Class	M.Sc.
Semester	II
No of Credits	2
Nature	Practical
Type	Major: Elective
Relevance with Employability/ Entrepreneurship/ Skill development	Physical chemistry experiments require precise laboratory skills, such as handling of sensitive instruments. Measuring accurately and executing complex procedures. It enhances ability to design and execute experiments and analyze data. By conducting advance Inorganic chemistry experiments at PG level hones laboratory techniques and analytical skills, making learner suitable for research and industry.

Course Outcomes:

At the end of the Course, the Learner will be able to

Physical Chemistry Practical

1. To use the concept of quantum chemistry to interpret the shape and information about the orbitals like 1s, 2pz and $3dz^2$.
2. To apply the subject fundamentals-principles with practical knowledge to design experiments, analyze and interpret data so as to reach to proper conclusions
3. Learner will train to handle the sophisticated instrument like digital potentiometer, conductivity meter, and spectrophotometer.

Inorganic Chemistry Practical

1. The learners will characterize different coordination compounds with the help of conductivity measurements, electronic and magnetic measurements and spectroscopic measurements.
2. Able to calculating the equilibrium constant for Fe^{3-}/SCN^{1-} by slope intercept method
3. Able to determine the electrolytic nature of some inorganic compounds by conductance measurements.

Course	Modules	No. of Credits
Physical Chemistry	**Non – Instrumental:** 1. Polar plots of atomic orbitals such as 1s, Pz and 3dz2 orbitals by using angular part of hydrogen atom wave functions. 2. To study the influence of ionic strength on the base catalysed hydrolysis of ethyl acetate. 3. To study phase diagram of three component system water – chloroform/ toluene - acetic acid. 4. To determine the rate constant of decomposition reaction of diacetone alcohol by dialtometric method. **Instrumental:** 5. To determine the formula of silver ammonia complex by potentiometric method. 6. To determine CMC of sodium Lauryl Sulphate from measurement of conductivities at different concentrations. To determine Hammette constant of m- and p- amino benzoic acid/nitro benzoic acid by pH measurement. 7. To determine the Michaelis – Menten‟s constant value (Km) of the enzyme Beta Amylase spectrophotometrically.	01
Inorganic Chemistry	**Inorganic Preparations (Synthesis and Characterization)** 1. Bis-(tetramethylammonium) tetrachloroCuprate (II) $(Me_4 N)_2[CuCl_4]$ 2. Bis-(tetramethylammonium) tetrachloroNickelate (II) $(Me_4 N)_2 [NiCl_4]$ 3. Bis (ethylenediammine) Copper (II) Sulphate $[Cu(en)_2]SO_4$ 4. HexaaamineNi(II) Sulfate $[Ni(NH3)_6]SO_4$ 5. Potassiumtrioxalato Chromate(III) $K_3[Cr(C_2O_4)_3]$ 6. Tetramminemonocarbanato Cobalt (III) Nitrate $[Co(NH_3)_4CO_3]NO_3$ **Instrumentation :** 1. Determination of equilibrium constant by Slope intercept method for Fe^{+3}/ SCN system 2. Determination of Electrolytic nature of inorganic compounds by Conductance measurement.	01
	Total	**02**

References:

Physical Chemistry Practical:

1. B. Viswanathan and P.S. Raghavan, Viva Books Private Limited, Practical Physical Chemistry, 2005.
2. A.M. James and F.E. Prichard, Practical Physical Chemistry, 3rd Edn., Longman Group Ltd., 1974.
3. V.D. Athawale and P. Mathur, New Age International Publishers, Experimental Physical Chemistry, 2001.

Inorganic Chemistry Practical:

1. G. N. Mukherjee., U.N. Dhuri and Sons Pvt. Ltd. Advanced experiments in Inorganic Chemistry., 1st Edn., 2010.
2. William L. Jolly, The Synthesis and Characterization of Inorganic Compounds.
3. Dr. Deepak Pant, Inorganic Chemistry Practical Under UGC Syllabus for M.Sc. in all India Universities.

