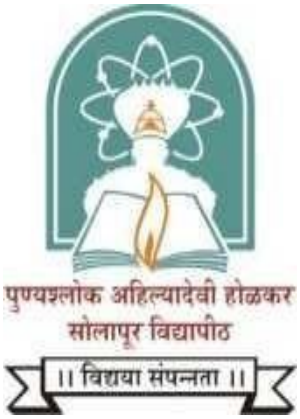
**Punyashlok Ahilyadevi Holkar Solapur University, Solapur**




**NAAC Accredited-2022**
**'B$^{++}$'Grade (CGPA 2.96)**

# Name of the Faculty: Science &Technology

(As per New Education Policy 2020)

# Syllabus: Industrial Chemistry

## Name of the Course: M.Sc. II (Sem. III &IV)

**(Syllabus to be implemented from June 2024)**

# Punyashlok Ahilyadevi Holkar Solapur University, Solapur
## Faculty of Science & Technology
## Nep 2020 Compliant Curriculum
## M.Sc. Industrial Chemistry
## Program Preamble

The Master of Science (MSc) in Industrial Chemistry is a comprehensive and dynamic program designed to provide students with a deep understanding of the fundamental principles of Industrial 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 Industrial Chemistry program spans two years, with each year offering a progressively advanced curriculum designed to build a strong foundation in Industrial 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 Industrial chemistry concepts, theories, and methodologies. Students will engage with topics ranging from Unit operation in chemical Engineering, Unit process in Chemical Industries, Spectroscopy, Nanotechnology, Solid State Chemistry, Electroanalytical technique, and Molecular spectroscopy ensuring a robust and comprehensive education in the discipline.
2. **Discipline Elective course:** 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 Chemistry and related fields.
4. **Research Methodology and Research Projects:** Research is a critical component of the MSc Industrial 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 **Industrial** 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 Industrial Chemistry**.
- **Year 2:** After two years, students may choose to exit with a **MSc Degree in Industrial Chemistry**

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

# Punyashlok Ahilyadevi Holkar Solapur University, Solapur
## Faculty of Science & Technology
## Nep 2020 Compliant Curriculum
## MSc (Industrial Chemistry)
## Program Outcomes (PO)

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

**Major Courses:**

- **PO1**: Apply the knowledge of given course to solve the complex scientific problems that may exist in Pharmaceutical and Chemical Industries
- **PO2**: Identify, formulate and analyse complex scientific problems reaching Substantiated conclusions using principles learnt in core subject.
- **PO3**: Acquire complementary knowledge and skills from a related or distinct discipline, enhancing interdisciplinary understanding and versatility.
- **PO4:** Understanding fundamental principles and laws of Organic, Inorganic, and physical chemistry
- **PO5:** Acquire to Develop and synthesis Organic, polymeric, and Nanomaterial and understand properties of materials using different spectroscopic tool.

**Elective course:**

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

**Research Methodology and Research Project:**

- **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:** Making the students capable to do independent research in the field of Chemical and Material science

**Punyashlok Ahilyadevi Holkar Solapur University, Solapur**
**Faculty of Science & Technology**
**Nep 2020 Compliant Curriculum**

# MSc (Industrial Chemistry)

## Program Specific Outcomes (PSOs)

**Students graduating from MSc (Industrial Chemistry) will able to:**

**PSO1: Mastery on Core Industry based concept: D**emonstrate understanding of fundamental of Industrial Chemistry with topics ranging from Unit operation in chemical Engineering, Unit process in Chemical Industries, Spectroscopy, Nanotechnology, Solid State Chemistry, Electroanalytical technique, material Balance and Molecular spectroscopy etc, allowing students to analyze and solve complex critical problems that may arise in industries.

**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 Industrial 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.

**M. Sc. II, INDUSTRIAL CHEMISTRY COURSE SYLLABUS**
**CHOICE BASED CREDIT SYSTEM (CBCS) (w.e.f. June 2024)**

A two-year duration **M. Sc. Industrial Chemistry** course syllabus has been prepared as per the CBCS semester system. M. Sc. II, SEM-III & SEM-IV Industrial Chemistry syllabus will be implemented from June 2024. The syllabus has been prepared taking into consideration the syllabi of other Universities, SET, NET, UGC guidelines, and the specific inputs of the Expert Committee Members.

**General Structure of the Course:**

| Level/ Difficulty | Sem. | Paper Code | Title of the Paper | Semester exam | | | L | T | P | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | **Mandatory** | **Theory** | **IA** | **Total** | | | | |
| | | **DSC-5 2325301** | Unit operation in Chemical Engineering | 60 | 40 | 100 | 4 | -- | - | 4 |
| | | **DSC-6 2325302** | Unit process in Chemical Industries | 60 | 40 | 100 | 4 | | - | 4 |
| | | | **Elective (Anyone)** | | | | | | | |
| | | **DSE-3 A 2325306** | Industrial Analytical Chemistry-I | 60 | 40 | 100 | 4 | | - | 4 |
| | **III** | **DSE-3 B 2325307** | Industrial Analytical Chemistry-II | 60 | 40 | 100 | 4 | | - | |
| | | | | | | | | | | |
| | | | **Field Project/RP/Internship/Apprenticeship/** | | | | | | | |
| | | **RP 2325303** | Research Project | 60 | 40 | 100 | 4 | - | 0 | 4 |
| | | | **Practical** | | | | | | | |
| **6.5/400** | | **DSC-5 P 2325304** | Industrial Inorganic Chemistry | 30 | 20 | 50 | - | - | 2 | 6 |
| | | **DSC-6 P 2325305** | Industrial organic Chemistry y | 30 | 20 | 50 | - | - | 2 | |
| | | | **Elective (Any one)** | | | | | | | |
| | | **DSE-3A P 2325308** | Industrial Physical Chemistry-I | 30 | 20 | 50 | | | 2 | |
| | | **DSE-3B P 2325309** | Industrial Physical Chemistry-II | 30 | 20 | 50 | | | 2 | |
| | | | | | | | | | | |
| | | | **Total for III semester** | **330** | **220** | **550** | **16** | **550** | **6** | **22** |
| | | | **Mandatory** | | | | | | | |
| | | **DSC-7 2325401** | **Pollution Monitoring and Control** | 60 | 40 | 100 | 4 | -- | - | 4 |
| | | **DSC-8 2325402** | Industrial Management and Nonconventional energy sources | 60 | 40 | 100 | 4 | | - | 4 |
| | | | **Elective (Any one)** | | | | | | | |
| | **IV** | **DSE-4A 2325405** | Nanomaterial and its Characterization | 60 | 40 | 100 | 4 | | - | 4 |
| | | **DSE-4B 2325406** | **Advanced Topics in Industrial Chemistry** | 60 | 40 | 100 | 4 | | - | |
| | | | **Field Project/RP/Internship/Apprenticeship/** | | | | | | | |
| | | **RP 2325403** | Research Project | 90 | 60 | 150 | 6 | - | 0 | 6 |
| | | | **Practical** | | | | | | | |
| | | **DSC-7 P 2325404** | Organic Preparations | 30 | 20 | 50 | - | - | 2 | 4 |

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| | | | **Elective (Any one)** | | | | | | | |
| | | **DSE-4A P 2325407** | Drug assay and drug formulations | 30 | 20 | 50 | | | 2 | |
| | | **DSE-4B P 2325408** | Physical Pharmaceutical Technology | 30 | 20 | 50 | | | 2 | |
| | | | **Total for II semester** | **330** | **220** | **550** | **18** | **550** | **4** | **22** |

DSC- Discipline Specific Course, DSE- Discipline Elective course
RM- Research Methodology, OJT- On Job Training
RP – Research Project
L – Lecture, T – Tutorial, P – Practical
Credits of Theory = 4 Hours of teaching per week
2 Credits of Theory = 4 Hours per week

**Nature of Examination:**
Each semester will have theory external assessment examination of 60 marks each (2.5 hrs. duration) and 40 marks college assessment. The practical examination of Semesters III to IV will be conducted at the end of each Semester. Duly certified copy of laboratory record must be produced at the time of examination.

