

**DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY**  
**Chhatrapati Sambhajnagar.**



NAAC- 'A+' Grade

**CIRCULAR /SU/ AEDP / Sci & Tech./ Comm.& Mang. / Humani. /79/2026**

It is hereby inform to all concerned that, on the recommendation of the Board of Dean's,; **the Academic Council at its meeting held on 02 june, 2026 has been accepted the following Subject wise under "Apprenticeship Embedded Degree Programme (AEDP)" run at colleges level.**

| Sr.No. | Name of the Courses's                                     | Faculty               | College Name                                                               | Semester |
|--------|-----------------------------------------------------------|-----------------------|----------------------------------------------------------------------------|----------|
| 1      | B.Sc.Industrial Chemistry (AEDP)                          | Science & Technology  | Maulana Azad College of Arts, Science & Commerce Chhatrapati Sambhajinagar | III & IV |
| 2      | B.A. Psychology (AEDP)                                    | Humanities            |                                                                            |          |
| 3      | B.Sc.Medical Laboratory Technology (AEDP)                 | Science & Technology  | Deogiri College (Autonomous) Chhatrapati Sambhajinagar.                    |          |
| 4      | B.Com in Banking, Financial Services and Insurance (AEDP) | Commerce & Management |                                                                            |          |

**This is effective from the Academic Year 2026-27 and Onwards as per appended herewith.**

All concerned are requested to note the contents of this circular and bring notice to the students, teachers and staff for their information and necessary action.

University Campus,  
Chhatrapati Sambhajnagar  
-431 004.

REF.NO. SU/2026 / 124-27

Date:- 05 /06 / 2026.

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*Deputy Registrar,  
Syllabus Section*

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**Copy forwarded for Information and necessary action:-**

- 1] The Principal, Maulana Azad College of Arts, Science & Commerce Dr. Rafiq Zakaria Campus, Chhatrapati Sambhajnagar.
- 2] The, Principal, Deogiri College (Autonomous), railway station road Chhatrapati Sambhajnagar.
- 3] The Director, Board of Examination & Evaluation,
- 4] The Director, University Network & Information Centre, UNIC, with a **request to upload this Circular on University Website.**

Dr.Babasaheb Ambedkar Marathwada University **Chhatrapati Sambhajnagar.**

Dr. Babasaheb Ambedkar Marathwada University

Chhatrapati Sambhajinagar- 431001



## Course Structure and Syllabus

For

**B.Sc. Industrial chemistry Apprenticeship  
Embedded Degree Program (AEDP) (Second Year)  
Semester III & IV**

(AS PER NEP-2020)



Subject ( Major ) :

**Industrial Chemistry**



Effective from 2025-26

**B.Sc. Industrial chemistry AEDP Semester 3<sup>rd</sup>:**

| Course type                                                                                                          | Course Code        | Course Name                                               | Teaching Scheme (Hrs/week) |           | Credits Assigned |           | Total Credits |
|----------------------------------------------------------------------------------------------------------------------|--------------------|-----------------------------------------------------------|----------------------------|-----------|------------------|-----------|---------------|
|                                                                                                                      |                    |                                                           | Theory                     | Practical | Theory           | Practical |               |
| Industrial Chemistry (Major) Mandatory SUB/DSC                                                                       | INC/DSC-5/ T/200   | Unit Operation-I                                          | 2                          |           | 2                |           | 2+2+2+2=08    |
|                                                                                                                      | INC /DSC-6/T/20 1  | Chemical Reaction Engineering-I                           | 2                          |           | 2                |           |               |
|                                                                                                                      | INC /DSC-7/P/ 226  | Practical based on Ind.Chem/DSC-5/T/2 00                  |                            | 4         |                  | 2         |               |
|                                                                                                                      | INC /DSC-8/P/ 227  | Practical based on Ind.Chem./DSC-6/T/ 201                 |                            | 4         |                  | 2         |               |
| Industrial Chemistry (Minor)                                                                                         | INC/Mn-1/T/ 200    | Industrial Instrumentation and Chemical Analysis          | 2                          |           | 2                |           | 2+2= 04       |
|                                                                                                                      | INC /Mn-2/T/ 201   | Electrochemistry                                          | 2                          |           | 2                |           |               |
| Generic/Open Elective (GE/OE)                                                                                        | INC/GE/O E-3/T/200 | Agrochemical Chemistry                                    | 2                          |           | 2                |           | 02            |
| VSC ( Vocational Skill Courses) (Choose any one from SUB/VSC/T/ 200 and SUB/VSC/T/ 201) and corresponding Practicals | INC/ VSC-3/T/ 200  | Industrial Water Treatments                               | 1                          |           | 1                |           | 1+1=02        |
|                                                                                                                      | INC/ VSC-3/T/ 201  | Industrial Wastes & Treatments                            | 1                          |           | 1                |           |               |
|                                                                                                                      | INC/ VSC-4/P/ 226  | Practicals based on Ind.Chem/VSC-3/T/ 200                 |                            | 2         |                  | 1         |               |
|                                                                                                                      | INC/VSC-4/P / 227  | Practicals based on Ind.Chem /VSC-3/T/ 201                |                            | 2         |                  | 1         |               |
| AEC, VEC, IKS                                                                                                        | INC/AEC-3/ T/200   | Computational Chemistry                                   | 2                          |           | 2                |           | 2+2=04        |
|                                                                                                                      | INC/VEC-3/ T/201   | Environmental Studies-1                                   | 2                          |           | 2                |           |               |
| OJT/ FP/CEP/CC/RP                                                                                                    | FP-1/ 226          | Field Project                                             |                            | 4         |                  | 2         | 02            |
|                                                                                                                      | CC-3               | Cultural Activity / NSS,NCC ( Common for all the faculty) |                            | 4         |                  | 2         |               |
|                                                                                                                      |                    |                                                           | <b>13</b>                  | <b>18</b> | <b>13</b>        | <b>09</b> | <b>22</b>     |

