Punyashhlok Ahilyadevi Holkar Solapur University, Solapur

NAAC Accredited-2022
'B^{++}'Grade (CGPA2.96)

Name of the Faculty: Science &Technology

(As per New Education Policy 2020)

Syllabus: Chemistry

Name of the Course: M.Sc. I (Sem. I & II)

(Syllabus to be implemented from June 2024)

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ

।। विद्यया संपन्नता ।।

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'B++' Grade (CGPA-2.96)

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Faculty of Science & Technology

Nep 2020 Compliant Curriculum

M. Sc. I Chemistry

Program Preamble

The Master of Science (MSc) in Chemistry is a comprehensive and dynamic program designed to provide students with a deep understanding of the fundamental principles of Chemistry, along with the practical skills required to apply this knowledge in various scientific and technological contexts. Aligned with the vision of the National Education Policy (NEP) 2020, the program offers a flexible, multidisciplinary, and learner-centric curriculum that encourages critical thinking, innovation, and holistic development. The MSc Chemistry program spans two years, with each year offering a progressively advanced curriculum designed to build a strong foundation in Chemistry while allowing for specialization and interdisciplinary learning. The curriculum is structured around several key components:

1. **Discipline Specific Core Courses:** These core courses form the backbone of the program, providing in-depth knowledge and understanding of essential physics concepts, theories, and methodologies. Students will engage with course like Physical Chemistry and Organic chemistry with the topics ranging from wave mechanics, Thermodynamics, Photochemistry, electrochemistry, chemical kinetics, macromolecules, Nature of bonding, rearrangements, stereochemistry, Elimination, addition, oxidation and reduction reactions ensuring a robust and comprehensive education in the discipline.
2. **Discipline Specific Elective Courses:** The program encourages intellectual exploration beyond the core discipline by offering a wide range of elective courses. These electives enable students to pursue their interests in diverse subjects, fostering creativity, critical thinking, and a well-rounded educational experience.
3. **Field Projects/Internships/Apprenticeships/Community Engagement Projects/On-Job Training:** To bridge the gap between theoretical knowledge and real-world applications, the program includes opportunities for field projects, internships, apprenticeships, and community engagement. These experiences provide students with practical insights, problem-solving abilities, and exposure to professional environments, enhancing their readiness for careers in physics and related fields.
4. **Research Methodology and Research Projects:** Research is a critical component of the MSc Chemistry program, with students acquiring skills in research methodology, data collection, analysis, and scientific inquiry. By engaging in independent research projects, students are encouraged to develop innovative solutions to complex scientific problems, preparing them for advanced studies and research-oriented careers.

Multiple Entry and Multiple Exit Options

In accordance with the NEP 2020, the MSc Chemistry program incorporates a Multiple Entry and Multiple Exit framework, offering students the flexibility to enter or exit the program at various stages. This approach ensures that students can tailor their educational journey according to their personal and professional goals, with options to earn certificates, diplomas, or degrees based on the duration of study completed.

- **Year 1:**
  Upon completion of the first year, students may exit with a **Certificate in Physical Chemistry**.
- **Year 2:**
  After two years, students may choose to exit with a M**Sc Degree in Physical Chemistry**

Eligibility for M.Sc. Chemistry: The candidate having B. Sc. with Chemistry as a principal subject / Chemistry at subsidiary level

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Students graduating from the Master of Science in Physical Chemistry program will be able to:

Major Courses:

- **PO1**: Demonstrate in-depth knowledge and understanding of core concepts, theories, and methodologies in the chosen major discipline.
- **PO2**: Apply disciplinary knowledge to solve complex problems, analyze data, and make informed decisions in professional and research contexts.
- **PO3**: Acquire complementary knowledge and skills from a related or distinct discipline, enhancing interdisciplinary understanding and versatility.
- **PO4:** Understanding fundamental principles and laws of physical chemistry
- **PO5:** Development of abilities to study and understand properties of materials

Elective Courses:

- **PO6**: Explore diverse subjects beyond the core discipline, fostering a broad-based education and cultivating critical thinking and creativity.

Research Methodology and On Job Training:

- **PO7**: Acquire research skills, including data collection, analysis, and interpretation, fostering a scientific approach to problem-solving to develop independent research projects handling capabilities.
- **PO8:** Empowering the students to do independent research of high caliber

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Faculty of Science & Technology

Nep 2020 Compliant Curriculum

M.Sc. (Chemistry)

Program Specific Outcomes (PSOs)

Students graduating from MSc (Chemistry) will able to :

PSO1: Mastery of Core Chemistry Concepts: demonstrate understanding of fundamental Chemistry principles, of Physical, Inorganic, Organic Chemistry and allowing them to analyze and solve complex problems.

PSO2: Experimental and Analytical Skills: demonstrate proficiency in designing and conducting experiments, using modern laboratory equipment, and employing analytical techniques to interpret and present scientific data effectively.

PSO3: Application of Chemistry knowledge in Technology and Research: apply their knowledge to develop innovative solutions in technology, engineering, and applied sciences, contributing to research and development in both academic and industrial settings.

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Faculty of Science & Technology
Nep 2020 Compliant Curriculum
MSc (Chemistry)
Structure

Proposed structure for Two Year PG Program (M.Sc.) Degree

Level/ Difficulty	Sem.	Major		Minor	Open Elective OE	Vocational and Skill Enhancement Courses (SEC/VSC)	Ability Enhancement Course (AEC), IKS, VEC	Field Project/ RP/CC/Internship/Apprenticeship/ Community Engagement & Services	Credits	Cumulative Credits
		Mandatory	Elective							
6.0/400	I	DSC1-1 (4+2) DSC1-2 (4+2) DSC1-3 (4+2)	DSE1-1 (4+2)	Research Methodology (4)	------	----	----	----	22	44 PG Diploma in Discipline
	II	DSC1-4 (4+2)	DSE1-2 (4+2)	- ---	----	-----	----	OJT/In-house Project/ Internship/ Apprenticeship (4)	22	
	Total 1 Yrs	24	12	04				04	44	
Exit option: Award of PG Diploma in Discipline with 44 credits OR Continue with Discipline										
6.5/400	III	DSC1-5 (4+2) DSC1-6 (4+2)	DSE1-3 (4+2)	----	------	----	----	RP (4)	22	
	IV	DSC1-7 (4+2) DSC1-8 (4)	DSE1-4 (4+2)	- ---	----	-----	----	RP (6)	22	88 PG Degree in Discipline

M. Sc. I Chemistry Syllabus (w.e.f. academic year 2023-24)

Credit Frameworks for M. Sc. Programs as per NEP to be implemented in 2023-24

Semester	Paper Code	Title of the Paper with course code	Semester exam			L	T	P	Credits
		Mandatory	**Theory**	**IA**	**Total**				
I	**DSC-1**	Physical Chemistry -I (2302101/ 2303101/ 2304101/2324101/ 2325101/ 2326101/ 2327101)	80	20	100	4	--	-	4
	DSC-2	Organic Chemistry -I (2302102/ 2303102/ 2304102/2324102/ 2325102/ 2326102/ 2327102)	80	20	100	4		-	4
		Elective (any one)							
	DSE-1	A. Inorganic Chemistry -I 2302107/ 2303107/ 2304107/2324107/ 2325107/ 2326107/ 2327107	80	20	100	4		-	4
		B. Chemistry in Life Sciences 2302108/ 2303108/ 2304108/2324108/ 2325108/ 2326108/ 2327108	80	20	100	4		-	
		C. Medicinal Chemistry 2302109/ 2303109/ 2304109/2324109/ 2325109/ 2326109/ 2327109	80	20	100	4		-	
		RM							
	RM	Research Methodology (2302103/ 2303103/ 2304103/2324103/ 2325103/ 2326103/ 2327103)	80	20	100	4	-	-	4
		Practicals							
	DSC-1P	Practical I (2302104/ 2303104/ 2304104/2324104/ 2325104/ 2326104/ 2327104)	40	10	50	-	-	4	2
	DSC-2P	Practical II (2302105/ 2303105/ 2304105/2324105/ 2325105/ 2326105/ 2327105)	40	10	50	-	-	4	2
	DSE-1P	Practical III (2302106/ 2303106/ 2304106/2324106/ 2325106/ 2326106/ 2327106)	40	10	50	-	-	4	2

		Total for Semester-I	**440**	**110**	**550**				**22**
II									
		Mandatory							
	DSC-3	Physical Chemistry -II (2302201/ 2303201/ 2304201/2324201/ 2325201/ 2326201/ 2327201)	80	20	100	4	--	-	4
	DSC-4	Organic Chemistry -II (2302202/ 2303202/ 2304202/2324202/ 2325202/ 2326202/ 2327202)	80	20	100	4		-	4
		Elective (any one)							
	DSE-2	A. Inorganic Chemistry -II (2302207/ 2303207/ 2304207/2324207/ 2325207/ 2326207/ 2327207)	80	20	100	4		-	4
		B. Green Chemistry (2302208/ 2303208/ 2304208/2324208/ 2325208/ 2326208/ 2327208)	80	20	100	4		-	
		C. Industrial Chemicals and Environment (2302209/ 2303209/ 2304209/2324209/ 2325209/ 2326209/ 2327209)	80	20	100	4			
	OJT	OJT/In-house Project/ Internship/Apprenticeship (2302203/ 2303203/ 2304203/2324203/ 2325203/ 2326203/ 2327203)	80	20	100	--		8	4
		Practicals					--		
	DSC-3P	Practical IV (2302204/ 2303204/ 2304204/2324204/ 2325204/ 2326204/ 2327204)	40	10	50	-	-	4	2
	DSC-4P	Practical V (2302205/ 2303205/ 2304205/2324205/ 2325205/ 2326205/ 2327205)	40	10	50	-	-	4	2
	DSE-2P	Practical VI (2302206/ 2303206/ 2304206/2324206/ 2325206/ 2326206/ 2327206)	40	10	50	-	-	4	2
		Total for Semester-II	**440**	**110**	**550**				**22**
		Total M.Sc. I	**880**	**220**	**1100**				**44**