**Practical Examination of M. Sc. II**
The practical examination will be of 3 days for each semester.

**Semester III:**

Practical courses each : 30 (UA)+ 20 (CA)
Research Project work : 60 (UA) + 40 (CA)

**Semester IV:**

Practical courses each : 30 (UA)+ 20 (CA)
Research Project work : 90 (UA) + 60 (CA)

** The evaluation of Research Project will be done by both external and internal examiners at the time of examination

# Nature of question paper (M. Sc. II):

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.

Question Paper

**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.

## Semester III

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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**<br>**MSc (Industrial Chemistry) Semester-III**<br>**Vertical: DSC**<br>**Course Code: 2325301**<br>**Course Name: Unit operations in Chemical Engineering** |
| ***Teaching Scheme**<br>**Lectures:04 Hours/week, 04 Credits** | ***Examination Scheme**<br>**UA:60 Marks**<br>**CA: 40 Marks** |

**Course Preamble:** Unit operation is one of the core courses in the chemical Engineering curriculum and one of the traditional courses, dating back from the last many centuries. This course provides an in-depth understanding of various unit operation and their application to Industries. Students will study the Heat exchanger, distillation, extraction, crystallization equipment. By combining theoretical knowledge with numerical treatment, the course aims to develop practical skills in analyzing and optimizing unit operations for engineering applications

**Course Objectives:**

- To introduce mass and heat transfer processes, their practical application in industries,
- To introduce Material balance calculation and basic equipment extensively demanded in industries.

**Course Outcomes:**

- Apply basic principles of Heat & mass transfer to basic engineering systems
- Understand the construction & working of various equipment used in distillation, extraction, leaching, drying, and filtration.
- Analyze and design plate & packed columns for distillation, mixer-settlers and RDC for extraction, packed column batch & continuous driers, Constant rate & constant pressure filters
- Apply basic principles of Heat & mass transfer to basic engineering systems
- Apply basic knowledge to make material balance calculation

**Unit I**

A) **Heat Exchangers** **(No. of lectures-07 Weightage:9-12 Marks)**

Introduction; Shell and Tube Heat Exchanger, Shell side and tube side passes; Classification of Shell and Tube Heat Exchangers-Fixed tube sheet heat exchanger, Fixed tube sheet 1-2 heat exchanger, Internal floating head heat exchanger, U-tube heat Exchanger, Kettle Reboiler.

**B) Evaporation** **(No. of lectures-08 Weightage:9-12 Marks)**

Introduction; Types of evaporators-Jacketed, Horizontal and Vertical tube evaporators, forced Circulation evaporation; Effect of various parameters on Evaporation; Multiple effect evaporators.

Unit-II

**A) Distillation** **(No. of lectures-08 Weightage:9-12 Marks)**

Introduction; Boiling and Distillation; Vapor liquid equilibria; Azeotropic mixture; Steam distillation;

Extractive distillation; Batch / Continuous distillation; Equipment and working of Rectifier/Fractionating Column-Bubble cap plate, Valve plate, Downcomers.

**B) Extraction** **(No. of lectures-07 Weightage:9-12 Marks)**

Introduction; Selection of solvent for Extraction; Extraction with agitation and its Equipment's-Mixer Settler, packed column, Rotating disc Contactor

**C) Leaching** **(No. of lectures-08 Weightage:9-12 Marks)**

Introduction; solid liquid leaching- Bollman extractor; continuous leaching Equipment's-Dorr Agitator, Dorr thickener, Continuous counter- current extraction.

**Unit-III**

A) **Filtration** **(No. of lectures-04 Weightage:4-6 Marks**)

Introduction; Types of filtration-Constant rate, Constant pressure filtration; Filtration Equipment – centrifugal filtration, Rotary drum filter

**B) Crystallization** **(No. of lectures-06 Weightage:6-8 Marks)**

Introduction; Supersaturation, Methods of supersaturation, Nucleation, Crystal hydrates; Deliquescence and Hygroscopicity; Efflorescence; crystallization equipment- Swenson -walker crystallizer, vacuum crystallizer

**C) Crushing, Grinding, Drying and Mixing**

**(No. of lectures-04 Weightage:4-6 Marks)**

Equipment for crushing-Blake Jaw crusher, Equipment for grinding –Hammer mill; Equipment for drying processes-Tray, Tunnels,

**D) Mechanical Separation and Beneficiation**

**(No. of lectures-04 Weightage:4-6 Marks)**

Introduction; Screening sieves- equipment and use, Removal of solid from gases- Cyclone, Hydro cyclone

**Unit-IV**

**A) Material Balance**

**(No. of lectures-10 Weightage:12-15 Marks)**

Material Balance – Process classification; Integral Balances on Batch Processes; Material Balance Calculations- Flow Chart, Flow Chart Scaling and Basis of Calculation;

Balances on multiple unit processes; Recycle and Bypass.

**B) Energy Balance** **(No. of lectures-02 Weightage:2-4 Marks)**

Forms of energy; Kinetic and Potential energy; Energy Balances on closed systems; Energy Balances on open systems at steady state- Flow Work and Shaft Work.

**Reference books:**

1. F.A. Henglein: Chemical Technology (Pergamon)

2. J.M. Coulson, J.F. Richardson, Chemical Engineering Vol I, II, III (Pergamon)

3. R.N. Shreve: The Chemical Process industry (MGH)

4. W.L. Badger and J.T. Bandchero: Introduction to Chemical Engineering (MGH).

5. O.A. Hougen, K.M. Watson and R.A. Ragetz: Chemical Process Principal Vol I II (JW).

6. Prakash G. More, Comprehensive Industrial Chemistry, Pragati prakashan, Meerut (Uttar Pradesh)

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| | **Punyashlok Ahilyadevi Holkar Solapur University, Solapur**<br>**MSc (Industrial Chemistry) Semester-III**<br>**Vertical: DSC**<br>**Course Code: 2325302**<br>**Course Name: Unit process in Chemical Industries** |
| ***Teaching Scheme**<br>**Lectures:04 Hours/week, 04 Credits** | ***Examination Scheme**<br>**UA:60 Marks**<br>**CA: 40 Marks** |

**Course Preamble:** Unit process is one of the core courses in the chemical Engineering curriculum and one of the traditional courses, for the last many centuries. This course provides an in-depth understanding of various unit process and their application in Industries. Students will study the Nitration, polymerization, esterification, halogenation processes carried out in industries. By combining theoretical knowledge with numerical treatment, the course aims to develop practical skills in analyzing and optimizing unit process for Industrial applications

## Course Objective

- To impart knowledge to the students with regards to unit processes available commercially
- To blend of unit operation with unit processes that covers various unit processers like halogenations, nitration, sulfonation, esterification, Polymerization
- To make students understand process technologies of various organic and inorganic process industries

## Course Outcomes

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

- Gain knowledge about raw materials, reagents, their stoichiometry, and reaction conditions required to carry out the specific unit process.
- Understand reaction mechanism, kinetics and thermodynamics of unit processes carried out in large scale.
- Knowledge of material of construction for designing different types of equipment for different unit processes.
- Understand the safety and hazard criteria related to each type of unit processes

## Unit I:

### A) Nitration **(No. of lectures-8 Weightage:10-12 Marks)**

Introduction; Nitrating agents, Aromatic nitration, Mixed acid for nitration- Acid processing, Mixed acid composition, D.V.S. Calculation, Relation between D.V.S. and Stability of Nitrator Charge; Typical industrial Nitration process (Nitrobenzene)

**B) Sulphonation** **(No. of lectures-8 Weightage:10-12 Marks)**

Introduction; Sulphonating agents and their applications; The Desulphlonation Reaction – General consideration, Separation of isomers, Raw material and waste Recovery; Technical preparation of Sulfonates - Aromatic Sulfonates (The mono sulfonation of Benzene).