**B.Sc. Industrial chemistry AEDP Semester 4<sup>th</sup>:**

| Course type                                                                                                         | Course Code        | Course Name                                | Teaching Scheme (Hrs/week) |           | Credits Assigned |           | Total Credits |
|---------------------------------------------------------------------------------------------------------------------|--------------------|--------------------------------------------|----------------------------|-----------|------------------|-----------|---------------|
|                                                                                                                     |                    |                                            | Theory                     | Practical | Theory           | Practical |               |
| Industrial Chemistry (Major) Mandatory SUB/DSC                                                                      | INC/DSC-9/ T/250   | Unit operation-II                          | 2                          |           | 2                |           | 2+2+2+2=08    |
|                                                                                                                     | INC /DSC-10/T/25 1 | Chemical Reaction Engineering-I.           | 2                          |           | 2                |           |               |
|                                                                                                                     | INC /DSC-11/P/ 276 | Practical based on Ind.Chem/DSC-9/T/2 00   |                            | 4         |                  | 2         |               |
|                                                                                                                     | INC /DSC-12/P/ 277 | Practical based on Ind.Chem./DSC-10/T/ 201 |                            | 4         |                  | 2         |               |
| Industrial Chemistry (Minor)                                                                                        | INC/Mn-3/T/ 250    | Organic Molecular Design                   | 2                          |           | 2                |           | 2+2= 04       |
|                                                                                                                     | INC /Mn-4/T/ 251   | Chemistry of Named reaction                | 2                          |           | 2                |           |               |
| Generic/Open elective (GE/OE)                                                                                       | INC/GE/O E-4/T/250 | Material Science & Heavy Organic Chemicals | 2                          |           | 2                |           | 02            |
| SEC (Skill Enhancement Courses) (Choose any one from SUB/SEC/T/2 50and SUB/SEC/T/ 251) and corresponding Practicals | INC/ SEC-3/T/ 250  | Industrial Water Treatments                | 1                          |           | 1                |           | 1+1=02        |
|                                                                                                                     | INC/ SEC-3/T/ 251  | Industrial Wastes & Treatments             | 1                          |           | 1                |           |               |
|                                                                                                                     | INC/ SEC-4/P/ 276  | Practicals based on Ind.Chem/SEC-3/T/ 200  |                            | 2         |                  | 1         |               |
|                                                                                                                     | INC/VSC/P / 277    | Practicals based on Ind.Chem /SEC-3/T/ 201 |                            | 2         |                  | 1         |               |
| AEC, VEC, IKS                                                                                                       | INC/AEC-4/ T/250   | Enzyme chemistry                           | 2                          |           | 2                |           | 2+2=04        |
|                                                                                                                     | INC/VEC-4/ T/251   | Environmental Studies-2                    | 2                          |           | 2                |           |               |
| OJT/ FP/CEP/CC/RP                                                                                                   | INC/CEP-1/ 276     | Community Engagement Service               |                            | 4         |                  | 2         | 02            |
|                                                                                                                     | CC-4               | Visual Pollution                           |                            | 4         |                  | 2         |               |
|                                                                                                                     |                    |                                            | 13                         | 18        | 13               | 09        | 22            |

**B.Sc. Third Year: 5th Semester**

| Course Type                        | Course Code      | Course Name                                                                                             | Examination Code | Teaching Scheme (Hrs/Week) Theory | Teaching Scheme (Hrs/Week) Practical | Credits Assigned Theory | Credits Assigned Practical | Total Credits |
|------------------------------------|------------------|---------------------------------------------------------------------------------------------------------|------------------|-----------------------------------|--------------------------------------|-------------------------|----------------------------|---------------|
| Major (Core) M1 Mandatory          | INC/DSC-13/T/350 | Advanced Mass Transfer Operations & Separation Technology                                               |                  | 2                                 | —                                    | 2                       | —                          | 2+2 = 4       |
|                                    | INC/DSC-16/P/376 | Practical based on DSC-13 Lab Course                                                                    |                  | —                                 | 4                                    | —                       | 2                          |               |
| Major (Core) M2 Mandatory          | INC/DSC-14/T/351 | Chemical Reactor Design, Optimization & Process Dynamics                                                |                  | 2                                 | —                                    | 2                       | —                          | 2+2 = 4       |
|                                    | INC/DSC-17/P/377 | Chemistry Practical based on DSC-14                                                                     |                  | —                                 | 4                                    | —                       | 2                          |               |
| Major (Core) M3 Mandatory          | INC/DSC-15/T/352 | Instrumental Methods of Analysis                                                                        |                  | 2                                 | —                                    | 2                       | —                          | 2+2 = 4       |
|                                    | INC/DSC-18/P/378 | Analytics Practical based on DSC-5                                                                      |                  | —                                 | 4                                    | —                       | 2                          |               |
| Discipline Specific Elective (DSE) | INC/DSE-13/T/350 | Choose any one:<br>i) Polymer & Plastics Chemistry<br>ii) Chemistry of Functional Organic Intermediates |                  | 2                                 | —                                    | 2                       | —                          | 2             |

|                               |                  |                                           |  |   |    |   |    |    |
|-------------------------------|------------------|-------------------------------------------|--|---|----|---|----|----|
| Vocational Skill Course (VSC) | INC/VSC-13/1/350 | Industrial Safety Management              |  | 1 | —  | 1 | —  | 2  |
|                               | INC/VSC-13/P/376 | Practical based on Industrial Safety      |  | — | 2  | — | 1  |    |
| OJT / FP / RP                 | INC/RP-13/2/370  | Mini Project / Pre-Apprenticeship Seminar |  | — | 4  | — | 2  | 2  |
| Total                         |                  |                                           |  | 9 | 18 | 9 | 11 | 20 |

Optional 5<sup>th</sup> semester apprenticeship:

| Course Type                       | Course Code      | Course Name                                                                                               | Examination Code | Teaching Scheme (Hrs/Week) Theory | Teaching Scheme (Hrs/Week) Practical | Credits Assigned Theory | Credits Assigned Practical | Total Credits |
|-----------------------------------|------------------|-----------------------------------------------------------------------------------------------------------|------------------|-----------------------------------|--------------------------------------|-------------------------|----------------------------|---------------|
| OJT / Apprenticeship (Core Track) | INC/APT-14/1/350 | Full-Time Industrial Apprenticeship / Internship (Minimum 24 Weeks at an assigned Chemical/Process Plant) | SJC00611 02P     | —                                 | 32                                   | —                       | 16                         | 16            |
| Major (Core Component)            | INC/DSC-14/2/350 | Industrial Field Project Report & Documentation/examine by subject expert                                 | SAC00612 02T     | —                                 | 4                                    | —                       | 2                          | 2             |
| Comprehensive Viva                | INC/DSC-14/3/350 | Technical Project Viva-Voce (Conducted by External Industry/ College Expert)                              | SAC00613 02T     | —                                 | 4                                    | —                       | 2                          | 2             |
| Total                             |                  |                                                                                                           |                  | 0                                 | 40                                   | 0                       | 20                         | 20            |