L = Lecture T = Tutorials P = Practical

4 Credits of Theory = 4 Hours of teaching per week

2 Credit of Practical = 4 hours per week

DSC- Discipline Specific Course

DSE- Discipline Specific Elective Course

RM- Research Methodology

OJT- On Job Training

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***Teaching Scheme** **Lectures:04 Hours/week, 04 Credits**	***Examination Scheme** **UA:60 Marks** **CA: 40 Marks**

Course Preamble: The course of physical chemistry-I is designed as a major course for M.Sc.I. This course comprises four units. Each unit is of 15 hours. This course consists of wave mechanics, thermodynamics and statistical thermodynamics. The unit of wave mechanics includes basic principles of quantum mechanics, failures of classical mechanics, Schrodinger wave equation and applications of it. Thermodynamics units covers laws of thermodynamics, activity coefficient determination methods and solution state thermodynamics whole statistical thermodynamics unit covers basic principles of statistical thermodynamics, Maxwell-Boltzmann distribution law and its derivation.

Course outcomes:

CO1: Students should be able to remember the concepts of thermodynamic parameters, quantum mechanical postulates, rate laws of chemical reactions and computation of macroscopic properties of matter.

CO2: Students should understand the basics like state function and path function, Schrodinger wave equation, kinetics of fast reactions, partition functions and ensembles.

CO3: Students should be able to apply the knowledge of various quantum mechanical methods to determine the different molecular properties and built the concept of the relation between thermodynamics and quantum mechanics.

CO4: Students should be able to analyze the rates of various chemical reactions both theoretically and experimentally and also observe the effect of catalyst and determine energies of activation of such reactions.

CO5: Students should be able to evaluate variation of thermodynamic parameters for multi component systems and their variation with other extensive properties, Schrodinger wave equation and its application to hydrogen and hydrogen like atoms

CO6: Students should be able to create the solutions to avoid excess use of energy in chemical reactions by

applying their knowledge of thermodynamics and chemical kinetics.

Unit-I: Wave Mechanics: **Hrs: 15, Weightage:20**

Origin of quantum theory, black body radiation, atomic spectra, photoelectric effect, matter waves, wave nature of the electron, Heisenberg's uncertainty principle, Schrodinger wave equation, particle in one dimensional box, the particle in three dimensional box, the hydrogen atom, transformations of coordinates, separation of variables and their significance, the Φ equation, the Θ equation and the Radial equation.

Unit-II: Chemical Thermodynamics: **Hrs: 15, Weightage:20**

Review of Thermodynamics laws, Derivations of Maxwell's Relations, Thermodynamic equation of state, Entropy and Third law of thermodynamics, residual entropy. Concept of fugacity and determination of fugacity, Activity and activity coefficients of solute and solvent, their determination by freezing point depression and vapour pressure measurement, criteria for equilibrium between phases, Derivation of phase rule, application of phase rule to three component system.

Unit-III: Thermodynamics of Solutions: **Hrs: 15, Weightage:19**

Thermodynamics of ideal solutions, Raoult's and Henrey's law, Deviations, partial molar quantities, Gibbs-Duhem equation, Duhem-Margules equation, Excess and mixing thermodynamic properties of Non- ideal solutions and their determination.

Unit-IV: Statistical Thermodynamics: **Hrs: 15, Weightage:19**

Weights and configurations, the most probable configuration, thermodynamic probability and entropy: Boltzmann – Planck equation. Ensembles, ensemble average and time average of property. Maxwell-Boltzmann (MB) distribution law and its application to viscosity and diffusion of gases. Physical significance of distribution Law.

RECOMMENDED BOOKS

1. Quantum Chemistry- R. K. Prasad
2. Quantum Chemistry – Donald A. MacQuarrie

3. Physical Chemistry- P.W. Atkins

4. Text book of Physical Chemistry- S.Glasstone

5. Principles of Physical Chemistry – Marron and Prutton

6. Physical Chemistry- G.M.Barrow

7. Thermodynamics for Chemists – S.Glasstone

8. Thermodynamics – Lewis and Randall, revised by Pitzer

9. An introduction to Chemical Thermodynamics- R. R. Mishra and R. P. Rastogi

10. Kinetics and Mechanism – Frost and Pearson

11. Chemical and Kinetics by K. J. Laidler

12. An Introduction to Statistical Thermodynamics – T.L. Hill, Addison-Wesley. 1960.

13. Statistical Mechanics – Donald A. McQuarrie, 2000.

14. Elements of statistical thermodynamics - L. K. Nash, 2nd Ed. Addison Wesley. 1974

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***Teaching Scheme** **Lectures:04 Hours/week, 04 Credits**	***Examination Scheme** **UA:60 Marks** **CA: 40 Marks**

Course Preamble: Organic chemistry-I is a major course. This course consists of four units. Unit I deals with nature of chemical bonding in organic molecules. Structure and stability of molecules is included in unit II. Various electrophilic and nucleophilic substitution reaction study is given in unit III while last unit deals the concepts of stereochemistry.

Course Outcome: Student will able to –

CO1: Understand the concepts of chemical bonding, various structural effects, acids and bases, and types of reactions

CO2: Basic knowledge of aliphatic and aromatic substitutions, elimination and addition reactions

CO3: Understand and identify the types of organic reactions.

CO4: Write the mechanism of aliphatic and aromatic substitutions, elimination and addition reactions and oxidation-reduction reactions

CO5: Solve the problems involving multiple steps.

CO6: Develop problem solving ability of the students

Unit I: Nature of Bonding in Organic Molecules: Hrs: 15, Weightage:19

Delocalized chemical bonding, conjugation, cross conjugation, Resonance, Hyperconjugation, Tautomerism, Bonding in Fullerenes. Acidity and Basicity, Aromaticity in benzenoid and non–benzenoid compounds, Alternant and non–alternant compounds, Huckel rule, Aromaticity, Annulenes, Azulenes, Antiaromaticity, homo–aromaticity, Crown ethers complexes and cryptands, Inclusion compounds.

Unit II A: Structure, Stability and Reactions of Reactive Intermediates:

Hrs: 05, Weightage:07

Generation, structure, stability and reactivity of Carbocation, Carbanion, Free Radical, Carbenes and Nitrenes. Effect of structure on reactivity, Resonance and field effect, Steric effect, Quantitative treatment, The Hammett equation, Linear free energy relationship, Substituents and reaction constants, Taft equation.

Unit II B: Rearrangements **Hrs: 10, Weightage:13**

Curtius, Schmidt, Lossen, Wolff, Bayer-villiger, Sommelet-Hauser, Favorskii, Pinacol-pinacolone, Benzil-benzilic acid, Fries migration, Tiffeneau Demjanov, Wittig.

Unit III: Aliphatic Nucleophilic & Electrophilic Substitution reactions

Hrs: 15, Weightage:20

The SN^2, SN^1, mixed SN^1 and SN^2 and SET mechanism. The neighbouring group mechanism, The Neighbouring group participation by π & σ bonds, anchimeric assistance, classical and non-classical carbocations, phenonium ions, norbornyl system, carbocation rearrangements in neighbouring group participation. The SN^i mechanism. Nucleophile Substitution at an allylic, aliphatic trigonal and vinylic carbon. Reactivity effects of structure, attacking Nucleophile, leaving group and reaction medium. ambident nucleophile and regioselectivity. Bimolecular mechanisms – SE^1, $SE^2$and SE^i mechanisms. Electrophilic substitution accompanied by double bond shifts.

Unit IV: Stereochemistry **Hrs: 15, Weightage:19**

Elements of symmery, Chirality, Enantiomeric and diastereomeric Relationships, R and S, E and Z nomenclature, Molecules with more than one chiral center, Threo and Erythro isomers, Prochiral relationships, groups and faces, stereospecific and stereoselective reactions. Optical activity in the absence of Chiral carbon (Biphenyls, allenes and Spiranes), Chirality due to helical shape, Methods of resolution, optical purity, stereochemistry of the compounds containing Nitrogen, Sulphur and phosphorous, Conformations analysis of cycloalkanes, Mono and disubstituted cyclohexanes, decalins, Effect of conformation on reactivity.