**Unit II**

**A) Reagents in Organic Synthesis**: **(No. of lectures-08 Weightage:10-12 Marks)**

Use of following reagents in organic synthesis and functional group transformations- Gilman's reagent, dicyclohexylcarbodimide, Woodward and Prevost hydroxylation, osmium tetraoxide, DDQ, selenium dioxide,

**B) Selective Organic Name Reactions:** **(No. of lectures-08 Weightage:10-12 Marks)**

Favorskii reaction, Michael addition, Barton reaction, Hofmann Loffler-Freytag reaction, Shapiro reaction, Baeyer-Villiger reaction, Chichibabin reaction

**Unit III:**

**A) Halogenation** **(No. of lectures-08 Weightage:10-12 Marks)**

Introduction; Design and construction of Equipment for Halogenation; Technical Halogenations - Manufacturing Processes for Monochlorobenzene, and Vinyl chloride (Ethylene and Acetylene).

**B) Esterification** **(No. of lectures-08 Weightage:10-12 Marks)**

Introduction; Esterification by organic acid; Esterification of carboxylic acid Derivative; Ester by addition to unsaturated system; Manufacture of Vinyl acetate,

**C) Polymerization** **(No. of lectures-10 Weightage:12-14 Marks)**

Introduction; Chemistry of polymerization reactions; Methods of polymerization, industrially importance polymerization and polymers: Phenolic, Urea and melamine, Polyamides, Polyesters, Epoxy resins, Polyethylene

**Unit IV**

**Paints and Pigments Industries**

**A) Paints-** **(No. of lectures-06 Weightage: - 6-8)**

Introduction; Classification of paints; Constituents of paints; Formulation of paints; Mixing of paints; Manufacturing processes of paints; Failure of paints; Varnishes, Enamals, Emulsion paints- Constituents.

**B) Pigment-** **(No. of lectures-06 Weightage:8-10 Marks)**

Manufacturing Pigment- Manufacturing processes of zinc oxide and titanium dioxide, properties and Application

**C) Cement Industry** **(No. of lectures-06 Weightage:8-10 Marks)**

Introduction; Classification and Manufacturing processes of Cement and Lime; Setting and Hardening process.

**D) Glass Industry** **(No. of lectures-06 Weightage:8-10 Marks)**

Introduction; Raw material, Manufacturing process of glass; Ceramic- Raw material, Manufacturing process of White ware, Glazing.

**Reference Books**


1. P.H.Groggins: Unit processes in organic synthesis (MGH)
2. F.A.Henglein: Chemical Technology (Perga mon)
3. M.G.Rao & M. Sitting: Outlines of Chemical Technology (EWP)
4. Clausen,Mattson: Principle of Industrial Chemistry
5. F.A. Lowenheim & M.K. Moran: Industrial Chemicals
6. Kirks & others: Encyclopedia of Chemical Technology
7. Kent: Riegels Industrial Chemistry (N-R)
8. Prakash G. More, Comprehensive Industrial Chemistry, Pragati Prakashan, Meerut (Uttar Pradesh)
9. S.D.Shukla & G.N.Pandey: A text book of Chemical Technology Vol. II
10. J.K.Stille: Industrial Organic Chemistry (PH)
11. Billmayer: A text book of Polymer Science

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| पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ<br>॥ विद्यया संपन्नता ॥<br>NAAC Accredited-2022<br>'B++' Grade (CGPA-2.96) | **Punyashlok Ahilyadevi Holkar Solapur University, Solapur**<br>**MSc (Industrial Chemistry) Semester-III**<br>**Vertical: DSE**<br>**Course Code: 2325306**<br>**Course Name: INDUSTRIAL ANALYTICAL CHEMISTRY-I** |
| ***Teaching Scheme**<br>**Lectures:04 Hours/week, 04 Credits** | ***Examination Scheme**<br>**UA:60 Marks**<br>**CA: 40 Marks** |

**Course Preamble:** Analytical chemistry is one of the core courses in the chemical Engineering curriculum and one of the traditional courses, for the last many centuries. This course provides an in-depth understanding of various Instrumental technique and their application in Industries. Students will study the electroanalytical sensor, polarography, voltammetry essential to be used in research process and a useful tool in industries. By combining theoretical knowledge with numerical treatment, the course aims to develop practical skills in analyzing and optimizing analytical tool for Industrial applications**.**

## Course Objective

- To provide basic information regarding application of various Instrumental tools like, electro-analytical technique
- To provide information and application of distinct Chromatographic tool
- To provide information and application of three electrode system
- To provide basic information and the tools used to polymer processing

## Course Outcomes

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

- Understand the basic of Instrumentation
- Understand theory, principle and application of various analytical techniques like electro-analytical technique that help to examine the authenticity and also chemical nature of unknown compound.
- Analysis of sample with the best utilization of technique that provide structure information.
- Identification of impurities and purities in sample and also method development for specific compound nature

**Unit I:**

**Polymer processing:** **(No. of lectures-10 Weightage:12-14 marks)**

Polymer processing Compression, transfer, injection, Extrusion, blow molding, calendaring, thermoforming, thin film

**Unit II:**

**A) Electro Analytical Techniques/Sensor** **(No. of lectures-10 Weightage:12-14 marks)**

Sensors; Electro analytical sensors, Sensor's electrode- Metal electrode sensors, Membrane electrode- pH Sensor, Liquid membrane, Crystalline membrane, Gas sensing, Biomembrane /Enzyme electrode; Ionic conductors- Zirconia, Tin oxide, Zinc oxide, Titania

B) **Electron spin Resonance [ESR]** **(No. of lectures-6 Weightage:8-10 Marks)**

A) Principles of ESR, hyperfine splitting in simple systems, Instrumentation, factors affecting G values, applications to inorganic complexes.

**Unit III:**

**A) Introduction to three electrode system:** **(No. of lectures-6 Weightage:8-12 marks)**

Modern polarography and voltammetry necessity and development of new voltammetry techniques and their comparison with classical DC polarography,

**B) Voltammetry methods:** **(No. of lectures-6 Weightage:8-12 Marks)**

Sampled DC polarography (TAST), linear sweep voltammetry (LSV), cyclic voltammetry (CV), diagnostic criteria of cyclic voltammetry

**Unit IV: Chromatography** **(No. of lectures-12 Weightage:12-14 Marks)**

Principles of gas chromatography, plate theory of gas chromatography, Instrumentation for gas chromatography, working gas chromatography, application of gas chromatography, programmed temperature chromatography, , gas-solid chromatography, and hyphenated techniques in chromatography- GC-MS, LC-MS