**B.Sc. Third Year: 6th Semester (Full-Semester Apprenticeship Option)**

*This option converts the entire final semester into a continuous, full-time industrial apprenticeship with an absolute focus on field experience.*

| Course Type                       | Course Code      | Course Name                                                                                               | Examination Code | Teaching Scheme (Hrs/Week) Theory | Teaching Scheme (Hrs/Week) Practical | Credits Assigned Theory | Credits Assigned Practical | Total Credits |
|-----------------------------------|------------------|-----------------------------------------------------------------------------------------------------------|------------------|-----------------------------------|--------------------------------------|-------------------------|----------------------------|---------------|
| OJT / Apprenticeship (Core Track) | INC/APT-15/1/450 | Full-Time Industrial Apprenticeship / Internship (Minimum 24 Weeks at an assigned Chemical/Process Plant) | SJC00611 02P     | —                                 | 32                                   | —                       | 16                         | 16            |
| Major (Core Component)            | INC/DSC-15/2/450 | Industrial Field Project Report & Documentation/examined by subject expert.                               | SAC00612 02T     | —                                 | 4                                    | —                       | 2                          | 2             |
| Comprehensive Viva                | INC/DSC-15/3/450 | Technical Project Viva-Voce (Conducted by External Industry Expert/College Expert)                        | SAC00613 02T     | —                                 | 4                                    | —                       | 2                          | 2             |
| Total                             |                  |                                                                                                           |                  | 0                                 | 40                                   | 0                       | 20                         | 20            |

**Key Structural Highlights:**

- ❖ **Exit Option Available:** Upon finishing the 6th semester with 20 credits of industrial experience, students graduate with a **B.Sc. in Industrial Chemistry** along with a specialized **Apprenticeship Course Certificate**.
- ❖ **Credit Equilibrium:** Both semesters maintain a regular **20-credit** balance to satisfy regulatory university degrees without creating uneven academic stress.

| <p align="center"><b>B.Sc. Industrial Chemistry (Major) : Semester III</b></p> <p><b>Course Code:INC/DSC/T/200 : Unit Operation-1</b>      Examn. Code : SAC00142003T</p> <p>Total Credits : 2      Total Contact Hours : 30 Hrs</p> <p>Maximum Marks : 50</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |               |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| <p><b>Learning Objectives of the Course:</b>The students are expected to learn -</p> <p>1. General Principles of mass transfer operations, types of mass transfer operations &amp; their Importance &amp; Distillation, typical distillation equipment, principles of stage processes, material balance &amp; enthalpy balances</p> <p>2. Types of distillation &amp; material balances in plate column &amp; liquid-liquid extraction, Applications of Liquid-Liquid Extraction, Principles of Liquid-liquid equilibria, Triangular diagrams, Types of extraction system,</p> <p>3. Introduction, Principles of Comminution, Criteria for comminution, Characteristics Of comminuted products, Energy&amp;Power requirements in comminution, Crushing efficiency</p> <p><b>Course Outcomes ( COs) :</b> After completion of the course, students will be able to -</p> <p>CO1: The students understood about types of mass transfer operations. The students acquire knowledge of application of different types Distillation, typical distillation equipment.</p> <p>CO2: The students understood about Types of distillation &amp; material balances in plate Column. The students understood about applications of Liquid-Liquid Extraction, Principles of liquid-liquid equilibria, Triangular diagrams, Types of extraction system.</p> <p>CO3: The students are knowing Principles of Comminution, Criteria for comminution, Characteristics of comminuted Products, Energy&amp; Power requirements.</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |               |
| Module No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Topics / actual contents of the syllabus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Contact Hours |
| <b>Unit - I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Overview of Mass Transfer Operations-</b> General Overview - Introduction to Mass Transfer operations, - Benefits, General Principles of Mass Transfer, Various types of Mass Transfer Operations & their importance. <b>Equilibrium Stage Operations-</b> Introduction, Typical distillation equipment, Principles of Stage Processes, Terminology for Stage Contact Plants, Material Balances, Enthalpy balances, Graphical method for two component system, Operating line diagram, Ideal contact stages, Determining the number of ideal stages.                                                                                                                          | <b>10 Hrs</b> |
| <b>Unit - II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Distillation-</b> Introduction, Flash Distillation, Simple Distillation, Steam Distillation, Rectification, Material Balances in Plate Columns, Number of Ideal Plates, McCabe Thiele Method, Constant molal overflow. Reflux Ratio, Condenser and Top Plate, Bottom Plate and Reboiler, Feed Plate, Minimum Reflux, Optimum Reflux Ratio, Plate Efficiency, Types, Relations, Factors influencing plate efficiency, Rectification in packed towers, Batch distillation                                                                                                                                                                                                       | <b>12 Hrs</b> |
| <b>Unit - III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>Liquid Extraction</b> – Introduction to liquid-liquid extraction, Applications of Liquid-Liquid Extraction, Principles of liquid-liquid equilibria, Triangular diagrams, Types of extraction system, I & U, Temperature effects on systems types, Solvent selection, Commercial extraction system, Typical extraction system, Extraction calculations-Single Stage Operations, Multi Stage Cross Current Operation, Continuous multistage counter current operations, Design considerations of packed beds, Extraction Equipments-Mixer Settlers, Spray & Packed extraction towers, Perforated plate towers, Baffle towers, Agitated Tower extractor, Centrifugal Extractors. | <b>08 Hrs</b> |
| <p><b>Text Books:</b> Unit Operations of Chemical Engineering- W.L.McCabe, J.C.Smith, Pier Harriott</p> <p>2. Mass Transfer Operations- Robben E. Treybal</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |               |

**Course Code:** INC /DSC/T/201: **Chemical Reaction Engineering-1** **Examn. Code :** SAC00142013T  
**Total Credits :** 2 **Total Contact Hours :** 30 Hrs  
**Maximum Marks :** 50

Total Credits : 2

Total Contact Hours : 30 Hrs

Maximum Marks : 50

1. Typical Chemical Process, Classification of reactions & The rate equation, Concentration-Dependent Term of a rate equation, Single & multiple Reactions,
2. Temperature-Dependent Term of a Rate Equation & Introduction of Batch Reactor. Constant-Volume Batch Reactor, 3. First Order Reversible Reactions, Second Order Reversible Reactions,

**Course Outcomes ( COs) :** After completion of the course, students will be able to -

CO1: The students are learned typical Chemical Process, Classification of Reactions. The students can explain the rate equation, Concentration-Dependent term of a rate equation. Single & multiple Reactions, CO2: The students can solve the problems on Material Balances without chemical Reaction. The students can solve the problems/examples on rate of reaction. CO3 : Students know the first order reversible reactions, Second order reversible reactions.