RECOMMENDED BOOKS

1. Advanced Organic Chemistry, IV Edn –J. March
2. Stereochemistry of carbon Compounds: E. L. Eliel
3. Advanced organic chemistry: F. A. Carey and R. J. Sundberg
4. A guide book to mechanism in organic chemistry: Peter Sykes.
5. Mechanism and Structure in organic Chemisry, E.S.Gould
6. Principle of Organic Synthesis: R.O.C. Norman.
7. Modern Methods of Organic Synthesis: W. Carruthers
8. Organic Chemistry: Clayden, Greeves, Warren and Wothers
9. Stereochemistry of Organic Compounds: D. Nasipuri
10. Stereochemistry: P. S. Kalsi
11. Basic Stereochemistry of Organic Molecules: Subrata Sen Gupta

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***Teaching Scheme** **Practicals: 04 Hours/week, 04 Credits**	***Examination Scheme** **UA:60 Marks** **CA: 40 Marks**

Course Preamble: The research methodology course is included in the syllabus in order to introduce the foundations of research. The various concepts of research will be learned by the students. The unit II includes data interpretation and research article/paper writing. In Unit III electroanalytical techniques like polarography and amperometry are included. While Unit IV explores XRD and ICP techniques. Proton NMR spectroscopy is also added in this unit. The students will understand the research methods and some chemistry instrumentation techniques to characterize the organic/inorganic molecules.

Course outcomes:

On completion of this course the students will be able to understand:

Course outcomes:

CO1: Cultivate critical thinking and analytical skills necessary for identifying research problems and formulating research questions.

CO2: Foster effective communication skills for presenting research findings orally and in written form.

CO3: Promote ethical research practices and awareness of responsible conduct in mathematical research

CO4: Research, types of research, and execution of research

CO5: Data Interpretation and Paper Writing

CO6: Instrumentation technique of various analytical tools like polarography, ampherometry, XRD, TGA, DTA and ICP.

CO7: Application of analytical tools (XRD, TGA, DTA, ICP) in characterization and elemental detection of chemical compounds: solids (crystalline, amorphous, nanomaterials), liquids and gases.

CO8: Basic principles of 1H NMR spectroscopy.

CO9: Nuclear over Hauser effect (NOE)

Unit I: Foundations of Research: **Hrs:15, Weightage:19**

Meaning of research, objectives of research, criteria of good research, types of research, meaning of research problem, selection of research problem, review of related literature: meaning, necessity and sources, hypothesis meaning, function and types of hypothesis, Null/alternative hypothesis, research design: types-exploratory, descriptive, diagnostic and experimental, Execution of the research-Sampling: types, steps involved in sampling, sample size, advantages and limitations, Measurement: Concept of measurement, Problem in measurement in research, Validity and Reliability.

Unit II: Data Interpretation and Paper Writing: **Hrs: 15, Weightage:19**

Observation and Collection of data, Methods of data collection, Data processing, data analysis. Layout of a Research Paper: Introduction, experimental, results and discussion, Referring style MLA style, APA style, Review writing, Journals in chemical sciences, citation, h-index, Impact factor of Journals, Ethical issues related to publishing, Plagiarism and Self-Plagiarism, Use of e-tools for Research: Google scholar, Scopus, Sci-Finder, Reference Management Software: Mendeley, Software for paper formatting: LaTeX/ MS Office, Software for detection of Plagiarism: iThenticate, drawing software: chemdraw, data plotting softwares: origin and MS excel.

Unit III A: Electroanalytical Techniques **Hrs: 10, Weightage:13**

Polarography: - Introduction, Instrumentation, Ilkovic equation and its application in quantitative analysis. Half wave potential. Derivation of wave equation, Determination of halfwave potential, qualitative and quantitative applications Amperometry: - Principles, instrumentation, nature of titration curves, analytical applications.

Unit-III B: Thermal method of analysis: **Hrs: 5, Weightage:7**

Thermogravimetry [TG]: Principle, instrumentation, applications to inorganic compounds Differential thermal analysis [DTA]: Principle, instrumentation, applications to inorganic compounds (problems are expected)

Unit-IV A: X-ray diffraction & ICP: **Hrs: 5, Weightage:7**

Theory of X-ray diffraction, diffraction of X-rays by crystals, Instrumentation, application of X-ray diffraction in determination of crystal structure. Inductively coupled plasma spectroscopy (ICP): Introduction, instrumentation, Applications.

Unit IV B: ^{1}H-NMR Spectroscopy **Hrs: 10, Weightage:13**

Basic principle of NMR, Chemical and Magnetic equivalence and nonequivalence, Homotopism, Enantiotopism, Diastereotopism, Chemical shifts and factors influencing chemical shift: electronegativity, NMR solvent polarity, temperature, anisotropic effect, chemical shifts of acidic protons, D_2O exchange, Multiplicity patterns and Coupling Constants: Pascal's triangle, tree diagram, complex splitting patterns in aromatic, vinylic, and saturated monocyclic compounds, Nuclear over Hauser effect (NOE), Problems based on spectral data of ^{1}H-NMR.

References:

1. Kumar, R., Research Methodology - A Step-By-Step Guide for Beginners, Pearson Education, Delhi (2006).
2. Montgomery, D. C., Design & Analysis of Experiments, 5th Ed., Wiley India (2007).
3. Kothari, C. K., Research Methodology-Methods and Techniques, 2nd Ed., New Age International, New Delhi.
4. Principles of Instrumental Analysis- D. Skoog and D. West.
5. Treatise on Analytical Chemistry: Vol. I to Vol. II-I .M. Kolthoff.
6. The principles of ion selective electrodes and membrane transport.-W.E Mort
7. Instrumental Methods of Analysis: Chatwal and Anand.
8. Instrumental Methods of Analysis (CBS)-H. H. Willard, L. L. Merrit, J.A. Dean & F. A. Settle.
9. Applications of Spectroscopy techniques in Organic Chemistry – (Wiley Eastern)-P.S.Kalsi.
10. Spectroscopic methods in Organic Chemistry (T. M .Hill)-D .H.Williams and I.Fleming.
11. Introduction to Spectroscopy, D.L. Pavia, G.M. Lampman, G.L. Nelson.
12. Spectroscopic identification of Organic Compound (J.W.)R. M. Silverstein and G. C. Bassler.
13. Absorption Spectroscopy of Organic molecules (Addison-Wesley) V.M.Parikh.
14. Introduction to spectroscopy by D. L. Pavia, G. M. Lamplan
15. Principles of Instrumental Analysis- D. Skoog and D. West.
16. Elements of X-ray diffraction, B.D. Cullity, Addison Wisley, 1967
17. Spectroscopy by H. Kour

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***Teaching Scheme**	***Examination Scheme**
Practicals:04 Hours/week, 02 Credits	**UA:30 Marks** **CA: 20 Marks**

Course Preamble: The practical course is designed in such a way that students will get an experiential learning. The practicals are set on the core paper Physical Chemistry-I. The practicals based on Chemical kinetics, viscosity, adsorption, surface tension, phase equilibria, refractometry, conductometry, and Potentiometry are included in the course. The students will be trained in instrument handling and calibration.

Course Outcomes (COs)

CO1: In-depth training on laboratory solution preparations on all concentration scales

CO2: Training on laboratory safety and lab ethics in scientific work

CO3: Training on planning, design and execution of experiments

CO4: Training on scientific literature search, defining the objective of the work, research skills, data representation in tabular and graphical form etc.

CO5: Training on experimental verification of fundamental theories, comparison of data with literature and scientific discussion on any deviation of data from expected theoretical values or reported literature.

CO6: Training on electrochemical analysis of different physicochemical aspects of materials

CO7: Training on different techniques needed to characterize the substances

CO8: Application of theoretical and practical knowledge for research training through mandatory research/industrial projects

NON-INSTRUMENTAL

Kinetics (any two)

1. To investigate the auto-catalytic reaction between potassium permanganate and oxalic acid.
2. Iodination of acetone
3. Determination of energy of activation of acid catalyzed hydrolysis of an ester.

Viscosity

1. Determine the molecular weight of PVA by viscosity measurements.

Adsorption

1. Acetic acid on activated animal charcoal

Phase Equilibria :- (any one)

1. Three component system: Acetic acid, chloroform, water
2. To determine the CST of phenol-water system in presence of 1% NaCl

Surface Tension:

1. To determine the surface tension of a liquid by stalagmometer (drop number method)

INSTRUMENTAL

Refractometry

1. To determine the structure of given Organic Liquids

2. pHmetry: (any one)

1. Determination of pKa of dibasic acid (Oxalic acid)
2. Determination of hydrolysis constant of aniline hydrochloride

Conductometry (any one)

1. Titration of $ZnSO_4$ / $MgSO_4$ against $BaCl_2$ and $Ba(CH_3COO)_2$ and calculation of amount of Sulphate Present .
2. Conductometric estimation of NH4Cl with NaOH solution.

Potentiometry (Any one)

1. To determine the basicity and pKa value of organic acids by potentimetricmethod. (Orthophosphoric acid)
2. Determine the solubility and solubility product of sparingly soluble salts.

RECOMMENDED BOOKS

1. Findlay's Practical Physical Chemistry by J.A. Kitchnar
2. Text-book of Quantitative Inorganic Analysis including elementaryInstrumental Analysis- A.I.Vogel, Revised by J.Bassott, R.C.Banney
3. Experimental Physical Chemistry – F.Daniels&J.Williams
4. Experimental Physical Chemistry – R.C.Das&B.Behra
5. Systematic experimental Physical Chemistry by- Rajbhoj and Chondhekar.
6. Experimental physical Chemistry- V.D. Athawale and P. Mathur
7. Advanced practical physical Chemistry- J. B. Yadav
8. Advanced physical Chemistry Experiments- Gurtu and Gurtu

	Punyashlok Ahilyadevi Holkar Solapur University, Solapur **MSc (Chemistry) Semester-I** **Vertical : DSC** **Course Code: 2302105/ 2303105/ 2304105/2324105/ 2325105/ 2326105/ 2327105** **Course Name: Practical-II**
***Teaching Scheme** **Practicals:04 Hours/week, 02 Credits**	***Examination Scheme** **UA:30 Marks** **CA: 20 Marks**

Course Preamble: The practical course is designed in such a way that students will get an experiential learning. The practicals are set on the core paper Organic Chemistry-I. The practicals based on qualitative analysis. The students will identify the organic compounds from the given mixture. Some demonstrative experiments are also added in the course such as TLC and Extraction.