**Books Recommended:**

1. Introduction to Spectroscopy – D. L. Pavia, G.M. Lampman, G. S. Kriz, 3rd Ed. (Harcourt college publishers).

2. Spectrometric identification of organic compounds R. M. Silverstein, F. X. Webster, 6th Ed. John Wiley and Sons.

3. Spectroscopic methods in organic chemistry – D. H. Williams and I. Flemming McGraw Hill.

4. Absorption spectroscopy of organic molecules – V. M. Parikh

5. Nuclear Magnetic Resonance – Basic Principles- Atta-Ur-Rehman, Springer- Verlag (1986).

6. One- and Two-dimensional NMR Spectroscopy- - Atta-Ur-Rehman, Elsevier (1989).

7. Organic structure Analysis- Phillip Crews, Rodriguez, Jaspars, Oxford University Press (1998).

8. Organic structural spectroscopy- Joseph B. Lambert, Shurvell, Lightner, Cooks, Prentice-Hall (1998).

9. Organic structures from spectra- Field L. D., Kalman J.R. and Sternhell S. 4th Ed. John Wiley and sons Ltd.

10. NMR spectroscopy of Organic compounds. Jackmann and Sternhell S.

11. Spectroscopy: Donald L. Pavia, Gary M. Lampman.

12. A.J.BardandL.R.Faulkner,Electrochemical Methods,2ndEd,John Wiley and sons, Asia Pvt. Ltd,(2004)

13. J.J.Lingane , Electro-analytical Chemistry, 2nd Ed, Inter science Publishers, Inc., New York (1958)

14. A.M.Bond, Modern Polarographic Methods in Analytical Chemistry, Marcel Dekker Publishers, Inc., New York,(1980)

15. A.J.Bard(Ed), Electro-analytical Chemistry, Marcel DekkreInc., New York (A series of volumes)..

16. Donald T.Sawyer ,A.Sobkowiak and J.L.Roberts,Jr., Electro chemistry for Chemists, 2nd Ed., John Wiley and Sons, Inc., New York.,(1995).

17. D.A.Skoog, F.J.Holler, J.A.Nieman, Principles of Instrumental analysis, 6thEd.

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| पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ<br>॥ विद्यया संपन्नता ॥<br>NAAC Accredited-2022<br>'B++' Grade (CGPA-2.96) | **Punyashlok Ahilyadevi Holkar Solapur University, Solapur**<br>**MSc (Industrial Chemistry) Semester-III**<br>**Vertical: DSE**<br>**Course Code: 2325307**<br>**Course Name: INDUSTRIAL ANALYTICAL CHEMISTRY-II** |
| ***Teaching Scheme**<br>**Lectures:04 Hours/week, 04 Credits** | ***Examination Scheme**<br>**UA:60 Marks**<br>**CA: 40 Marks** |

**Course Preamble:** Analytical chemistry is one of the core courses in the chemical Engineering curriculum and one of the traditional courses, for the last many centuries. This course provides an in-depth understanding of various Instrumental technique and their application in Industries. Students will study the analysis technique of fertilizer, fuel, drug and synthesis of drug, essential to be used in research process and a useful tool in industries. By combining theoretical knowledge with numerical treatment, the course aims to develop practical skills in analyzing and optimizing analytical tool for Industrial applications

## Course Objective

- To gain knowledge on types of fuels and their characteristics, combustion systems with emphasis on engineering applications
- To provide fundamental information concerning pharmaceutical dosage forms, their merits and demerits
- To provide practical information on analysis of fertilizer constituent

## Course Outcomes

At the completion of this course, students should be able to:

- Understand various types of formulation of pharmaceutical dosage forms viz. solid, semi-solid, syrup and intravenous.
- Understand thoroughly tablet and capsule production at commercial scale.
- Meticulously understand analysis procedure of constituents in fertilizer.
- Recognize and carry out methods to purify fuels on the basis of phase.
- Understand how to implement and work as per green chemistry guidelines

### Unit -I:

**A) Analysis of Fertilizers – (No. of lectures-12 Weightage:12-14 marks)**

Sampling, sample preparation. Analysis of nitrogen, phosphrous and potassium. Nitrogen- urea nitrogen, Kjeldahl nitrogen method, Ammonia nitrogen; phosphrous- Total phosphrous. Alkalimetric ammonium molybdophosphate method, potassium - potassium by sodium tetraphenyl borate method.

**B) Fuel analysis: (No. of lectures-10 Weightage:10-12 Marks)**

Introduction to Solid, liquid and Gaseous fuel; Analysis of coal - Ultimate and Proximate analysis; Analysis of Liquid fuel-Aniline point, Flash point and Fire point;Octane number of Liquid; Determination of Calorific valve of Fuel by bomb Calorimeter; Orsat apparatus and its

use in exhaust gas analysis. Lubricant analysis-cloud point and pour point, carbon residue, viscosity by Redwood method

**Unit II:**

**A) Drug (No. of lectures-12 Weightage:12-14 Marks)**

Introduction; Pharmacokinetics-absorption, istribution,metabolism,excretion,Toxicity: Pharmacodynamics-receptor, protein receptor, DNA as receptor; Concept of prodrug; Pharmacophore; $LD_{50}$, $ED_{50}$ , $IC_{50,}$ MIC,; Structure activity relationship in drug- elucidation with sulpha drug; Synthesis of drug- chloroquine, Salbutamol, Ibuprofen ,methyldopa, Alprazolam, ciprofoxacin.

**Unit III:**

**Formulation of Drug (No. of lectures-12 Weightage:12-14 Marks)**

Introduction; Need for the conversation of drug into medicine; Additives and their role; Classification of drug –Route-wise dosage forms, Solid dosage forms; solid dosage forms- Tablets, Capsule; liquid dosage forms-parenterals; liquid oral dosage forms- Syrups, suspension; Semi –solid dosage forms – ointments, creams.

**Unit-IV:**

**A) Pharmacopeial analysis of drugs (No. of lectures-08 Weightage:10-14 Marks)**

Introduction, Assay of drug-Analgesic drug; Analysis of pharmaceuticals using IP/B.P./U.S.P procedures.

**B) Green Chemistry (No. of lectures-08 Weightage:10-14 Marks)**

Introduction, Alternative energy sources for initiation and execution of chemical reaction: Microwave and sonochemistry.

**Books Recommended:**


1.P.T. Aastae and J.C. Werner: Green Chemistry Theory and practical (Oxford Press 1998).

2. F.J. Welder: Standard Methods of chemicals analysis Vol III part A and B.

3. I.P./B. P and U.S.P. books latest edition

4. Burger: Medicinal chemistry (I.W.)

5. W.O. Foye: Principles of medicinal chemistry (L.E.)

6. Zechmeister: Progress in chemotherapy (C.H.)

7. Lendicer and Mitscher: The Organic Chemistry of drug synthesis

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| | **Punyashlok Ahilyadevi Holkar Solapur University, Solapur**<br>**MSc (Industrial Chemistry) Semester-III**<br>**Vertical : RP**<br>**Course Code: 2325303**<br>**Course Name: Research Project-I** |
| ***Teaching Scheme**<br><br>**Practicals:08 Hours/week, 04 Credits** | ***Examination Scheme**<br>**UA:60 Marks**<br>**CA: 40 Marks** |

**Course Preamble:** The research project for M. Sc. Industrial Chemistry is to introduce students to get familiarize with research process. They will be able to identify research problem based on the area of their interest, subsequently finalize research problem by literature survey. It is expected that project should provide hands on training to the students on various instruments. It is mandatory for each individual student to undertake and independently work on a short research project.