| Module No.                                                                                                                                                                             | Topics / actual contents of the syllabus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Contact Hours |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| Unit - I                                                                                                                                                                               | <b>Overview of Chemical Reaction Engineering</b> - Typical Chemical Process, Classification of reactions, Variable affecting the Rate of Reaction. Definition of Reaction Rate <b>Kinetics of Homogeneous Reactions</b> – The rate equation, Concentration-Dependent Term of a rate equation, Single & multiple Reactions, Elementary & Nonelementary reactions, Molecular Weight & Order of Reaction, Rate Constant (K). Representation of an Elementary Reaction, Representation of Non elementary Reaction, Kinetic Models for Non elementary Reactions-free radicals, Ions & polar substances, Molecules, Transition Complex, Non Chain Reactions, Chain Reactions-Free radicals, Chain reaction mechanism, Molecular intermediates, non chain mechanism, Transition Complex • non chain mechanism. | 10 Hrs        |
| Unit - II                                                                                                                                                                              | <b>Temperature-Dependent Term of a Rate Equation</b> -Temperature Dependency from Arrhenius Law. Comparison of Theories with Arrhenius law, Activation Energy and Temperature Dependency, (Example 2.3). <b>Interpretation of Batch Reactor Data</b> - Introduction of Batch Reactor. Constant-Volume Batch Reactor, Analysis of Total Pressure data obtained in a Constant-Volume System, Integral Method of Analysis of Data, Irreversible Unimolecular-I type First Order Reactions, Irreversible Bimolecular-Type Second Order Reactions, Zero Order Reactions, Overall Order of Irreversible Reactions from the half-Life $t_{1/2}$ , Irreversible reactions in Parallel, Homogeneous Catalyzed Reactions, Autocatalytic Reactions, Irreversible Reactions in Series.                              | 10 Hrs        |
| Unit - III                                                                                                                                                                             | <b>First Order Reversible Reactions</b> , Second Order Reversible Reactions, Reactions of Shifting Order, Differential Method of Analysis of Data, Varying- Volume Batch Reactor, Differential Method of Analysis, Integral Method of Analysis, Zero Order Reactions. First Order Reaction, Second Order Reactions. The Search for a Rate Equation.                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 10 Hrs        |
| <b>Text Books:</b> 1. Chemical Reaction Engineering - Octave Levenspiel (Wiley India Pvt. Ltd, Third Edn.)<br>2. Chemical Reaction Engineering - K.A. Gavhane (Nirali Prakashan, Pune) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |               |
| <b>Reference Books:</b> 1. Principles of Reaction Engineering- S.D. Duwonde (Central Techno Publication)                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |               |

**B.Sc. Industrial Chemistry (Major) : Semester III**

**Course Code:**INC /DSC/P/ 226 : **Practical** based on SUB/DSC/T/200 Exam. Code : SAC00142263P

Total Credits : 2

Total Contact Hours : 60 Hrs

Maximum Marks : 50

**Learning Objectives of the Course:**

The students are expected to learn experimentally -

1. General Principles of mass transfer operations, types of mass transfer operations & their importance.
2. Distillation, typical distillation equipment, principles of stage processes, material balance & enthalpy balances
3. Types of distillation & material balances in plate column
4. liquid-liquid extraction, Applications of Liquid-Liquid Extraction, Principles of Liquid- liquid equilibria, Triangular diagrams, Types or extraction system.

of comminuted products, Energy & Power requirements in comminution, Crushing efficiency

**Course Outcomes ( COs ) :** After completion of the course, students will be able to -

CO1: The students understood about types of mass transfer operations. The students acquire knowledge of application of different types Distillation, typical distillation equipment.

CO2: The students understood about Types of distillation & material balances in plate Column. The students understood about applications of Liquid-Liquid Extraction, Principles of liquid- liquid equilibria, Triangular diagrams, Types or extraction system.

CO3: The students are knowing Principles of Comminution, Criteria for communication, Characteristics of comminuted Products, Energy & Power requirements.

| Module No. | Topics / actual contents of the syllabus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Contact Hours |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| Unit - I   | <p>1. To Perform a experiment on <b>Simple Distillation</b> using binary mixture (<i>Methanol +water or Ethanol+Water</i>) &amp; Verify the Rayleigh's Equation. Calculate the Material Balance for binary mixtures and find The composition of the distillate &amp; the residue.</p> <p>2: To Perform a experiment on <b>Steam Distillation</b> using <i>Turpentine Or Nitrobenzene</i> and Calculate Material Balance for Steam Distillation ..</p> <p>3. To Perform a experiment on <b>Distillation with total reflux</b> using Binary mixture ( <i>Methanol+Water or Ethanol+Water</i>) and Determine theoretical plates by McCabe-Thiele Method.</p> <p>Liquid Extraction:</p> <p>1. To study the experiment on <b>Liquid-Liquid Extraction</b> by using Mixer-Settler System &amp; Calculate Percentage of Extraction of a given liquid.</p> <p>2. To study the <b>Liquid-Liquid Equilibria</b> for three component system (Glacial Acetic Acid +Chloroform+ Distilled Water) and Calculate the Percentage composition of each component at heterogeneous mixture.</p> <p>3. To Separate various types of Organic compounds by control of the <math>P^H</math> of the extraction medium.</p> <p>4. A. Preparation of Column B. Separation and Purification of anti-Azobenzene.</p> | 60 Hrs        |