Course Outcomes (COs)

CO1: Training on laboratory safety and lab ethics in scientific work

CO2: Training on planning, design and execution of experiments

CO3: Training on scientific literature search, defining the objective of the work, research skills, data representation in tabular and graphical form etc.

CO4: Training on experimental verification of fundamental theories, comparison of data with literature and scientific discussion on any deviation of data from expected theoretical values or reported literature.

CO5: Application of theoretical and practical knowledge for research training through mandatory research/industrial projects

Qualitative analysis:

1. Separation and identification of the two component mixtures using

Chemical and physical methods. **(Minimum Five Mixtures)**

Demonstrative Experiments:

1. Thin layer chromatography (TLC).

2. Vacuum and steam distillation techniques.

3 Extraction by Soxhlet Method

RECOMMENDED BOOKS

1. A text book of practical Organic Chemistry- A. I. Vogel.
2. Practical organic Chemistry- Mann and Saunders.
3. A handbook of quantitative and qualitative analysis- H. T. Clarke.
4. Organic Synthesis Collective Volumes by Blat.
5. Systematic Lab Experiments in Organic Chemistry by ArunSethi
6. Advanced practical chemistry by Jagdamba Singh

	Punyashlok Ahilyadevi Holkar Solapur University, Solapur **MSc (Chemistry) Semester-I** **Vertical : DSC** **Course Code: 2302106/ 2303106/ 2304106/2324106/ 2325106/ 2326106/ 2327106** **Course Name: Practical-III**
***Teaching Scheme** **Practicals:04 Hours/week, 02 Credits**	***Examination Scheme** **UA:30 Marks** **CA: 20 Marks**

Course Preamble: The practical course is designed in such a way that students will get an experiential learning. The practicals are set on the elective courses. In this course the practicals are designed on ore analysis, alloy analysis and also on preparation and determination of purity of given inorganic compounds.

Course Outcome: Student will able to -

CO-1: Prepare solution of required conc. and handle the laboratory equipment properly.

CO-2: Perform experiment accurately and able to perform calculation.

CO-3: Explain experiment and principal of experiment in detail.

CO-4: Perform calculations and discuss results and write conclusions of the experiment.

CO-5: Apply knowledge to a) design experiment for given aim or modify experiment to enhance results. b) to find out lacuna in experimental procedure.

CO-6: Solve problem/ numerical depending on given experimental data / information

Ore Analysis:

1. Iron Ore

2. Dolomite Ore

Alloy Analysis: (any one)

1. Brass alloy

2. Bronze alloy

Preparation and determination of purity: (any two)

1. Potassium trioxalatochromate(III)

2. Nitritopentacyano ferrate (III) monohydrate

3. Copper acetate

4. Manganese acetate

5. Hexathioureaplumbus nitrate

Note: Any other relevant experiment shall be added

RECOMMENDED BOOKS

1. Vogel's Text Book of Quantitative Inorganic Analysis.

2. W. G. Palmer, Experimental Inorganic Chemistry, Cambridge at the University Press, 1965.

3. M. A. Malati, Experimental Inorganic/Physical Chemistry, Harwood publishingChichester.

4. A.J.E.Welch, Inorganic Preparations, George Allen & Unwin Ltd.

	Punyashlok Ahilyadevi Holkar Solapur University, Solapur **MSc (Chemistry) Semester-I** **Vertical : DSE** **Course Code: 2302107/ 2303107/ 2304107/2324107/ 2325107/ 2326107/ 2327107** **Course Name: Inorganic Chemistry-I**
***Teaching Scheme** **Practicals:04 Hours/week, 04 Credits**	***Examination Scheme** **UA:60 Marks** **CA: 40 Marks**

Course Preamble: This course aims at giving students theoretical understanding about the basic constituents of matter – atoms, ions and molecules in terms of their electronic structure and reactivity. Structure and bonding in/of these are to be dealt with basic quantum chemistry treatment. Reactivity of chemical species based on their electron transfer affinity is introduced. Further, periodic classification of elements in the periodic table and changes in properties along the periods and groups to be studied in detail. Accompanying laboratory course is designed for students to have hands-on experience of basic quantitative analytical techniques related to volumetric titrations.

Course outcomes:

On completion of this course the students will be able to understand:

CO1: Periodic properties of elements including transition elements

CO2: Valence bond, molecular orbital theory and VSEPR model of inorganic systems

CO3: the inorganic materials like semiconductors

CO4: know the basics of nuclear chemistry

CO5: the structures of metal clusters and metal carbonyls

Unit I: Chemistry of Transition Elements: **Hrs: 15, Weightage:19**

General characteristic properties of transition elements, co-ordination chemistry of transition metal ions, ligand field theory, ligand field energy parameters (Racah parameters B and C, Slater Condon Parameters, Slater Condon Shortly Parameters), splitting of d orbitals in low symmetry environment, Jahn-Teller effect, interpretation of electronic spectra including charge transfer spectra, spectrochemical series, nephelauxetic effect and nephelauxetic series. Diapara-ferro and antiferromagnetism, quenching of orbital angular moments, spin orbit coupling.

Unit-II: A) Stereochemistry and Bonding **Hrs:8, Weightage:11**

VSEPR theory, Walsh diagrams (tri and penta-atomic molecules) dπ – pπ bonds, Bent`s rule and energetics of hybridization, some simple reactions of covalently bonded molecules.

Unit-II: B) Inorganic Materials **Hrs: 7, Weightage:10**

Insulators and semiconductors, electronic structure of solids, band theory, intrinsic and extrinsic semiconductors, doping of semiconductors and conduction mechanism, semiconductor devices, rectifiers, transistors, photoconductors, photovoltaic cell.

Unit-III: Nuclear Chemistry **Hrs: 15, Weightage:19**

Radioactive decay and equilibrium, Nuclear reactions, Q values, cross sections, types of reactions. Chemical effects of nuclear transformations, fission and fusion, fission products and fission yields. Radioactive techniques, tracer techniques, neutron activation analysis, counting techniques such as G.M., ionization and proportional counters, fissile and fertile isotopes, nuclear reactors, application of radio isotopes.

Unit- IV Metal Cluster and Metal Carbonyls **Hrs: 15, Weightage:19**

Metal Cluster: Introduction, Classification of metal clusters, Structures of Carbonyl Clusters (LNCC and HNCC), Structural aspects of Halide type Clusters (Di, tri, tetra & hexa nuclear clusters)

Metal Carbonyls: Introduction, Classification of carbonyl complexes, Formation of CO molecule, Coulson's modification and explanation of strong field effect of Co ligand, Bonding in metal carbonyl complexes (mono, di & tri nuclear carbonyl complexes, synergic relationship between metal and CO ligands), Preparation, properties & structures of mono, di & tri nuclear carbonyl complexes [$V(CO)_6$, $Cr(CO)_6$, $Ni(CO)_4$, $Fe(CO)_5$, $Mn_2(CO)_{10}$, $Co_2(CO)_8$,$Fe_2(CO)_9$, $Fe_3(CO)_{12}$], EAN rules for metal carbonyls and problems based on EAN, 18 electron rule for metal carbonyls and problems based on 18 electron rule.

RECOMMENDED BOOKS

1. A. F. Wells, Structural Inorganic Chemistry – 5th Edition (1984), Oxford Science Publication

2. James H. Huheey, Inorganic Chemistry- Principle, Structure and Reactivity,

3. J. D. Lee, Concise Inorganic Chemistry, ELBS with Chapman and Hall, London

4. A.R. West, Solid State Chemistry and its applications, Plenum-John Wiley and Sons

5. N.B. Hanny, Solid State Physics

6. H.V. Keer, Solid State Chemistry

7. S.O. Pillai, Solid State Physics, New Age International Publication

8. W.D. Callister, Material Science and Engineering: An Introduction, John Wiley and Sons

9. R. Raghwan, First Course in Material Science

10. R.W. Cahan, The coming of Material Science

11. A.R. West, Basic Solid State Chemistry, 2nd Edition, John Wiley and Sons

12. U. Schubest and H. Husing, Synthesis of Inorganic Materials, Wiley VCH (2000)

13. M.C. Day and Selbin, Theoretical Inorganic Chemistry, Reinhold, EWAP

14. A.H. Hanny, Solid State Chemistry, A.H. Publication

15. John Wullf, The Structure and Properties of Materials, Vol. 4, Electronic properties, Willey Estern

16. L.V. Azoroff and J.J. Brophy, Elecronic Processes in Materials, McGraw Hill –I

17. Prakash G. More, Comprehensive Industrial Chemistry, PragatiPrakashan,Meerut

18. F.A. Cotton and R.G. Wilkinson, Advanced Inorganic Chemistry, Wiley Students Edition

19. Williams and L. Jooly, Modern Inorganic Chemistry, McGraw-Hill International Edition

20. ManasChanda, Atomic Structure and Bonding, TMH Publication

21. N.N. Greenwood and A. Earnshaw, Chemistry of Elements, Pergamon

22. Chakrabarty, Solid State Chemistry, New Age International Publication

23. J.J. Lipard, Progress in Inorganic Chemistry, Vol 18 and 38, Wiley

24. E. Konig, Structure and Bonding, Vol 9, 1971, 175

25. H.J. Arnikar, Essentials of Nuclear Chemistry, New Age International Publication

26. Friendlander, Kennedy and Miller, Nuclear and Radiochemistry, Wiley and Sons

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पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ।। विद्यया संपन्नता ।। NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **MSc (Chemistry) Semester-I** **Vertical : DSE** **Course Code: 2302108/ 2303108/ 2304108/2324108/ 2325108/ 2326108/ 2327108** **Course Name: Chemistry in Life Sciences**
***Teaching Scheme** **Practicals:04 Hours/week, 04 Credits**	***Examination Scheme** **UA:60 Marks** **CA: 40 Marks**

Course Preamble: Chemistry in Life Sciences is an elective course offered to the students. The first unit of this course deals with cell biology and structural study of cell organelles. The next unit devotes to the amino acids and nucleic acids. The students will learn DNA and RNA chemistry. Followed by protein chemistry. The last unit includes bioenergetics. The structural study of ATP, ADP is included in this unit.