***In Semester III, there is a Research Project of 4 credits. Students have to carry out project either at university laboratory or in any recognized R & D laboratory (Public/Private/Government) or Industry or Institute of National repute across the country under the guidance of scientist or a post-graduate faculty member***

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| | **Punyashlok Ahilyadevi Holkar Solapur University, Solapur**<br>**MSc (Industrial Chemistry) Semester-III**<br>**Vertical : DSC**<br>**Course Code: 2325304 and 2325305**<br>**Course Name: Practical I and II**<br>**&**<br>**Vertical : DSE**<br>**Course Code: 2325308/2325309**<br>**Course Name: Practical III Based on DSE3A/3B** |
| ***Teaching Scheme**<br>**Practicals:04 Hours/week, 02 Credits** | ***Examination Scheme**<br>**UA:30 Marks**<br>**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 papers as well as on elective courses. The practical's based on pH-metry, Potentiometry, Spectrophotometry, Thermochemistry, Conductometry and Chemical Kinetics are included in the course. Moreover, Organic synthesis, especially drugs and subsequently their analysis and estimation. These practicals are further divided into short and long experiments.

Industrial chemistry practical course aims to provide students with hands-on experience in the laboratory, reinforcing theoretical concepts and developing essential laboratory skills.

## Couse Objectives

- **Experimental Techniques:**
  - Master fundamental laboratory techniques such as weighing, measuring, titration, filtration, and crystallization.
  - Develop proficiency in using laboratory equipment, including balances, glassware, burners, and heating devices.
- **Observation and Data Collection:**
  - Observe chemical reactions and record accurate observations, measurements, and data.
  - Develop skills in data analysis, including graphing, calculations, and interpretation of results.
- **Problem-Solving and Critical Thinking:**
  - Apply theoretical knowledge to solve practical problems and design experiments.
  - Develop critical thinking skills to analyze experimental results and draw conclusions.

- **Laboratory Safety:**
  - Understand and adhere to laboratory safety procedures and regulations.
  - Handle chemicals and equipment safely and responsibly.

**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 detergents

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

1. To determine of capacity of cation exchange resin.
2. To determine of capacity of anion exchange resin.
3. Analysis of commercial caustic soda.
4. Prepare aluminum as 8 – hydroxy quinolate.
5. Preparation of nickel oxide.
6. Estimate the amount of chlorine from bleaching powder.
7. Preparation of potash alum from aluminum metal.
8. To determine the influence of surface on rate of corrosion – Kinetics of corrosion I
9. To determine the influence of surface on rate of corrosion – Kinetics of corrosion II
10. Preparation and Analysis of copper ferrite.
11 To estimate phosphoric acid in cola drink by molybdenum blue method.
12. Estimation of Na, K and Li individually by Flame Photometry.
13. Determination of amount of Zinc from the given sample solution by Nephelometric/Turbidimetric titration using standard solution of Ba $(NO_3)_2$ or Pb $(NO_3)_2$.
14, Estimation of purity of a given azo dye by colorometry.
15. To estimate the amount of D-Glucose in given solution polarimetrically.
16. Preparation of p-nitroso N N dimethyl aniline.
17. Preparation of benzyl acetate.
18. Preparation of benzanilide from benzophenone. (Beckman Rearrangement)
19. Estimation of sulphur, nitrogen.
20. Preparation of Nitrophenol from Phenol

21. Preparation of Benzyl alchol and benzoic acid from Benzaldehyde. (Cannizaro Reaction)
22. Preparation of β-hydroxynaphthaldehyde from β-naphthol (Reimer-Tiemann Reaction).
23. Interpretation of IR spectrum with reference to stretching vibration 0-2 C=N, C=O, N-, M-O
24. Interpretation of NMR spectrum with reference to calculation of chemical shifts and general comments.
25. Preparation of p- Idonitrobenzene by Sandmeyer reaction.
26. Preparation of p- chloro nitrobenzene by Sandmeyer reaction
27. To determine stoichiometry & stability constant of ferric Sulphosalicylic acid/salicylic acid complex by Job's Method and mole ratio method spectrophotometrically.
28. To determine equilibrium constant of reaction $KI + I_2 \quad KI_3$ Spectrophotometrically.
29. Determination of unknown concentration of $Cd^{+2}$ / $Zn^{+2}$ ion in the given solution by standard addition method. (Polarography)
30. Estimation of various transition elements like Zn/Ni/Co/Cd/Al from various commercial samples by complexometric titrations on potentiometer by using mercury electrode
31. Analysis of malathion by colorometry.

**Note: Any other relevant experiments may be added**

# Semester-IV

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| पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ<br>॥ विद्यया संपन्नता ॥<br>NAAC Accredited-2022<br>'B++' Grade (CGPA-2.96) | **Punyashlok Ahilyadevi Holkar Solapur University, Solapur**<br>**MSc (Industrial Chemistry) Semester-IV**<br>**Vertical : DSC**<br>**Course Code: 2325401**<br>**Course Name: Pollution Monitoring and Control** |
| ***Teaching Scheme**<br><br>**Lectures:04 Hours/week, 04 Credits** | ***Examination Scheme**<br>**UA:60 Marks**<br>**CA: 40 Marks** |

**Course Preamble:** Pollution monitoring and control is one of the core courses in the chemical Engineering curriculum and one of the traditional courses, for the last many centuries. This course provides an in-depth understanding pollutant. Students will study the analysis and estimation technique of various pollutant released by pharmaceutical and chemical industries. By combining theoretical knowledge with numerical treatment, the course aims to develop practical skills in analysis and optimizing analytical tool for Industrial applications.

**Course Objective:**

- To learn the essential Laws framed by Government of India to control pollution
- To understand major industrial pollutant
- To focus on analysis and control measure performed in industries
- To study chemical and physical method to combat pollution

**Course Outcomes**

- Become aware of environmental regulatory legislations and standards.
- Comprehension about the quantification and analysis of wastewater and their treatment before discharge.
- Understand the atmospheric dispersion of air pollutants, and operating principles.
- Understand analysis and quantification of inorganic and organic hazardous chemical waste treatment before discharge.
- Capable to understand the methods to recycle polymeric waste

## Unit I: (No. of lectures-08 Weightage:10-12 marks)

### A) Regulatory aspects

Environmental legislation -Water (prevention and control of pollution) Act 1974, Air (Prevention and control of pollution) Act 1981, its implication application and effectiveness in industrial pollution control, water quality management in India; Indian standards- IS – 2490, IS – 3360, IS – 3307 and IS – 2296; MINAS for- Sugar industries, Distilleries, Synthetic fiber industries, Oil refineries.

### B) Removal of phenolic residues (No. of lectures-08 Weightage:10-12 marks)

Sources of phenolic residues; Analytical treatment/Removal methods- Stream gas Stripping, Ion exchange, Solvent extraction, Oxidation method, biological treatment.

## Unit II:

### A) Waste Water Treatment (No. of lectures-10 Weightage:12-14 marks)

Treatment of waste water:

**b) Primary Treatment-S**edimentation, Flocculation.

**c) Secondary treatment-** Tricking filters, Activated sludge process, oxidation pond.

**d) Tertiary treatment-** Ion-exchange, Electrodialysis, and Reverse osmosis.

**e) Advanced waste water treatment-N**itrogen and Phosphorus removal.

### B) Air Pollution and its measurements (No. of lectures-08 Weightage:10-12 marks)

Nature of Industrial effluents- Gaseous and liquid effluents; Methods of gas analysis-Analysis of CO, $SO_2$, $NO_x$, $H_2S$, in the gaseous effluents. Methods of removal of pollutants from gaseous effluents- Particulate matter, Particle size analysis;

## Unit III:

### A) Removal of Heavy toxic metals (No. of lectures-10 Weightage:10-12 marks)

Chromium-control method; Removal method- Reduction Precipitation, ion Exchange, Reverse osmosis, Lime coagulation and absoption; Mercury- Measurement of mercury, Removal of mercury from Gaseous streams, Removal of mercury from liquid streams, Ion exchange method

### B) Polymer Recycling (No. of lectures-06 Weightage:6-10 marks)

Polymer recycling technologies- Melt processing, Chemical Conversation.