| B.Sc. Industrial Chemistry (Major) : Semester III                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |
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| Course Code:INC /DSC/P/ 227: Practical based on Ind.Chem./DSC/T/201 Examn. Code : SAC00142273P                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |
| Total Credits : 2                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Total Contact Hours : 60 Hrs |
| Maximum Marks : 50                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |
| <b>Learning Objectives of the Course:</b> The students are expected to learn experimentally- 1. Typical Chemical Process, Classification of reactions, Single & multiple Reactions, Temperature-Dependent Term of a Rate Equation, Batch Reactor, Constant-Volume Batch Reactor.                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |
| <b>Course Outcomes ( COs) :</b> After completion of the course, students will be able to - CO1- learned & Explain typical Chemical Process, Classification of Reactions, Conc. CO2- Dependent term of a rate equation, Single & multiple Reactions, problems on Material Balances without chemical Reaction., can solve the problems/examples on rate of reaction. CO3 : Students knows the first order reversible reactions, Second order reversible reactions. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |
| Module No.                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Topics / actual contents of the syllabus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Contact Hours                |
| Unit - I                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 1. To study the Performance of Batch Reactor :To study the Saponification of Ethyl acetate with NaOH in order to determine Order of reaction (n) & Rate constant (K) using Batch reactor.<br>2. To study the residence time distribution in Mixed Flow Reactor (MFR).<br>3. To study the Performance of Plug Flow Reactor (PFR): To study the Performance of plug flow reactor used and to calculate theoretical & practical conversion for a second order reaction between Ethyl acetate & NaOH.<br>4. To find out Residence time distribution in Plug Flow Reactor or Tubular reactor.<br>5. To study the Performance equation of Coil Tube Reactor (CTR): To study the Performance of coil tube reactor for second order reaction between Ethyl acetate & NaOH.<br>6. To study the First Order Reaction: Hydrolysis of an Ester (Methyl Acetate in presence of HCL).<br>7. To study the Zero Order Reaction: Investigate the kinetics of Iodination of Acetone.<br>8. To Study the Autocatalytic reaction: Reaction between Potassium Permanganate & Oxalic acid.<br>9. To study the Rate of reaction (rA) between Ethylbromoacetate & Sodium thiosulphate kinetically using Batch Reactor.<br>10. To determine the Order of reaction (n) of given reaction Kinetics by using Substitution method, Fractional change method and Differential method,<br>11. To determine the Rate Constant (K) of the reaction between Potassium Persulphate & Potassium Iodide having equal concentration of reacting species (a=b) by using Mixed Reactor,<br>12. To determine the Rate Constant (K) of the reaction between Potassium Persulphate & Potassium Iodide having unequal concentration of reacting species (a≠b) by using Mixed Reactor.<br>13. To determine rate constant (K) of the reaction between Bromic acid and Hydroiodic acid having equal concentration of reacting species (a=b) using Batch reactor.<br>14. To determine the Energy of Activation (Ea.) of hydrolysis of Ethylacetate in presence of NaOH.<br>15. To determine the Energy of Activation (Ea.) of the reaction between Potassium Persulphate & Potassium Iodide. | 60 Hrs                       |
| <b>Text Books:</b> 1. Chemical Reaction Engineering -K.A.Gavhane<br>2. Systematic Experimental Physical Chemistry-S.W.Rajbhoj & T.K.Chondhekar                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |

| <b>Industrial Chemistry (Minor): Semester-III</b><br><b>Course Code: INC/Mn-1/T/ 200 Industrial Instrumentation and Chemical Analysis</b><br><b>Credits-02</b><br><b>Maximum Marks-50</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                            |               |
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| <b>Total Contact Hours-30</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                            |               |
| <b>Learning Objectives of the Course</b><br>The students are expected to learn: <ol style="list-style-type: none"> <li>1. The principles, instrumentation, operation, and applications of chromatographic techniques used for separation and analysis of chemical compounds.</li> <li>2. The fundamentals of modern instrumental analytical methods, including pH measurement, conductivity measurement, optical rotation, and spectrophotometry.</li> <li>3. The theoretical principles and practical applications of spectroscopic techniques for qualitative and quantitative analysis.</li> <li>4. The interpretation of analytical data obtained from chromatographic and spectroscopic methods.</li> <li>5. The selection of suitable analytical techniques for the identification, characterization, and estimation of chemical substances.</li> <li>6. The application of instrumental methods in industrial, environmental, pharmaceutical, and research laboratories.</li> </ol> <b>Course Outcomes (COs):</b><br>After successful completion of the course, students will be able to:<br>CO1: Explain the principles, instrumentation, and applications of chromatographic techniques. CO2: Select and apply appropriate chromatographic methods for the separation, identification, and analysis of chemical compounds.<br>CO3: Describe the principles and applications of optical rotation and spectrophotometric methods in chemical analysis.<br>CO4: Explain the theoretical basis and instrumentation of UV-Visible and Infrared (IR) spectroscopy and interpret simple molecular spectra, analyze the structural characteristics of organic molecules using Nuclear Magnetic Resonance (NMR) spectroscopy and Mass Spectrometry. |                                                                                                                                                                                            |               |
| Module No                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Topic/ Actual Content of syllabus                                                                                                                                                          | Contact hours |
| Unit-I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>Chromatography:</b> Principles, methods and applications of paper chromatography, TLC, GLC, HPLC & GLC.                                                                                 | 10 hrs        |
| Unit-II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Modern instrumental methods of analysis:</b> pH and conductivity measurements with special reference to water and soil analysis, optical rotation of chiral compound, spectrophotometer | 10 hrs        |
| Unit-III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Spectroscopic methods:</b> (theories applications to simple organic molecules) UV-visible spectroscopy, Infra-Red spectroscopy, NMR Spectroscopy, Mass spectroscopy.                    | 10 hrs        |

**Reference books:** 1. Spectroscopy of organic compounds: P.S. Kalsi. 2. Introduction to spectroscopy: B.K. Sharma. 3. **Fundamentals of Molecular Spectroscopy:** C.N. Banwell. 4. **Chromatography: Principles and Applications:** M. S. M. Khan. 5. **Introduction to Modern Liquid Chromatography:** Lloyd R. Snyder, Joseph J. Kirkland, and John W. Dolan. 6. **Instrumental Methods of Chemical Analysis:** Gurdeep R. Chatwal.