Course outcomes:

On completion of this course, the students will be able to understand:

CO1: Understanding of interface of Chemistry and Biology

CO2: Molecular design of life, biochemical reactions, Chemical and physical foundations of biomolecules

CO3: proteins and enzyme chemistry

CO4: bioenergetics

Unit I: Introduction to cell biology and Structure of different cell organelles
Hrs: 15, Weightage:20

Prokaryotic (archaea and eubacteria) and eukaryotic cell (animal and plant cells), cells as experimental models. Structure of nuclear envelope, nuclear pore complex. ER structure. Organization of Golgi. Lysosome. Structure and functions of mitochondria, chloroplasts and peroxisomes. Zellweger syndrome.

Unit II: Amino acids and Nucleic acids **Hrs: 15, Weightage:20**

Structure and classification, physical, chemical and optical properties of amino acids Nucleotides - structure and properties. Nucleic acid structure – Watson-Crick model of DNA. Structure of major species of RNA - mRNA, tRNA and rRNA.

Nucleic acid chemistry - UV absorption, effect of acid and alkali on DNA. Other functions ofnucleotides - source of energy, component of coenzymes, second messengers

Unit : III: Protein Chemistry Hrs: 15, Weightage:19

Polypeptide backbone, covalent and non-covalent interactions, end-group analysis by chemical and enzymatic methods, Conformation, Configuration, Details of primary, secondary, tertiary and quaternary structures, problems based on determination of primary structure, Ramchandran Plot, structure- function relation of protein (Ex. Haemoglobin) Chemical modification and cross-linking in proteins, dynamic properties and mechanisms of protein folding

Unit IV: Introduction to bioenergetics Hrs: 15, Weightage:19

Laws of thermodynamics, state functions, equilibrium constant, coupled reactions, energy charge, ATP cycle, phosphorylation potential, phosphoryl group transfers. Chemical basis of high standard energy of hydrolysis of ATP, other phosphorylated compounds and thioesters.Redox reactions, standard redox potentials and Nernst equation. Universal electron carriers.

RECOMMENDED BOOKS

1. Principles of Biochemistry, Lehninger C Rs. Publ. (1982).
2. Biochemistry, L. Stryer, W.H. Freeman, San Francisco.
3. Schaum's Outline Series of Theory and Problems of Biochemistry, Philip W. Kucheland G.B. Ralston. Int. Ed., McGraw-Hill Book Co.
4. Molecular Biology of the cell – Bruce Alberts – J.D. Watson et al Garlandpublishing Inc., N.Y. (1983).
5. Cell and Molecular Biology – De Robertis and Saunders (1980).
6. The cell – C.P. Swanson, Prentice Hall (1989)
7. Cell Biology – C.J. Avers, Addision Wesley Co. (1986).
8. Metabolic Pathways - Greenberg.
9. Biochemistry – G. Zubay, Addision Wesley Publ. (1983).
10. Biochemistry – Stryer (1988) 3rd Edition W.H. Freeman and Co.

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ॥ विद्यया संपन्नता ॥ NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **MSc (Chemistry) Semester-I** **Vertical : DSE** **Course Code: 2302109/ 2303109/ 2304109/2324109/ 2325109/ 2326109/ 2327109** **Course Name: Medicinal Chemistry**
***Teaching Scheme** **Practicals:04 Hours/week, 04 Credits**	***Examination Scheme** **UA:60 Marks** **CA: 40 Marks**

Course Preamble: This is an elective course offered to the students. The unit I deals with basics of drugs and drug design. The unit II deals with pharmacokinetics and pharmacodynamics. The cardiovascular drugs and detailed study of anti inflammatory drugs are included in unit III. The unit IV deals with the chemistry of drugs like antibiotics, analgesics, etc.

Course outcomes:
On completion of this course, the students will be able to understand:
CO1: Modern approaches to drug design and clinical trials
CO2: Importance of heterocyclic compounds in medicinal chemistry and drug design
CO3: Nomenclature, classification, synthesis and reactivity of non-aromatic, aromatic, benzo-fused heterocycles containing one, two or more heteroatom
CO4: Pharmacokinetics and Pharmacodynamics

Unit –I **Hrs: 15, Weightage:19**

a) **Drugs:** Essential Drugs, Nomenclature of Drugs, Routes of Drug Administration, Adverseeffects of Drugs, IUPAC Naming of Drugs.
b) **Drug Design:** Development of New Drugs, Factors Affecting Development of New Drugs.Sources of lead compounds, Concept of prodrugs and soft drugs, Drug Receptors, Theoriesof Drug Action.

Unit –II **Hrs: 15, Weightage:19**

a) **Pharmacokinetics:** Introductions, Drug Absorption, Distribution and Disposition of Drugs, Excretion and Elimination, Pharmacokinetics of Elimination.
b) **Pharmacodynamics:** Introduction, Enzyme Stimulation, Enzyme Inhibition, Membrane Active Drugs, Drugs Metabolism, Biotransformation, Toxicology, Types of Interactions.

Unit-III **Hrs: 15, Weightage:20**

a) **Cardiovascular Drugs:** Introductions, Classification, Cardiovascular Diseases, Synthesis of Diltiazem, Verapamil, Methyldopa, Atenolol.
b) **Non Steroidal Anti-inflammatory Drugs (NSAIDs):** Introductions, Classification,

Synthesis, Mechanism of action of Indomethacin, Ibuprophen, Dichlorophenac, Naproxen, Allorpurinol.

Unit –IV **Hrs: 15, Weightage:20**

a) Antibiotics: Introductions, Classification, β-Lactum antibiotics, Cephalosporins, AnticancerAntibiotics. Synthesis of Penicillin-G, Penicillin-V, Ampicillin, Amoxycillin, Chloramphenicol, Cephalophalosporin, Tetracyclin and Strectomycin.

b) General anaesthetics and local anaesthetics: Introduction, Classification, Mode of Action and mechanism of action of general and local anaesthetics.

Reference books:

1. Medicinal Chemistry by Ashutosh Kar, New Age International Publishers.
2. Medicinal Chemistry by Alka L. Gupta.

SEMESTER II

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ।। विद्यया संपन्नता ।। NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **MSc (Chemistry) Semester-II** **Vertical : DSC** **Course Code: 2302201/ 2303201/ 2304201/2324201/ 2325201/ 2326201/ 2327201** **Course Name: Physical Chemistry-II**
***Teaching Scheme** **Lectures:04 Hours/week, 04 Credits**	***Examination Scheme** **UA:60 Marks** **CA: 40 Marks**

Course Preamble: Physical chemistry II is discipline specific core course. This course is designed to learn the important branches of physical chemistry like photochemistry, electrochemistry, chemical kinetics and macromolecular chemistry. The basic principles of all the above is included along with the applications of these fields.

Course outcomes:
After completion of the course, the learner shall be able to understand:
CO1: Basic principles and laws involved in photochemistry
CO2: Photophysical phenomena and quenching concept
CO3: Chemical kinetics of simple and complex reactions
CO4: Primary salt effect and its applications
CO5: Kinetics of ionic reactions in solution phase
CO6: electrical double layer theories
CO5: Macromolecule chemistry

Unit-I: Photochemistry **Hrs: 15, Weightage:19**

Introduction, Franck–Condon principle, electronic excitation, photo-dissociation and Pre-dissociation, photo-reduction, photo-oxidation, role of photochemistry in environment (Green house effect, ozone depletion).

Photophysical phenomenon. Jablonski diagram. Kasha's rule, fluorescence, phosphorescence, delayed fluorescence, differences between phosphorescence and delayed fluorescence. Inter & intra molecular excitation energy transfer (EET) processes. Quenching offluorescence and kinetics of biomolecular quenching processes, Stern-Volmer equation, formation of photodimer, (with suitable examples) excimer and exciplex.

Unit-III: Electrochemistry **Hrs: 15, Weightage:19**

Electrical double layer and its significance (Helmholtz, Gouy-Chapmann and Stern model), evaluation of mean activity coefficients of ions from e.m.f. data,

determination of dissociation constant of monobasic acid by e.m.f. method. Debye Huckel theory (without derivation) and limiting law. Storage batteries: acid and alkali storage cells.