Evaluation Pattern: Practical Max. Marks 50

A) Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Assessment during practicals (Interaction / Performance) Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of Journal.	15
04	Overall performance (attendance, punctuality, interaction during Practical session throughout semester).	05
Total		**20**

B) Semester End Examination: 60% (30 Marks)

Sr. No.	Name of course	Method	Duration	Marks
1.	Physical Chemistry	Experiment performance as per the practical slip	Three and half hours	25
2.	Inorganic Chemistry	Experiment performance as per the practical slip	Three and half hours	25
	Journal + Viva			5+5
Total				**60**

Practical examination will be of 60 marks at the end of semester which will be converted to 30 Marks.

CIE	Semester End	Total Marks
20	30	50

Revised Syllabus of Courses of Master of Science (M.Sc.)

Programme atSemester II with Effect from the Academic Year

2023-2024

Name of the Course	Industrial Training/Field Project
Course Code	PSCH209
Class	M.Sc.
Semester	II
No of Credits	4
Nature	Practical
Type	Industrial Training/Field Project
Relevance with Employability/ Entrepreneurship/ Skill development	On the job training provides learner with the opportunity to acquire hands on experience and practical skills required for specific job roles. It bridges the gap between theoretical knowledge and the practical requirements of the job. Learner can gain valuable insights into the industry practice, company culture, this experience makes them confident and competent candidate when applying for the position increasing the employability prospects. OTT is instrumental in skill development as it focuses on practical job specific competencies like technical skills, soft skills. Overall OTT enhances employability, foster entrepreneurship by providing valuable industry exposure.

Guidelines and Evaluation pattern for On Job Training/ Field Project (100 Marks)

Introduction:

Inclusion of On Job Training/ Field Project in the course curriculum of the M.Sc. programme is one of the ambitious aspects in the programme structure. The main objective of inclusion of On Job Training/ Field Project is to inculcate ability to interpret particular aspect of the study in his/ her own words.

Guidelines for On Job Training

On-the-Job Training/Field Project: Students will be required to undertake a designated project or tasks in an organization or industry relevant to their field of study. The course aims to provide students with practical exposure and hands-on experience in a professional work environment related to their field of study.

Course Objectives:

By the end of the course, students should be able to:

1. Gain exposure to real-world insights and apply theoretical knowledge to practical situations
2. Enhance skills regarding problem-solving, decision-making, and communication skills.
3. Understand organizational dynamics and work culture.
4. Build industry connections and networking opportunities.

Course Duration:

Minimum 15 days / 120 hours of On Job Training with an Organization /Private firm.

- The theme of the internship should be based on any study area of the Major course.
- Project Report should be of minimum 30 pages.
- Experience Certificate is Mandatory.

Report Structure:

The students will be required to submit a comprehensive report at the end of the On-the-Job Training. A project report has to be brief in content and must include the following aspects:

a) **Title Page:**

Mentioning the title of the report, name of the student, program, institution, and the period of training.

b) **Certificate of Completion:**

A certificate issued by the organization or supervisor confirming the successful completion of the training.

c) Declaration:

A statement by the student declaring that the report is their original work and acknowledging any assistance or references used.

d) Acknowledgments:

Recognizing individuals or organizations that provided support, guidance, or resources during the training.

e) Table of Contents:

Providing a clear outline of the report's sections and page numbers.

f) Executive Summary:

A bird‟s eye view of your entire presentation has to be precisely offered under this category.

g) Introduction on the Company:

A concise representation of company/ organization defining its scope, products/ services

h) Your Role in the Organization during the on Job Training:

The key aspects handled, the department under which you were deployed and brief Summary report duly acknowledged by the reporting head.

i) Challenges:

The challenges confronted while churning out theoretical knowledge into practical world.

j) Conclusion:

A brief overview of your experience and suggestions to bridge the gap between theory and practice.

Evaluation Pattern: On Job Training

Evaluation of On Job Training will be done at the end of semester for 100 marks.

Evaluation / Marking Scheme:

Sr. No.	Criteria	Marks
1	OTT Report	30
2	Content Understanding	15
3	Application Learning	15
4	Reflection and Critical thinking	15
5	Writing and presentation	15
6	Overall performance	10
	Total Marks	**100**

Guidelines for Field Project

Course Outcomes:
By the end of the course, learners should be able to:

1. Understand the ethics and research methodology.
2. Do a literature review.
3. Do research.
4. Analyze the research work data.
5. Write research theses.

Course Duration: One Semester Minimum 120 hours of field project work.