## Unit IV:

### A) Soil Pollution and analysis (No. of lectures-08 Weightage:10-12 marks)

Concept of Soil pollution; Sources, types of pollutants and pollution;

**Analysis of soil:** Moister, pH, total nitrogen, phosphorous, silica, lime, Magnesia, Manganese, sulfur & alkali salts.

### B) Water Pollution and Analysis (No. of lectures-08 Weightage:10-12 marks)

Analysis of process waste water - free acids and bases, dissolved oxygen, inorganic compounds – chloride, fluoride, cyanide, $SO_x$, $PO_x$, $NO_x$ , suspended solids.

### Reference Books


1. S P Mahajan: Pollution control in process industry (J W).

2. J R Holmes: Refuse Recycling and recovery (JW)

3. M Sitting: Resources recovery recycling handbook and industrial waste (N D S).

4. J O Niagh: Sulphur in the environment Vol I & II (J W)
5. P S Milor: The industry EPA contribution (MGH)
6. R B Pojasele: Toxic and hazardous waste disposal Vol. I and II(AAS)
7. A K Dey: Environmental chemistry
8. W Handley: Industrial safety handbook.
9. J E Huheey: Inorganic Chemistry (1993)
10. A.C. Stern: Air pollution: Engineering control Vol (IV) A.P.
11. P.N. Cheremsioff and R.A. Young: Air pollution control and design handbook Vol I and II Dekkar.
12. Liptak: Air pollution
13. Wark & Warner: Air pollution origin and control
14. A.K. De: Environmental chemistry
15. S.M. Khopkar: Environmental pollution analysis
16. R.S. Ramalho: Introduction to waste water treatment process (A.P.0
17. M.J. Hammar: Water and waste water technology (J.W)

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| पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ<br>॥ विद्यया संपन्नता ॥<br>NAAC Accredited-2022<br>'B++' Grade (CGPA-2.96) | **Punyashlok Ahilyadevi Holkar Solapur University, Solapur**<br>**MSc (Industrial Chemistry) Semester-IV**<br>**Vertical : DSC**<br>**Course Code: 2325402**<br>**Course Name: Industrial Management and Non-conventional energy Sources** |
| ***Teaching Scheme**<br><br>**Lectures:04 Hours/week, 04 Credits** | ***Examination Scheme**<br>**UA:60 Marks**<br>**CA: 40 Marks** |

**Course Preamble:** Industrial Management and Non-conventional energy Sources is one of the core courses in the Industrial chemistry curriculum and one of the traditional courses, for the last many centuries. This course provides an in-depth understanding various department in any industry. Students will study the research and development quality control and such allied department, and their purpose. Moreover, students will come to know the importance of Non-conventional energy Sources. By combining theoretical knowledge with numerical treatment, the course aims to develop practical skills in analyzing and optimizing analytical tool for Industrial applications

.

**Course Objective:**

- To understand and apply the basics of calculations related to material and energy flow in the processes,
- To study various types of conventional (coal, petroleum and natural gas) and non-conventional energy resources (solar, wind, nuclear, geothermal, tidal and biomass) and necessity to explore alternate energy resources.
- To make students realize personal safety, industrial safety, and various elements of process safety management.
- To make students aware of small-scale industries, management practices in industry so as to motivate to become a future entrepreneur.

**Course Outcome:**

- Ability to make material balances on unit operations and processes
- Understand the energy demand of world, nation and available resources to fulfill the demand
- Comprehension about the conventional energy resources and their effective utilization
- Capable to identify available nonconventional (renewable) energy resources and techniques to utilize them effectively.
- Understand personal safety and design safe systems for unit operations & unit processes.

## Unit I

### A) Environmental Management of Toxic and Hazardous Chemicals

**(No. of lectures-06 Weightage:08-12 marks)**

Classification and segregation of Industrial chemicals Potentially explosive chemicals; Incompatible chemical; Pyrophoric chemical; Transportation of hazardous chemicals; Incineration of hazardous chemicals; Safety concept in Industry.

### B) Small Scale Industries

**(No. of lectures-08 Weightage:10-12 marks)**

Need and scope of Small-Scale Industries, SSI registration, license, Incentives-Financial and Non-Finacial; Indian factory act-1948; FDA; Export –Import regulations.

## Unit II:

### A) R & D and Technology Transfer

**(No. of lectures-08 Weightage:10-12 marks)**

Role of R & D; University-Industry interface; Introduction to Intellectual Property: Patents, Technology transfer,

### B) Pilot Plant Operation and Scale up

**(No. of lectures-04 Weightage:04-06 marks)**

Pilot Plant- Introduction, Typical Research program undertaken to avoid risk.

### C) Quality Control

**(No. of lectures-06 Weightage:08-10 marks)**

Concept of quality control; Role of Quality Control - Control Charts-Types of control chart, Preparation of Control charts -X-Bar Chart, R-Chart, p-Chart, C-chart; Application of Control chart, Sampling, Inspection.

## Unit III:

**Mossbauer Spectroscopy** **(No. of lectures-10 Weightage:10-12 marks)**

Introduction to Mossabaur effect, recoilless emission & absorption of x-rays, Instrumentation, isomer shift, Quadrapole splitting and hyperfine interactions, application of Mossbaur effect to the investigations of compounds of iron and tin

.

## Unit IV: APPICATIONS

### A) Fuel cells and batteries –

**(No. of lectures-04 Weightage:06-08 marks)**

primary and secondary power cells, fuel cells, Li ion battery

### B) Energy Resources

**(No. of lectures-08 Weightage:10-12 marks)**

Introduction to Conventional and Nonconventional energy resources; Tide, wind sources, Energy from fission and fusion reaction. Solar Cells: photovoltaic and photogalvanic cells; photoelectron chemistry; prospects of solar energy conversion and storage, organic solar cells:

**C) Biofuels**

**(No. of lectures-06 Weightage:08-10 marks)**

Introduction; Types of Biofuels -Bioethanol, Biodiesel, Raw materials for the Synthesis of Biofuels; Manufacturing process of Bioethanol from molasses; Manufacturing process of Biodiesel; Biofuels and economy.

**Reference Books:**


1. R.R. Mukharjee: Element of Quality Control (Vanled books)
2. Industrial Organization & Engineering Economics-T.R.Banga
3. R.H. Lonter, N.C. Enrlok and H.E. Mottley: Quality for profit (IP)
4. W.N. Smith, E.G. Mayer and A.R. Hirsig: Industry R D Management ch 1, 3, 5, 10, 11, 13, 14, 15, 18 (Marcel Dekker)
5. A.Gerstenfield: Effective management of R & D (AW)
6. N.N Singh: Scientific management of SSI (Lalwani)
7. Kirk R Smith: Biofuels: Air pollution and Health: A Global Review (Kluwer Academic/Plenum publisher
8. K.K.Rohatgi-Mukherjee. Fundamentals of Photochemistry.Reprint 2002. New AgeInternationalPublisher,1978.-

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

**Course Preamble:** Nanomaterial and its Characterization is one of the core courses in the Industrial chemistry curriculum and one of the traditional courses, for the last many centuries. Students will study the nanomaterial, synthesis of nanomaterial required in research and development. Moreover, students will come to know the important characterization technique. By combining theoretical knowledge with numerical treatment, the course aims to develop practical skills in analyzing and optimizing analytical tool for Industrial applications

**Course Objective**

- To endow with basic information regarding synthesis of Nanomaterial and application of various instrumental techniques like, XRD, SEM, TEM, TGA and DSC
- To analyze and authenticate Nanomaterial synthesized in chemical laboratory

**Course Outcomes**

At the completion of this course, students should be able to:

- Acquires the basic knowledge of synthesis of Nanomaterial
- Understand theory, principle and application of various techniques like XRD, SEM, TEM, TGA and DSC.
- 3. Identification of impurities and purities in sample and also method development for specific compound nature.
- Educate in structure identification, topology, morphology, composition and crystallographic information by using XRD and TEM, SEM

**Unit I:**

**A) Nanoscience and Nanotechnology**

**(No. of lectures-02 Weightage:02-04 marks)**

Introduction, Possible application of nanotechnology for Nano device-Nano sensor (only introductory).