Unit-IV: Chemical Kinetics **Hrs: 15, Weightage:19**

Rate determining step, steady state approximation. fractional order kinetics, Higher order kinetics and their examples.

Reaction mechanism: Thermal decomposition of acetaldehyde, ethane, reaction between hydrogen and halogens, reaction between NO_2 and F_2, Decomposition of Ozone. Ionicreactions: Primary and secondary salt effect, Effect of ionic strength and dielectric constant of medium on the rate of ionic reactions in solution.

UNIT-IV Macromolecules **Hrs: 15, Weightage:19**

Introduction, molecular weight of a polymer (Number andmass average) viscosity average molecular weight. Degree of polymerization and molecular weight, practical significance of polymer molecular weight, methods of determining molecular weights (Osmometry, viscometry, light scattering, diffusion and ultra centrifugation) Chemistry of polymerization: Free radical polymerization (Initiation, propagation and termination), kinetics of free radical polymerization, step growth polymerization (Polycondensation), molecular weight distribution, kinetics of step polymerization, cationic and anionic polymerization. Electronically conducting polymers, Glass transition temperature and molecular weight, factors influencing Glass transition temperature, determination of glass transition temperature, Numerical Problems

RECOMMENDED BOOKS

1. Photo chemistry- J.G.Calverts & J.N.Pits
2. Fundamentals of Photochemistry- K.K.Rohatgi, Mukharji
3. Photochemistry of Solutions – C. A. Parker
4. Chemical Kinetics – K.J.Laidler
5. Kinetics and Mechanism - R. A. Frost and R. G. Pearson
6. Electrochemistry – S. Glasstone
7. Modern electrochemistry – Bockris & Reddy
8. Physical Chemistry – P. W. Atkins
9. Physical Chemistry – G. M. Barrow

10. Physical Chemistry: A molecular Approach – Donald A. McQuarrie and John D. Simon,Viva Books, New Delhi, 1998.
11. Introduction to Photochemistry-Wells
12. Electrolytic Solutions by R. A. Robinson and R. H. Strokes, 1959
13. Basic chemical Kinetics- G. L. Agarwal, Tata-McGraw Hill

14. Physical Chemistry of macromolecules- D. D. Deshpande, Vishal Publications.
15. Polymer Chemistry- F. W. Billmeyer Jr, John-Wiley&Sons, 1971.

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***Teaching Scheme** **Lectures:04 Hours/week, 04 Credits**	***Examination Scheme** **UA:60 Marks** **CA: 40 Marks**

Course Preamble: Organic chemistry II is discipline specific core course. The syllabus of this course is divided into four units. The important topics like aromatic electrophilic and nucleophilic substitution reactions, addition, elimination, oxidation and reduction reactions are covered in remaining three units.

Course outcomes:
On completion of this course, the students will be able to understand:
CO1: Important electrophilic and nucleophilc reactions
CO2: Stereochemical aspects of addition reactions
CO3: Elimination reactions
CO4: Oxidation and Reduction reactions
CO5: Chemistry of oxidation and reduction agents

Unit I: Aromatic Electrophilic & Nucleophilic Substitution reactions

Hrs: 15, Weightage:19

The arenium ion mechanism, orientation and reactivity, energy profile diagram, ortho/para ratio, ipso substitution, orientation in other ring system, recapitulation of halogenations, nitration, sulphonation and Friedel craft's reactions, Diazonium coupling.

The SN^{Ar}, SN^1, SN^2 and benzyne mechanism, Effect of substrate structure, leaving group and attacking nucleophilic on reactivity

Unit IIA: Addition to Carbon–Carbon and Carbon –Hetero multiple bond

Hrs: 10, Weightage:14

Mechanism and stereochemical aspects of addition reaction involving electrophile, nucleophile and free radical, Regio-selectivity and chemo selectivity, orientation and reactivity, Michael addition, Robinson annulation.

Addition of Grignard reagent, Organo zinc, Organo copper and Organo lithium reagent to carbonyl and unsaturated carbonyl compounds, Detailed mechanism and applications of Simon-Smith, Mc-Murry, Hunsdiecker, Nef reaction, Pummerer, Mitsunobu and Wittig reaction.

Unit II B: Elimination Reactions **Hrs: 05, Weightage:7**

The E1, E2 and E1cb mechanism. Orientation of double bond, reactivity: Effect of substrate substance, attacking base, the leaving group and the medium, pyrolytic elimination (Xanthate ester, Sulphoxides).

Unit III: Oxidation reactions **Hrs: 15, Weightage:19**

Introduction, different oxidative process, CrO_3 (Jones reagent), PDC, PCC, $KMnO_4$, MnO_2, Swern, $Pb(OAc)_4$, Pd-C, RuO_4, m-CPBA, Per acids, O_3, H_2O_2, $NaIO_4$, HIO_4, TEMPO (2,2,6,6-tetramethylpiperidine 1-oxyl radical), IBX (O-Iodoxybenzoic acid), CAN (*Ceric Ammonium Nitrate*), Dess-Martin Periodate (DMP), Iodobenzene diaacetate and Thallium (III) nitrate.

Unit IV: Reduction reactions **Hrs: 15, Weightage:19**

Introduction, different reductive process, Catalytic hydrogenation using Pt, Pd, Ni, Wilkinson's catalyst and Wolff-Kishner reduction, Birch reduction, Clemmenson reduction, Rosenmund, Lindlars catalyst, Bu_3SnH (TBTH), Reduction using $NaBH_4$, LAH and DIBAL-H, $NaCNBH_3$, Triphenyl phosphine.

RECOMMENDED BOOKS

1. Advanced Organic Chemistry: IV Edn. J. March
2. Stereochemistry of carbon Compounds: E. L. Eliel
3. Advanced organic chemistry: F. A. Carey and R. J. Sundberg
4. A guide book to mechanism in organic chemistry: Peter Sykes.
5. Mechanism and Structure in organic Chemisry: E. S.Gould
6. Principle of Organic Synthesis: R.O.C. Norman.
7. Modern Methods of Organic Synthesis: W. Carruthers
8. Organic Chemistry: Clayden, Greeves, Warren and Wothers
9. Stereochemistry of Organic Compounds: D. Nasipuri
10. Stereochemistry: P. S. Kalsi
11. Basic Stereochemistry of Organic Molecules: Subrata Sen Gupta
12. Synthetic Organic Chemistry: H.O. House
13. Organic Chemistry: J. Clayden, N. Greeves

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ।। विद्यया संपन्नता ।। NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **MSc (Chemistry) Semester-II** **Vertical : OJT** **Course Code: 2302203/ 2303203/ 2304203/2324203/ 2325203/ 2326203/ 2327203** **Course Name: OJT/In-house Project/ Internship/ Apprenticeship**

*Teaching Scheme	*Examination Scheme
Practicals:08 Hours/week, 04 Credits	**UA:60 Marks** **CA: 40 Marks**

Course Preamble: The four credit course on OJT is included in the syllabus of M.SC. I Chemistry. As per the NEP guidelines, student should get on job training during his M. Sc. Program. This will provide industrial/in plant training along with industrial skills.

Students in this course will be required to do On the Job Training (OJT)/Internship in relevant industries/government sectors/institutes, etc. to gain practical training. As a prerequisite for OJT, the department may conduct necessary lectures/workshops/seminars. The course will be run as per the guidelines of the Institute /the University and Government of Maharashtra. Most of our graduates are expected to seek employment in industries, pursue teaching careers, or establish small enterprises after obtaining their M.Sc. degree.

A detailed report should be submitted for the evaluation of On Job Training/Internship.

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ।। विद्यया संपन्नता ।। NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **MSc (Chemistry) Semester-II** **Vertical : DSC** **Course Code: 2302204/ 2303204/ 2304204/2324204/ 2325204/ 2326204/ 2327204** **Course Name: Practical-IV**
***Teaching Scheme** **Practicals:04 Hours/week, 02 Credits**	***Examination Scheme** **UA:30 Marks** **CA: 20 Marks**

Course Preamble: The practical course is designed in such a way that students will get an experiential learning. The practicals are set on the core paper Physical Chemistry-I. The practicals based on Chemical kinetics, viscosity, adsorption, surface tension, phase equilibria, refractometry, conductometry, and Potentiometry are included in the course. The students will be trained in instrument handling and calibration.

Course Outcomes (COs)

CO1: In-depth training on laboratory solution preparations on all concentration scales

CO2: Training on laboratory safety and lab ethics in scientific work

CO3: Training on planning, design and execution of experiments

CO4: Training on scientific literature search, defining the objective of the work, research skills, data representation in tabular and graphical form etc.

CO5: Training on experimental verification of fundamental theories, comparison of data with literature and scientific discussion on any deviation of data from expected theoretical values or reported literature.