| <b>Industrial Chemistry (Minor): Semester-III</b><br><b>Course Code: INC/Mn-1/T/ 201 Electrochemistry</b><br><b>Credits-02</b><br><b>Maximum Marks-50</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                      | <b>Total Contact Hours-30</b> |
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| <b>Learning Objectives of the Course</b><br>The students are expected to learn: <ol style="list-style-type: none"> <li>1. The principles of electrolytic conduction and ionic equilibria in electrolyte solutions.</li> <li>2. The variation of conductance with concentration and the applications of Kohlrausch's law and Ostwald's dilution law.</li> <li>3. The construction, representation, and working of electrochemical cells and the concept of EMF.</li> <li>4. The thermodynamic aspects of electrochemical cells and the significance of electrode potentials. The characteristics and applications of various indicator and reference electrodes.</li> <li>5. The use of EMF measurements in determining pH, valency, and solubility of electrolytes.</li> </ol> <b>Course Outcomes (COs):</b><br>After successful completion of the course, students will be able to:<br><b>CO1:</b> Explain the concepts of electrolytic conductance, ionic mobility, and ionic equilibria in electrolyte solutions. <b>CO2:</b> Apply Kohlrausch's law and Ostwald's dilution law to solve problems related to conductance and dissociation of electrolytes. <b>CO3:</b> Describe the construction and operation of galvanic cells and calculate cell EMF using the Nernst equation. <b>CO4:</b> Correlate cell EMF with thermodynamic parameters such as Gibbs free energy, enthalpy, and entropy changes. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                      |                               |
| <b>Module No</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Topic/ Actual Content of syllabus</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>Contact hours</b> |                               |
| Unit-I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Conductance and Ionic Equilibria: Basic Definitions: Electrolytic conduction, specific conductance, equivalent conductance, and molar conductance. Variation of Conductance: Effect of dilution on strong and weak electrolytes. Kohlrausch's Law: Law of independent migration of ions and its applications for weak electrolytes, solubility product of sparingly soluble salts. Arrhenius Theory: Theory of electrolytic dissociation, its limitations, and Ostwald's Dilution Law                                                                                                 | 10 hrs               |                               |
| Unit-II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Electrochemical Cells and EMF: Galvanic/Voltaic Cells: Reversible and irreversible cells, electrode-electrolyte interface, and conventional cell representation. Electromotive Force (EMF): Definition, measurement using the potentiometric compensation method, and sign conventions. Thermodynamics of Cells: Derivation of the Nernst equation; relationship between cell EMF, free energy change, enthalpy change, and entropy change. Standard Electrode Potential: Standard Hydrogen Electrode (SHE) as reference, electrochemical series, and its thermodynamic significance. | 10 hrs               |                               |
| Unit-III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Electrodes and Concentration Cells<br>Indicator and Reference Electrodes: Metal-metal ion, gas electrodes (Hydrogen, Chlorine), metal-insoluble salt electrodes (Calomel, Silver-Silver Chloride), and Redox electrodes (Quinhydrone). Commercial and Industrial Applications. Batteries and Fuel Cells: Primary cells (Dry cell), secondary cells (Lead-acid accumulator, Lithium-ion battery), and Hydrogen-Oxygen fuel cells.                                                                                                                                                      | 10 Rs                |                               |

Reference Books: 1. Electrochemistry-Samuel Glasstone 2. Modern Electrochemistry (Vol. I & II): John O'M. Bockris and Amulya K.N. Reddy. 3. Electrochemistry: Principles, Methods and Applications: Christopher M.A. Brett and Ana Maria Oliveira Brett. 4. Physical Chemistry: Ira N. Levine.

| <b>Industrial Chemistry: Semester-III</b><br><b>Course Code: INC/GE/O E-3/T/200 Generic/Open Elective (GE/OE): Agrochemical Chemistry</b><br><b>Credits-02</b><br><b>Maximum Marks-50</b><br><b>Total Contact Hours-30</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                               |               |
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| <b>Learning Objectives of the Course</b><br>After studying this course, students will be able to: <ol style="list-style-type: none"> <li>1. Understand the classification of pests and pesticides and their role in crop protection.</li> <li>2. Explain the types, properties, and mode of action of various inorganic and plant-derived insecticides.</li> <li>3. Analyse the environmental and soil impacts of pesticide application.</li> <li>4. Understand the chemistry, manufacture, and applications of chemical fertilizers and biofertilizers.</li> <li>5. Differentiate between chemical fertilizers, biofertilizers, and biopesticides.</li> <li>6. Explain the structure, properties, and mode of action of chlorinated hydrocarbon insecticides.</li> </ol> |                                                                                                                                                                                                                                                                                                                                                               |               |
| <b>Course Outcomes (COs):</b><br>After successful completion of the course, students will be able to:<br><b>CO1:</b> Classify different types of pests and pesticides and explain their modes of action.<br><b>CO2:</b> Describe the chemistry, preparation, and applications of inorganic insecticides and plant-based insecticides.<br><b>CO3:</b> Assess the effects of pesticides on soil health and the environment.<br><b>CO4:</b> Explain the composition, manufacture, and uses of chemical fertilizers and biofertilizers.<br><b>CO5:</b> Apply agrochemical knowledge for sustainable agricultural practices and environmental protection.                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                               |               |
| Module No                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Topic/ Actual Content of syllabus                                                                                                                                                                                                                                                                                                                             | Contact hours |
| Unit-I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Types of pest and pesticides: Stomach poison, contact poisons systemic poisons, fumigants. Effect of pesticides on soil and environment.                                                                                                                                                                                                                      | 10 hrs        |
| Unit-II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Inorganic insecticides: Arsenic insecticides, Paris green, Fluoro-insecticides. Insecticides of plant origin: Nicotine, Nor-nicotine, Pyrethroids, Rotenoids, Anabasin, Aliethrin                                                                                                                                                                             | 10 hrs        |
| Unit-III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Chemical and Biofertilizers: Introduction, Types of fertilizer, direct application fertilizers, mixed fertilizers (nitrogen, phosphorus and potassium sources, ammoniation), controlled release fertilizers and biofertilizers, liquid vs solid fertilizers, biopesticides. Chlorinated hydrocarbons: DDT, Nestran, DFDT, SAR in the class and mode of action | 10 Hrs        |

Reference Books: 1. **Agrochemicals and Pest Management** : A.K. Srivastava. 2. **Agrochemicals-Composition, Production, Toxicology and Applications** : T.S.S. Dikshit and P.C. Diwan. 3. **Introduction to Agrochemicals** : P.C. Jain and Monica Jain. 4. **Pesticides and the Environment**: R. White-Stevens. 5. **Handbook of Fertilizers** : G. Stuart Hill.