Course Outline

1. Identifying problem for project work (2 weeks).
2. Literature survey (2 weeks).
3. Designing and implementing the project through necessary experimental work (4 weeks).
4. Data collection and its analysis and interpretation. (2 weeks).
5. Report writing and presentation (2 weeks).

Format of Project Report

a) Title Page:

Mentioning the title of the report, name of the student, program, institution, and the period of training / project.

b) Certificate of Completion:

A certificate issued by the organization or supervisor confirming the successful completion of the training/project.

c) Declaration:

A statement by the student declaring that the report is their original work and acknowledging any assistance or references used.

d) Acknowledgments:

Recognizing individuals or organizations that provided support, guidance, or resources during the training/project.

e) Table of Contents:

Providing a clear outline of the report's sections and page numbers.

f) Abstract:

A bird‟s eye view of learner‟s entire presentation has to be precisely offered under this category. A brief overview of the project, its objectives and key findings should be mentioned.

g) Introduction

Background information about the field project and its significance. Objectives and scope of the project.

h) Literature Review:

Overview of relevant literature and studies related to the chosen field and development issues.

i) Methodology:

Description of Planning of experimental procedure as per the need of the project. Designing and implementation of the project as per the objectives through theoretical, experimental methods.

j) Observations and data analysis:

Data collection and analysis

k) Conclusion:

Summary of the key findings and outcomes of the project.

l) References and Appendices:

List of all sources cited in the project report. Additional supporting material.

The project report based on 'On Job Training/ Field Project' shall be prepared as per the broad guidelines given below:

- Font type: Times New Roman
- Font size: 12-For content, 14-for Title
- Line Space: 1.5-for content and 1-for in table work
- Paper Size: A4
- Margin: in Left-1.5, Up-Down-Right-1
- The Project Report shall be bounded.

Evaluation Pattern: Field Project

Evaluation of Project will be done at the end of semester for 100 marks.

Evaluation / Marking Scheme:

Sr. No.	Criteria	Marks
1	Research Project theme/objective	10
2	Literature Survey/ References	10
3	Experimental/Theoretical methodology/Working condition of project.	30
4	Depth of knowledge in the subject / Results and Discussion	20
5	Project report	15
6	presentation	15
	Total Marks	**100**

Format

1st page (Main Page)

Title of the problem of the Project

A Project Submitted

to

R. P. Gogate college of Arts and Science and

R.V. Jogalekar College of Commerce Autonomous College

Under

University of Mumbai

For partial completion of the degree

of

Master in Science

(Chemistry)

Under the Faculty of Science

By

Name of Student

Under the Guidance of

Name of the Guiding Teacher

R. P. Gogate college of Arts and Science and

R.V. Jogalekar College of Commerce Autonomous College,

Near District Court, Rtnagiri

Month and Year

Index

DECLARATION BY LEARNER

I the undersigned Miss/Mr. _____ [Name of the learner] here by, declare that work embodied in this project work titled _____ forms my own contribution to the research work carried out under the guidance of [Name of the guiding teacher]_____ is a result of my own research work and has not been previously submitted to any other University for any other Degree/ Diploma to this or any other University.

Wherever reference has been made to previous works of others, it has been clearly indicated as such and included in the bibliography.

I, here by further declare that all information of this document has been obtained and presented in accordance with academic rules and ethical conduct.

Name and Signature of the learner

Certified by

Name and signature of the Guiding Teacher

On separate page
Acknowledgment
(Model structure of the acknowledgement)

To list who all have helped me is difficult because they are so numerous and the depth is so enormous.

I would like to acknowledge the following as being idealistic channels and fresh dimensions in the completion of this project.

I thank the R. P. Gogate college of Arts and Science and R.V. Jogalekar College of Commerce, Ratnagiri (Autonomous) and University of Mumbai for giving me opportunity to dothis project

I would like to thank my Principal,_____for providing the necessary facilities required for completion of this project.

I take this opportunity to thank our HOD_____, for his moral support and guidance

I would also like to express my sincere gratitude towards my project guide _____whose guidance and care made the project successful.

I would like to thank my College Library, for having provided various reference books and magazines related to my project.

Lastly, I would like to thank each and every person who directly or indirectly helped me in the completion of the project especially my Parents and Peers who supported me throughout my project.

Date: 03/11/2023

Chairperson BoS
(Dr. M. G. Gore)