CO6: Training on electrochemical analysis of different physicochemical aspects of materials

CO7: Training on different techniques needed to characterize the substances

CO8: Application of theoretical and practical knowledge for research training through mandatory research/industrial projects

NON-INSTRUMENTAL

Kinetics (any one)

1. Determination of order of reaction by differential method
2. Comparison of acid strength by hydrolysis of ester

Viscosity

1. To determine the radius of molecule by viscosity measurements. (glycerol / sucrose)

Adsorption

1. Oxalic acid on activated animal charcoal

Phase Equilibria :-

1. Three component system: Benzene, ethyl alcohol and water
2. To determine the CST of phenol-water system in presence of 0.5% naphthalene (or 1%succinic acid)

Surface Tension:

1. To determine the atomic parachor of C, H and Cl by surface tension measurements.

INSTRUMENTAL

Refractometry

1. To determine the electron polarization and electron polarizability of a liquid.

2. pHmetry: (any one)

1. Determination of pKa of acid (Succinic acid)
2. Determination of hydrolysis constant of aniline hydrochloride

Conductometry

1. Solubility and solubility product of spranigly soluble salts.
2. Titration of a mixture of HCl, CH_3COOH and $CuSO_4$ against alkali.

Potentiometer: (any one)

1. Estimate the amount of halides present in the given mixture by titrating with AgNO3 solution.
2. Titration of mixture of acids with base.

Polarimetry

1. To determine the percentage of two optically active substances (d-sucrose and d-tartaricacid) in a given solution.

Note: Any other relevant experiments may be added

RECOMMENDED BOOKS

1. Findlay's Practical Physical Chemistry by J.A. Kitchnar
2. Text-book of Quantitative Inorganic Analysis including elementaryInstrumental Analysis- A.I.Vogel, Revised by J.Bassott, R.C.Banney
3. Experimental Physical Chemistry – F.Daniels&J.Williams
4. Experimental Physical Chemistry – R.C.Das & B.Behra
5. Systematic experimental Physical Chemistry by- Rajbhoj and Chondhekar.
6. Experimental physical Chemistry- V.D. Athawale and P. Mathur
7. Advanced practical physical Chemistry- J. B. Yadav
8. Advanced physical Chemistry Experiments- Gurtu and Gurtu

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ॥ विद्यया संपन्नता ॥ NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **MSc (Chemistry) Semester-II** **Vertical : DSC** **Course Code: 2302205/ 2303205/ 2304205/2324205/ 2325205/ 2326205/ 2327205** **Course Name: Practical-V**

***Teaching Scheme**	***Examination Scheme**
Practicals:04 Hours/week, 02 Credits	**UA:30 Marks** **CA: 20 Marks**

Course Preamble: The practical course is designed in such a way that students will get an experiential learning. The practicals are set on the core paper Organic Chemistry-I. The practicals based on one step and two step organic preparation. Experiments are also designed on estimation of hydroxyl group, iodine and amine.

Course Outcomes (COs)

CO1: Training on laboratory safety and lab ethics in scientific work

CO2: Training on planning, design and execution of experiments

CO3: Training on scientific literature search, defining the objective of the work, research skills, data representation in tabular and graphical form etc.

CO4: Training on experimental verification of fundamental theories, comparison of data with literature and scientific discussion on any deviation of data from expected theoretical values or reported literature.

CO5: Application of theoretical and practical knowledge for research training through mandatory research/industrial projects

Preparations:

One stage preparation involving various types of reactions (Minimum Two)

1. Aldol condensation: Dibenzal acetone from benzaldehyde.
2. Sandmeyer reaction: p- Chlorotoulene from p-toluidine.
3. Cannizzaro reaction: 4-Chlorobenzaldehyde as a substrate.

2) Two stage preparations involving various types of reactions (Minimum Four)

1. Aceotophenone- Oxime- Acetanilide
2. Phthalic anhydride- o-Benzoyl benzoic acid- anthraquinone
3. Chloroenzene-2,4-dintrochlorobenzene-2,4-dinitrophenol
4. Benzoin-benzil-benzilic acid

5. Acetanilide-p-bromoacetanilide-p-bromoaniline

6. Acetanilide-p-nitroacetanilide-p-nitroaniline

3) Estimations: (minimum Two)

1) Estimation of amine by acetylation method.

2) Estimation of hydroxyl group by acetylation method

3) Estimation of an iodine value of an oil or fat.

4) Determination of percentage of Keto-enol form.

(Any other relevant experiments may be added).

RECOMMENDED BOOKS

1. A text book of practical Organic Chemistry- A. I. Vogel.
2. Practical organic Chemistry- Mann and Saunders.
3. A handbook of quantitative and qualitative analysis- H. T. Clarke.
4. Organic Synthesis Collective Volumes by Blat.
5. Systematic Lab Experiments in Organic Chemistry by ArunSethi
6. Advanced practical chemistry by Jagdamba Singh

	Punyashlok Ahilyadevi Holkar Solapur University, Solapur **MSc (Chemistry) Semester-II** **Vertical : DSE** **Course Code: 2302206/ 2303206/ 2304206/2324206/ 2325206/ 2326206/ 2327206** **Course Name: Practical-VI**
***Teaching Scheme** **Practicals:04 Hours/week, 02 Credits**	***Examination Scheme** **UA:30 Marks** **CA: 20 Marks**

Course Preamble: The practical course is designed in such a way that students will get an experiential learning. The practicals are set on the elective courses. In this course the practicals are designed on ore analysis, alloy analysis and also on preparation and determination of purity of given inorganic compounds.

Course Outcome: Student will able to -

CO-1: Prepare solution of required conc. and handle the laboratory equipment properly.

CO-2: Perform experiment accurately and able to perform calculation.

CO-3: Explain experiment and principal of experiment in detail.

CO-4: Perform calculations and discuss results and write conclusions of the experiment.

CO-5: Apply knowledge to a) design experiment for given aim or modify experiment to enhance results. b) to find out lacuna in experimental procedure.

CO-6: Solve problem/ numerical depending on given experimental data / information

Ore analysis: (any one)

1. Pyrolusite ore

2. Bauxite ore

Alloy analysis: (any two)

1. Type metal alloy

2. Solder alloy

3. Cupro-nickel alloy

Preparation and determination of purity: **(any two)**

1. Potassium hexathiocyanatochromate (III)

2. Hexamine cobalt nitrate

3. Manganous ammonium phosphate

4. Prussian blue

Note: Any other relevant experiments may be added

RECOMMENDED BOOKS

1. Vogel's Text Book of Quantitative Inorganic Analysis.

2. W. G. Palmer, Experimental Inorganic Chemistry, Cambridge University Press, 1965.

3. M. A. Malati, Experimental Inorganic/Physical Chemistry, Harwood publishing Chichester.

4. A.J.E.Welch, Inorganic Preparations, George Allen & Unwin Ltd.

	Punyashlok Ahilyadevi Holkar Solapur University, Solapur **MSc (Chemistry) Semester-II** **Vertical : DSE** **Course Code: 2302207/ 2303207/ 2304207/2324207/ 2325207/ 2326207/ 2327207** **Course Name: Inorganic Chemistry-II**
***Teaching Scheme** **Practicals:04 Hours/week, 04 Credits**	***Examination Scheme** **UA:60 Marks** **CA: 40 Marks**

Course Preamble: This course is one of the elective course. This course comprises four units. Each unit is of 15 Hrs theory lectures. The students will learn the chemistry of non transition elements, lanthanides and actinides. They will be familiar with organometallic chemistry of transition metals. The study of metallurgy and bio-inorganic chemistry is included in unit IV.

Course outcomes:

On completion of this course the students will be able to understand:

CO1: Periodic properties of non transition elements

CO2: organometallic chemistry of transition elements

CO3: the chemistry involved in metallurgy

CO4: know the chemistry of lanthanides and actinides

CO5: the chemistry involved in medicine

CO6: the structure of Hemocyanin, Hemerythrin, cytochromes etc.

Unit-I: Chemistry of Non- transition Elements: Hrs: 15 Weightage: 20 Marks

General discussion of the properties of non- transition elements, special features of the individual elements, synthesis, properties and structure of their halides and oxides, polymorphism of carbon, phosphorous, sulphur. Synthesis, structure and properties of boranes, carboranes, borazines, silicates, carbides, silicones, phosphazenes, sulphur nitrogen compounds, oxyacids of nitrogen, phosphorous, sulphur and halogen, interhalogens, pseudohalides and noble gas compounds.

Unit-II: Organometallic Chemistry of Transition Elements: Hrs: 15 Weightage: 20 Marks

Synthesis, structure and bonding, organometallic reagents in organic synthesis and in homogenous catalytic reactions (hydrogenation, hydroformylation, isomerization,Monsanto

acetic acid process, synthesis gas, Wacker Process), Ziegler and Natta catalysis, pi-metal complexes, activation of small molecules by coordination.

Unit-III: A) Metal- Ligand Equillibria in Solution: Hrs: 07 Weightage: 09Marks

Stepwise and overall formation constants and their interaction, trends in stepwise constants, factors affecting the stability of metal complexes with reference to the metal ion and ligand, chelate effect and its thermodynamic origin, determination of formation constants by pH-metry and spectrophotometry.

Unit-III: B) Chemistry of Lanthanides and Actinides Hrs: 08 Weightage: 10Marks

Lanthanides: Introduction, spectral and magnetic properties. Classical methods of separation of lanthanides: (i) precipitation (ii) thermal reaction, (iii) fractional crystallization, (iv) complex formation, (v) solvent extraction and (vi) ion exchange, Applications of lanthanides.

Actinides: Introduction, spectral and magnetic properties. Methods of separation of actinides from lanthanide, Preparation of trans-uranic elements. Applications of actinides.

Unit-IV: A) Metallurgy Hrs: 08 Weightage: 10Marks

Occurance, extraction, properties and applications of silver, gold, tin and lead.