| <p align="center"><b>B.Sc. Industrial Chemistry (Major) : Semester II</b></p> <p><b>Course Code:</b>INC /VSC/T/ 200 : <b>Industrial Water Treatments</b> Examn. Code : SEC00142003T</p> <p>Total Credits : 1 Total Contact Hours : 15 Hrs</p> <p>Maximum Marks : 50</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                  |               |
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| <p><b>Learning Objectives of the Course:</b></p> <p>The students are expected to learn -</p> <ol style="list-style-type: none"> <li>1. Water treatment Process and chemical methods of sterilization.</li> <li>2. Physical methods of sterilization &amp; Determination of hardness of water.</li> <li>3. Industrial water treatment- removal of iron, removal of silica, removal of dissolved oxygen.</li> </ol> <p><b>Course Outcomes ( COs) :</b> After completion of the course -</p> <p><b>CO1 :</b> The students are learned typical chemical methods of stillization</p> <p><b>CO2 :</b> Physical methods of sterilization &amp; Determination of hardness of water</p> <p><b>CO3 :</b> Industrial water treatment- removal of iron, removal of silica, removal of dissolved oxygen.</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                  |               |
| Module No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Topics / actual contents of the syllabus                                                                                                                                                                                                                                                                                                                                                                                                         | Contact Hours |
| Unit - I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Unit 1 - Water treatment</b> – Water for Industry, Chemistry of water, water as a solvent, Main quality characteristics of water, Potability of water, Coagulation of water, Contact and electrochemical coagulation, Flocculants, Sterilisation and disinfection of water, Chemical methods of sterilization                                                                                                                                 | 5 Hrs         |
| Unit - II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>Physical methods of sterilization</b> -Softening of water, Lime Soda Process, Modified lime soda process, Ion exchange process, Demineralization of water, Determination of hardness-1) Calculation method, 2) Titration method, 3) Soap method 4) Complexometric method.                                                                                                                                                                     | 4 Hrs         |
| Unit - III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Industrial water treatment</b> - removal of iron, removal of silica, removal of dissolved oxygen, Removal of slime and algae from water,removal of smack and odour from water, deareation and deoxygenation of water, Chemical deoxygenation of water, removal of gas from water, Electrodialysis method, Reverse Osmosis method , Removal of iron and manganese from water, removal of silicic acid from water, Magnetic treatment of water. | 6 Hrs         |
| <p><b>TextBooks:</b> 1 Industrial Chemistry- B.K.Sharma, Goel publishing House, Meerut.</p> <p>1. Environmental Chemistry- B.K.Sharma, Goel publishing House, Meerut</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                  |               |
| <p><b>Reference Books:</b>1. Industrial Chemistry- B.K.Sharma, Goel publishing House, Meerut. 2. Environmental Chemistry- B.K.Sharma, Goel publishing House, Meerut Stocchi,E.(1990),IndustrialChemistry,Vol-I, EllisHorwoodLtd.UK. Kent,J.A.(ed)(1997),Riegel'sHandbookofIndustrialChemistry,CBSPublishers,New Delhi. Pani,B.(2017),TextbookofEnvironmentalChemistry,I.K.InternationalPublishingHouse. De,A.K.(2012),EnvironmentalChemistry,NewAgeInternationalPvt,Ltd,NewDelhi. Khopkar,S.M.(2010),EnvironmentalPollutionAnalysis,NewAgeInternationalPublisher.</p>                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                  |               |

| <b>B.Sc. Industrial Chemistry (Major) : Semester III</b><br><b>Course Code:INC /VSC/T/ 201 : Industrial Wastes and Treatment Process</b><br>Examn. Code : SEC00142013T<br>Total Credits : 1<br>Maximum Marks : 50<br>Total Contact Hours : 15 Hrs                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |               |
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| <b>Learning Objectives of the Course:</b><br>The students are expected to learn –<br>1. Characteristics of Industrial Wastes, Types of Industrial Wastes , Solid Industrial Wastes, Principles of Industrial Waste Treatment, Characteristics of Industrial effluent .<br>2. Basic trends in Biosphere protection for Industrial Wastes, Protection of Surface waters from Pollution with Industrial Sewage, Methods of sewage treatment, Removal of suspended matter, Extraction of Pollutants, Adsorption of Pollutants,<br>3. Methods of biological treatment, Classification of Industrial wastes, General methods used for treatment of industrial wastes, Treatment of wastes or effluents with organic impurities, Treatment of wastes or effluents with inorganic impurities.            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |               |
| <b>Course Outcomes ( COs) :</b> After completion of the course -<br><b>CO1:</b> Characteristics of Industrial Wastes, Types of Industrial Wastes , Solid Industrial Wastes, Principles of Industrial Waste Treatment, Characteristics of Industrial effluent .<br><b>CO2:</b> Basic trends in Biosphere protection for Industrial Wastes, Protection of Surface waters from Pollution with Industrial Sewage, Methods of sewage treatment, Removal of suspended matter, Extraction of Pollutants, Adsorption of Pollutants.<br><b>CO3 :</b> Methods of biological treatment, Classification of Industrial wastes, General methods used for treatment of industrial wastes, Treatment of wastes or effluents with organic impurities, Treatment of wastes or effluents with inorganic impurities. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |               |
| Module No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Topics / actual contents of the syllabus                                                                                                                                                                                                                                                                                                                                                                                                                                       | Contact Hours |
| <b>Unit - I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>Introduction-</b> Characteristics of Industrial Wastes, Types of Industrial Wastes , Solid Industrial Wastes, Principles of Industrial Waste Treatment, Characteristics of Industrial effluent and sewage in India, Waste strength reduction methods.                                                                                                                                                                                                                       | <b>5 Hrs</b>  |
| <b>Unit - II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Protection of Biosphere-</b> Basic trends in Biosphere protection for Industrial Wastes, Protection of Surface waters from Pollution with Industrial Sewage, Methods of sewage treatment, Removal of suspended matter, Extraction of Pollutants, Adsorption of Pollutants, Distillation of Pollutants with steam, Neutralisation of acids and bases, Floatation, Chlorination, Chemical treatment, Crystallisation, Biological treatment of sewage, Fermentation of sewage. | <b>5 Hrs</b>  |
| <b>Unit - III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Treatment and Disposal of Industrial Wastes-</b> Methods of biological treatment, Classification of Industrial wastes, General methods used for treatment of industrial wastes, Treatment of wastes or effluents with organic impurities, Treatment of wastes or effluents with inorganic impurities.                                                                                                                                                                       | <b>5 Hrs</b>  |
| <b>TextBooks:</b> 1 . Industrial Chemistry- B.K.Sharma, Goel publishing House, Meerut. 2 Environmental Chemistry- B.K.Sharma, Goel publishing House, Meerut                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |               |
| <b>Reference Books:</b> 1 . Industrial Chemistry- B.K.Sharma, Goel publishing House, Meerut. 2 . Environmental Chemistry- B.K.Sharma, Goel publishing House, Meerut Stocchi, E.(1990), Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK. Kent, J.A.(ed)(1997), Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi. Pani, B.(2017), Textbook of Environmental Chemistry, I.K. International Publishing House. De, A.K.(2012), Environmental Chemistry, New Age International Pvt, Ltd, New Delhi. Khopkar, S.M.(2010), Environmental Pollution Analysis, New Age International Publisher.                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |               |