## B) Synthesis and growth technique of Materials/Nanomaterial

**(No. of lectures-10 Weightage:12-14 marks)**

Synthesis of solid state materials conventional methods- Electrodeposition, Spray Pyrolysis, Sol-gel, Hydrothermal synthesis, Chemical bath deposition, Chemical Vapor deposition CVD, Photo assisted CVD, plasma assisted CVD, Magnetron Sputtering; Crystal growth from vapors, melt and solutions; Preparation of ultra pure elements of Gallium, Indium and Germanium for semiconductors- Czochralski method. Zone refining; Preparation and purification of silicon,; Amorphous and Crystalline silicon.

## Unit II:

**Optical and electron microscopy:**

**(No. of lectures-12 Weightage:12-14 marks)**

SEM, TEM, AFM, and XPS Instrumentation and application.

## Unit III:

**Thermal Methods**

**(No. of lectures-12 Weightage:12-14 marks)**

Introduction to TGA; Instrumentation; Chemical change versus weight loss plots, TGA analysis, Use in characterization of raw materials, minerals, polymers, hydrate analysis.

Introduction to DTA; Instrumentation; Exothermic and Endothermic chemical and physical changes; DTA profile; Applications,

Introduction to DSC; Instrumentation; Applications.

## Unit IV:

**X-Ray Diffraction**

**(No. of lectures-12 Weightage:12-14 marks)**

Methods of production of x-rays; Properties of x-rays; Diffraction of x-rays; Bragg's Law; lattice and powder diffraction methods; Analysis of molecular structure by XRD

**Problems**

**Reference Books**


1. Z.Wite, R. Speight: Ultra purity (MDI)
2. F. A. Kroger: Chemistry of Imperfect Crystals
3. H. Gopanov: Optical and Electronic Properties of Nanocrystalline Materials
4. F.J. Welder: Standard Methods of chemicals analysis Vol III part A and B.
5. H.A. Strobel: Chemical Instrumentation (AW).
6. Willard, Meritt & Dean: Instrumental Methods of analysis (FWAP)

7. F.D. Snell, Encyclopedia of Industrial: Chemical Inorganic analysis Vol. 1 to 20 (J.W.)
8. Hillebrand, Llundell and Hoffman: Applied inorganic analysis (Interscience)
9. D.K. Chakrabarry: Solid state chemistry.

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| | **Punyashlok Ahilyadevi Holkar Solapur University, Solapur**<br>**MSc (Industrial Chemistry) Semester-IV**<br>**Vertical : DSE**<br>**Course Code: 2325406**<br>**Course Name: Organic Spectroscopic technique** |
| ***Teaching Scheme**<br><br>**Lectures:04 Hours/week, 04 Credits** | ***Examination Scheme**<br>**UA:60 Marks**<br>**CA: 40 Marks** |

**Course Preamble:** The main objective of this course is to teach fundamental principles of various spectroscopic techniques used for structural elucidation of organic compounds. Along with the fundamental aspects, the focus will be given on problem solving which can help students from research perspective.

## Course Objective

- To promote students to understand Basic principles of IR, NMR, CMR and Two-dimensional spectroscopy
- To enable students to interpret spectra and finally to perceive structural elucidation
- To create opportunity to student to interpret structure of unknown sample

## Course Outcome:

- Understand Infrared spectroscopy and its applications to structural problems.
- Important terms and theory of Nuclear Magnetic Resonance spectroscopy. Its applications to structural problems.
- Problems solved based on UV, IR, NMR & MS Spectroscopy to interpret structure
- Students will be in position to interpret spectra and predict structure of unknown molecules
- To acquire knowledge on principle and different techniques of organic synthesis to prepare various classes of organic compounds and purification methods,
- To gain knowledge on characterization of organic compounds using physical methods and spectroscopic analysis of IR and NMR spectra.
- To understand quantitative analysis and develop experimental skill for determination of number of hydroxyl groups and estimation of amines, phenols in an organic compound using acetylation method.

## Unit I: Nuclear Magnetic Resonance Spectroscopy:

**(No. of lectures-15 Weightage:12-15 marks)**

General introduction and definition, chemical shift, spin-spin interaction, shielding mechanism, mechanism of measurement, chemical shift values and correlation for protons bonded to carbon (aliphatic, olefinic, aldehyde and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic

acids, amines, amides and mercapto), chemical exchange, effect of deuteration, complex spin-spin interaction between 2,3,4 and 5 nuclei (first order spectra), virtual coupling. Stereochemistry, Hindered rotation, Fourier transforms technique, Nuclear
Overhauser Effect (NOE) with examples

**Unit II: A) $^{13}$C-NMR Spectroscopy**

**(No. of lectures-12 Weightage:10-15 marks)**

Elementary ideas, instrumental difficulties, FT technique advantages and disadvantages. Proton Noise Decoupling technique advantages and disadvantages, off-resonance technique, factors affecting chemical shifts, analogy with 1H NMR, calculations of chemical shift of hydrocarbons, different types of carbons (alkene, alkyne, allene, carbonyl, nitrile, oxime and aromatic carbons and effect of substituent on chemical shifts of carbons. Chemical shifts of solvents

**B) Infra red spectroscopy**

**(No. of lectures-08 Weightage:08-10 marks)**

Factors affecting Infra-red spectroscopy, Stretching frequencies of functional group, fingerprint region

**Unit – III Two-dimensional (2D) NMR spectroscopy:**

**(No. of lectures-15 Weightage:12-15 marks)**

Introduction, DEPT, COSY and HETCOR techniques, (including interpretation of COSY and HETCOR spectra). NOESY and 2D-INADEQUATE techniques
Problems based on joint application of IR, NMR & CMR spectroscopy

**Unit – IV**

**Name reaction:**

**(No. of lectures-15 Weightage:12-15 marks)**

Julia olefination, Bamford-Steven, Wittig reaction, Corey-Fuchs Reaction, Grob rearrangement, Eshonmosar rearrangement, Mitsunobe reaction and reagents converting alkene to epoxide and its opening reaction

**Recommended Books**

1) Advanced organic chemistry by Jerry March, 4th edition, Mc Graw – Hill,
2) Advanced organic chemistry (Part-A) by F.A.Carey and R.J. Sundberg, 3rd edition, plenum press, New York and London, 1990. 1988.

3) Modern synthetic reactions by H.O. House, 2nd edition, Benjamin / Cummings Publishing Company, 1976.

4) Spectroscopic methods in organic chemistry by Williams & Fleming, Tata – McGraw Hill, 4th edition, 1988.

5) Spectroscopy of organic Compounds by P.S.Kalsi, New Age International, 2nd edition, 1995.

6) Spectroscopic Identification of organic compounds by R.M.Silverstein and G.C.Bassler, 5th edition, 1991.