Unit-IV: B) Bioinorganic Chemistry Hrs: 07 Weightage: 09Marks

Role of metals in medicines, Role of metal ions in biological processes, molecular mechanism of ion transport across membranes, ionophores, photosynthesis PS I and PS II, nitrogen fixation, oxygen uptake proteins: Hemocyanin, Hemerythrin, cytochromes, rubredoxin and ferredoxins, Calcium biochemistry, coenzyme B12.

RECOMMENDED BOOKS

1. A. F. Wells, Structural Inorganic Chemistry – 5th Edition (1984), Oxford Science Edition

2. James H. Huheey, Inorganic Chemistry- Principle, Structure and Reactivity, Harper and Row Publisher Inc., New York

3. J. D. Lee, Concise Inorganic Chemistry, ELBS with Chapman and Hall, London

4. M.C. Day and Selbin, Theoretical Inorganic Chemistry, Reinhold, EWAP

5. Jones, Elementary Coordination Chemistry

6. Morttel, Coordination Chemistry

7. T.S. Swain and D.S.T. Black, Organometallic Chemistry

8. Prakash G. More, Comprehensive Industrial Chemistry, PragatiPrakashan, Meerut

9. John Wullf, The Structure and Properties of Materials, Vol. 4, Electronic properties, Willey Eastern

10. L.V. Azoroff and J.J. Brophy, Elecronic Processes in Materials, McGraw Hill –I

11. F.A. Cotton and R.G. Wilkinson, Advanced Inorganic Chemistry, Wiley Student Edition

12. Williams and L. Jooly, Modern Inorganic Chemistry, McGraw Hill International Edition

13. ManasChanda, Atomic Structure and Bonding,TMH Publication

14. P.L. Pausan, Organometallic Chemistry

15. Cullen, Dolphin and James, Biological Aspects of Inorganic Chemistry

16. Williams, An Introduction to Bioinorganic Chemistry

17. M.N. Hughes, Inorganic Chemistry of Biological Processes

18. Ochi, Bioinorganic Chemistry

19. O.A. Phiops, Metals and Metabolism

20. S.J. Lipard and J.M. Berg, Principles of Bioinorganic Chemistry, University Science Books

21. G.L. Eichhron, Inorganic Bichemistry, Vol I and II, Elsevier

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ॥ विद्यया संपन्नता ॥ NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **MSc (Chemistry) Semester-II** **Vertical : DSE** **Course Code: 2302208/ 2303208/ 2304208/2324208/ 2325208/ 2326208/ 2327208** **Course Name: Green Chemistry**

***Teaching Scheme**	***Examination Scheme**
Practicals:04 Hours/week, 04 Credits	**UA:60 Marks** **CA: 40 Marks**

Course Preamble: Green chemistry is an elective course offered to M.Sc. I students. This course is of 60 Hrs, having 4 units. This course deals with basic principles involved in green chemistry. Some green synthesis reactions are included in the course, such as ibuprofen and adipic acid. The future trends in green chemistry will be discussed in unit four.

Course outcomes:

On completion of this course, the students will be able to learn:

CO1: Environmental impact and quality parameters of air, water and soil

CO2: Analysis and purification of water, wastewater, solid-wastes and air pollution.

CO3: Environmental protection and pollution prevention

CO4: Green chemistry principles and Design of green synthesis

UNIT I: **Green chemistry:** **Hrs: 15 Weightage: 20 Marks**

History, need, and goals. Green chemistry and Sustainability. Dimensions of sustainability, Limitations/Obstacles in pursuit of the goals of Green Chemistry. Opportunities for the next generation of materials designers to create a safer future. Hazard assessment and mitigation in chemical industry

UNIT II: Basic principles of Green Chemistry and their illustrations with examples:

Hrs: 15 Weightage: 20 Marks

Prevention of waste/byproducts, Maximum Incorporation of the materials used in the process into the final product (Atom Economy): Green metrics, Prevention/Minimization of hazardous/toxic products, Designing safer chemicals - different basic approaches,

Selection of appropriate auxiliary substances (solvents, separation agents etc), Energy requirements for reactions—use of microwave, ultrasonic energy, Selection of starting materials—use of renewable starting materials, avoidance of unnecessary derivatization—careful use of blocking/protection groups, Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents, Designing biodegradable products, Prevention of chemical accidents**.**

UNIT III: Examples of green synthesis/reaction and development of analytical techniques: Hrs: 15 Weightage: 20 Marks

Green starting materials, Green reagents, Green solvents and reaction conditions, Green catalysis, Green synthesis- Real world cases (Traditional processes and green ones) Synthesis of Ibuprofen, Adipic acid.

Strengthening/development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes. Development of accurate and reliable sensors and monitors for real time in process monitoring.

UNIT IV: Future Trends in Green Chemistry: Hrs. 15 Weightage: 20 Marks

Oxidation-reduction reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; Non covalent derivatization. Biomass conversion, emission control. Biocatalysis.

RECOMMENDED BOOKS

1. Green Chemistry: Theory and Practice. P.T. Anastas and J.C. Warner. OxfordUniversity Press.

2. Green Chemistry: Introductory Text. M. Lancaster Royal Society of Chemistry (London).

3. Introduction to Green Chemistry. M.A. Ryan and M. Tinnesand, American ChemicalSociety (Washington).

4. Real world cases in Green Chemistry, M.C. Cann and M.E. Connelly. AmericanChemical Society (Washington).

5. Real world cases in Green Chemistry (Vol 2) M.C. Cann and T.P.Umile. AmericanChemical Society (Washington**)**

	Punyashlok Ahilyadevi Holkar Solapur University, Solapur **MSc (Chemistry) Semester-II** **Vertical : DSE** **Course Code: 2302209/ 2303209/ 2304209/2324209/ 2325209/ 2326209/ 2327209** **Course Name: Industrial Chemicals and Environment**
***Teaching Scheme** **Practicals:04 Hours/week, 04 Credits**	***Examination Scheme** **UA:60 Marks** **CA: 40 Marks**

Course Preamble: Industrial Chemicals and Environment is an elective course. This course is designed for understanding the important industrial gases and inorganic chemicals. Students will learn the general principles of metallurgy and also various methods of purification of metals. They will understand the biochemical cycles for carbon, nitrogen and Sulphur. They will learn the various sources for energy including tidal and nuclear energy.

Course outcomes:

On completion of this course, the students will be able to learn:

CO1: Industrial gases and inorganic chemicals

CO2: Methods of purification of metals

CO3: Biogeochemical cycles of carbon, nitrogen and sulphur

CO4: Water treatment and purification

CO5: Nuclear Fusion and Fission process

CO6: Nuclear Pollution

Unit I: Industrial Gases and Inorganic Chemicals: Hrs. 15 Weightage: 20 Marks

Industrial Gases: Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene. Inorganic Chemicals: Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.

Unit II Industrial Metallurgy : Hrs. 15 Weightage: 20 Marks

General Principles of Metallurgy Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon as reducing agent. Hydrometallurgy, Methods of purification of metals (Al, Pb, Ti, Fe, Cu, Ni, Zn): electrolytic, oxidative refining, Kroll process, Parting process, van Arkel-de Boer process and Mond's process. Preparation of metals (ferrous and nonferrous) and ultrapure metals for semiconductor technology.

Unit III: Environment and its segments: Hrs. 15 Weightage: 20 Marks

Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur. Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, agro, fertilizer, etc. Sludge disposal. Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange).

Unit IV: Energy & Environment Sources of energy: Hrs. 15 Weightage: 20 Marks

Coal, petrol and natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydel, etc. Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.

Reference Books:

- E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
- R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
- J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
- S. S. Dara: A Textbook of Engineering Chemistry, S. Chand & Company Ltd. New Delhi.
- K. De, Environmental Chemistry: New Age International Pvt., Ltd, New Delhi.
- S. M. Khopkar, Environmental Pollution Analysis: Wiley Eastern Ltd, New Delhi. 42
- S.E. Manahan, Environmental Chemistry, CRC Press (2005).

- G.T. Miller, Environmental Science 11th edition. Brooks/ Cole (2006).
- A. Mishra, Environmental Studies. Selective and Scientific Books, New Delhi (2005).

Nature of question paper (M. Sc. I Chemistry):

Time: 2 ½ hours Maximum Marks: 60

Instructions

1. All questions are compulsory
2. All questions carry equal marks.
3. Figures to the right indicate full marks.
4. Use of log tables and calculators is allowed.

Q 1. A) Choose correct alternative **Marks 8 (1 x 8)**

Sub-questions (i) to (viii)

B) Fill in the blanks **Marks 4 (1 x 4)**

Sub questions (i) to (iv)

Q 2. Answer the following (any six) **Marks 12 (2 x 6)**

Sub-questions (a) to (h)

Q 3. Answer the following (any three) **Marks 12 (3 x 4)**

Sub-questions (a) to (d)

Q 4. Answer the following (any two) **Marks 12 (6 x 2)**

Sub-questions (a) to (c)

Q 5. Answer the following (any two) **Marks 12 (6 x 2)**

Sub-questions (a) to (c)

At least 25 % questions should be problem oriented, where-ever possible, in view to train students for the SET/NET/GATE and other competitive examinations. These questions should test the understanding of candidate rather than the memory. The question paper should cover all the Units included in the syllabus of the respective paper and the weightage of the questions should correspond to the number of lectures allotted to the respective Units / Topics.