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| पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ<br>।। विद्यया संपन्नता ।।<br>NAAC Accredited-2022<br>'B++' Grade (CGPA-2.96) | **Punyashlok Ahilyadevi Holkar Solapur University, Solapur**<br>**MSc (Industrial Chemistry) Semester-IV**<br>**Vertical : RP**<br>**Course Code: 2325403**<br>**Course Name: Research Project-II** |
| ***Teaching Scheme**<br><br>**Practicals:12 Hours/week, 06 Credits** | ***Examination Scheme**<br>**UA:90 Marks**<br>**CA: 60 Marks** |

**Course Preamble:** The research project for M. Sc. Industrial Chemistry is to introduce students to get familiarize with research process. They will be able to identify research problem based on the area of their interest, subsequently finalize research problem by literature survey. It is expected that project should provide hands on training to the students on various instruments. It is mandatory for each individual student to undertake and independently work on a short research project.

***In Semester IV, there is a Research Project of 4 credits. Students have to carry out project either at university laboratory or in any recognized R & D laboratory (Public/Private/Government) or Industry or Institute of National repute across the country under the guidance of scientist or a post-graduate faculty member***

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| पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ<br>।। विद्यया संपन्नता ।।<br>NAAC Accredited-2022<br>'B++' Grade (CGPA-2.96) | **Punyashlok Ahilyadevi Holkar Solapur University, Solapur**<br>**MSc (Industrial Chemistry) Semester-IV**<br>**Vertical : DSC**<br>**Course Code: 2325404**<br>**Course Name: Practical I and**<br>**Vertical : DSE**<br>**Course Code: 2325407/2325408**<br>**Course Name: Practical II Based on DSE4A/4B** |
| ***Teaching Scheme**<br><br>**Practicals:04 Hours/week, 02 Credits** | ***Examination Scheme**<br>**UA:30 Marks**<br>**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 papers as well as on elective courses. The practical's based on pH-metry, Potentiometry, Spectrophotometry, Thermochemistry, Conductometry and Chemical Kinetics are included in the course. Moreover, Organic synthesis, especially drugs and subsequently their analysis and estimation. These practicals are further divided into short and long experiments.

## Couse Objectives

- **Experimental Techniques:**
  - Master fundamental laboratory techniques such as weighing, measuring, titration, filtration, and crystallization.
  - Develop proficiency in using laboratory equipment, including balances, glassware, burners, and heating devices.
- **Observation and Data Collection:**
  - Observe chemical reactions and record accurate observations, measurements, and data.
  - Develop skills in data analysis, including graphing, calculations, and interpretation of results.
- **Problem-Solving and Critical Thinking:**
  - Apply theoretical knowledge to solve practical problems and design experiments.
  - Develop critical thinking skills to analyze experimental results and draw conclusions.
- **Laboratory Safety:**
  - Understand and adhere to laboratory safety procedures and regulations.
  - Handle chemicals and equipment safely and responsibly.

## 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 detergents

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

| | **Organic Preparations** |
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| | **List of Practicals:** |
| | **Two /Three stages organic preparations**<br>(TLC Analysis is recommended) |
| 1. | 1. Preparation of Benzanilide by Beckmann rearrangement |
| 2. | 2. Preparation of Antharanilic acid |
| 3. | 3. Preparation of Phthalimide |
| 4. | 4. Preparation of N- Bromosuccinamide |
| 5. | 5. Preparatin of p- Aminobenzoic acid |
| 6. | 6. Preparation of p- chloronitrobenzene by Sandmeyer reaction |
| 7. | 7. Preparation of p- Iodonitrobenzene by Sandmeyer reaction |
| 8. | 8. Pinacol- Pinacolone rearrangement |
| 9. | 9. Preparation of Acetophenones by Fries rearrangement |
| 10. | 10. Preparation of aromatic aldehydes by Vilsmer Hack reaction or R. T.<br><br>**(Note: Other suitable experiments may be added)** |

| | **Drug assay and drug formulations** |
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| | **List of Practicals** |

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Assay of Paracetamol Tablet

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Assay of Chloramphenicol Capsule

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Assay of Aspirin Tablet

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Assay of Vitamin-C

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Preparation and Evaluation of Tablet

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Draw Plant Layout of Tablet Unit

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Draw Process Flow chart of parenteral formulation

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Validation of UV-Visible spectroscopic analytical method

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Performance Qualification of IR

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Evaluation of Packaging Material (Glass/Plastic)

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Preparation of weak Iodine solution

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Preparation of Paracetamol Suspension

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Preparation of Castor Oil Emulsion

Preparation of Simple Syrup IP

Preparation of Lemon Syrup

Preparation of Sodium chloride eye lotion

Preparation of Methyl salicylate Ointment

Estimate the amount of calcium from plaster of paris.

Determine the amount of Cobalt in given unknown sample by colorimetric method

Determine the amount of Chromium and Nickel from given stainless-steel alloy.

Estimate the amount of Iron in given unknown sample by colorimetric method. Preparation of chrome alum.

Preparation and Analysis of Zinc ferrite.

Analysis of Cement

Analysis of Fertilizer

X-ray powder diffraction analysis of cubic compound

Determination of moisture content in food/drug sample by Karl Fisher reagents.

Estimation of various transition elements like Zn/Ni/Co/Cd/Al from various commercial samples by complexometric titrations on potentiometer by using mercury electrode

Analysis of iodized table salt.

**(Note: Other suitable experiments may be added)**

| | **Physical Pharmaceutical Technology** |
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| | **List of Practicals** |
| | Determine the acidic and basic dissociation constant of an amino acid and hence determine the isoelectric point of acid pH metrically.<br>2. To determine the specific refraction of given mixture of liquid and hence find out unknown concentration of mixture.<br>3. Investigate the autocatalytic reaction between potassium permangnate and oxalic acid.<br>4. To determine the latent heat of fusion a given solid naphthalene in toluene<br>5. To determine the molecular weight and state of benzoic acid in benzene by cryoscopic method. |

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| | 6. to determine the molecular weight and state of acetic acid in benzene Cryoscopy.<br>7. Demonstration of major sophisticated instruments (uv-visible, IR, TG-DSC, Brookefield viscometer, VPO etc)<br>8. To determine stoichiometry & stability constant of ferric Sulphosalicylic acid/ salicylic acid complex by Job's Method and mole ratio method spectrophotometrically.<br>9.To determine equilibrium constant of reaction KI + I2 KI3 Spectrophotometrically.<br>10.Determination of unknown concentration of Cd +2 / Zn+2 ion in the given solution. by standard addition method.(Polarography)<br>11. Estimation of various transition elements like Zn/Ni/Co/Cd/Al from various commercial samples by complexometric titrations on potentiometer by using mercury electrode<br>(**Note:** Other suitable experiments may be added) |

**Reference books for Practicals (Sem-III & IV):**


1. A Textbook of Practical Organic Chemistry - A. I. Vogel.
2. Practical Organic Chemistry - Mann & Saunders.
3. A Handbook of Quantitative & Qualitative Analysis- H. T. Clarke.
4. Organic Synthesis Collective Volumes by Blat.
5. Reagents in Organic Synthesis by Fieser and Fieser.
6. Organic Practicals by Ahluwalia.
7. Systematic Lab Experiments in Organic Chemistry by Arun Sethi. (New Age).
8. Advanced Practical Medicinal Chemistry by Ashutosh Kar
9. Practical Pharmaceutical Chemistry-part two by A.H.Beckett and J.B. Stenlake.
10. Practical Pharmaceutical Analysis by Dr.G. Devala Rao.
11. Laboratory Handbook of Instrumental Drug Analysis by B.G. Nagavi.
12. Spectrometric Identification of Organic compounds - Robert M Silverstein, Sixth edition, John Wiley & Sons, 2004.