| <p align="center"><b>B.Sc. Industrial Chemistry (Major) : Semester III</b><br/> <b>Course Code:INC/VSC/P/ 226 : Practicals based on Ind.Chem/VSC/T/ 200</b><br/> Examn. Code : SEC00142263P<br/> Total Credits : 1<br/> Maximum Marks : 50<br/> Total Contact Hours : 30 Hrs</p>                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |               |
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| <p><b>Learning Objectives of the Course:</b><br/> The students are expected to learn practical skills on-<br/> Determination of Hardness of water by complexometry method/by EDTA method, Determination of Alkalinity of waste water, Determination of dissolved oxygen in water, Determination of Chemical Oxygen Demand(COD), Determination of Biological Oxygen Demand(BOD), Percentage of available chlorine in bleaching powder.</p>                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |               |
| <p><b>Course Outcomes ( COs) :</b> After completion of the course , the students are able to know the skills related to waste water treatments.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |               |
| Module No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Topics / actual contents of the syllabus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Contact Hours |
| Unit - I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <ol style="list-style-type: none"> <li>1. Determination of Hardness of water by complexometry method/by EDTA method.</li> <li>2. Determination of Alkalinity of waste water.</li> <li>3. Determination of dissolved oxygen in water.</li> <li>4. Determination of Chemical Oxygen Demand(COD)</li> <li>5. Determination of Biological Oxygen Demand(BOD)</li> <li>6. Percentage of available chlorine in bleaching powder.</li> <li>7. Measurement of chloride, sulphate and salinity of waste/water samples by simple titration method. (AgNO<sub>3</sub>) and potassium chromate)</li> <li>8. Estimation of total alkalinity of water samples (CO<sub>3</sub><sup>2-</sup>,HCO<sub>3</sub><sup>-</sup>) using double titration method.</li> <li>9. Isolation of compound using solvent extraction method.</li> </ol> | 30Hrs         |
| <p><b>TextBooks:</b> 1 . Industrial Chemistry- B.K.Sharma, Goel publishing House, Meerut. 2 . Environmental Chemistry- B.K.Sharma, Goel publishing House, Meerut Systematic Experiments in Engineering Chemistry-S.S.Dara</p>                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |               |
| <p><b>Reference Books:</b>1 . Industrial Chemistry- B.K.Sharma, Goel publishing House, Meerut. 2 . Environmental Chemistry- B.K.Sharma, Goel publishing House, Meerut<br/> Stocchi, E. (1990), <b>Industrial Chemistry</b>, Vol-I, Ellis Horwood Ltd. UK.c<br/> Kent, J.A. (ed) (1997), <b>Riegel's Handbook of Industrial Chemistry</b>, CBS Publishers, New Delhi. Pani, B. (2017), <b>Textbook of Environmental Chemistry</b>, I.K. International Publishing House. De, A.K. (2012), <b>Environmental Chemistry</b>, New Age International Pvt. Ltd, New Delhi.<br/> Khopkar, S.M. (2010), <b>Environmental Pollution Analysis</b>, New Age International Publisher.</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |               |

| <p align="center"><b>B.Sc. Industrial Chemistry (Major) : Semester III</b></p> <p><b>Course Code:</b> INC /VSC/P/ 227: <b>Practicals</b> based on Ind.Chem/VSC/T/ 201</p> <p align="right">Examn. Code: SEC00142273P</p> <p>Total Credits : 1 <span style="float:right">Total Contact Hours : 30 Hrs</span></p> <p>Maximum Marks : 50</p>                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |               |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| <p><b>Learning Objectives of the Course:</b></p> <p>The students are expected to learn practical skills on-</p> <p>Determination of Hardness of water by complexometry method/by EDTA method, Determination of Alkalinity of waste water, Determination of dissolved oxygen in water, Determination of Chemical Oxygen Demand(COD), Determination of Biological Oxygen Demand(BOD), Percentage of available chlorine in bleaching powder.</p> <p><b>Course Outcomes ( COs) :</b> After completion of the course , the students are able to know the skills related to waste water treatments.</p>                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |               |
| Module No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Topics / actual contents of the syllabus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Contact Hours |
| Unit - I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <ol style="list-style-type: none"> <li>1. Determination of Hardness of water by complexometry method/by EDTA method.</li> <li>2. Determination of Alkalinity of waste water.</li> <li>3. Determination of dissolved oxygen in water.</li> <li>4. Determination of Chemical Oxygen Demand(COD)</li> <li>5. Determination of Biological Oxygen Demand(BOD)</li> <li>6. Percentage of available chlorine in bleaching powder.</li> <li>7. Measurement of chloride, sulphate and salinity of waste/water samples by simple titration method. (AgNO<sub>3</sub>) and potassium chromate)</li> <li>8. Estimation of total alkalinity of water samples (CO<sub>3</sub><sup>2-</sup>, HCO<sub>3</sub><sup>-</sup>) using double titration method.</li> <li>9. Isolation of compound using solvent extraction method.</li> </ol> | 30Hrs         |
| <p><b>TextBooks:</b> 1 . Industrial Chemistry- B.K.Sharma, Goel publishing House, Meerut. <span style="float:right">2 .</span><br/> Environmental Chemistry- B.K.Sharma, Goel publishing House, Meerut<br/> Systematic Experiments in Engineering Chemistry-S.S.Dara</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |               |
| <p><b>Reference Books:</b>1 . Industrial Chemistry- B.K.Sharma, Goel publishing House, Meerut. <span style="float:right">2 .</span><br/> Environmental Chemistry- B.K.Sharma, Goel publishing House, Meerut<br/> Stocchi, E. (1990), <b>Industrial Chemistry</b>, Vol-I, Ellis Horwood Ltd. UK.<br/> Kent, J.A. (ed) (1997), <b>Riegel's Handbook of Industrial Chemistry</b>, CBS Publishers, New Delhi. Pani, B. (2017),<br/> <b>Textbook of Environmental Chemistry</b>, I.K. International Publishing House. De, A.K. (2012),<br/> <b>Environmental Chemistry</b>, New Age International Pvt, Ltd, New Delhi.<br/> Khopkar, S.M. (2010), <b>Environmental Pollution Analysis</b>, New Age International Publisher.</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |               |

| <b>Industrial Chemistry (AEC, VEC, IKS): Semester-III</b><br><b>Course Code: INC/AEC-3/ T/200</b><br><b>Credits-02</b><br><b>Maximum Marks-50</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                     |               | <b>Computational Chemistry</b><br><b>Total Contact Hours-30</b> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-----------------------------------------------------------------|
| <b>Learning Objectives of the course:</b> <ol style="list-style-type: none"> <li>1. Understand the basic interface and tools of chemical drawing and molecular visualization software.</li> <li>2. Draw and edit chemical structures using software such as Chem-Draw, PyMOL, and ArgusLab.</li> <li>3. Generate molecular properties such as IUPAC names, molecular formulae, and molecular weights.</li> <li>4. Visualize molecular structures and predict basic physical properties.</li> <li>5. Understand the fundamentals of Molecular Dynamics (MD) simulations.</li> </ol> <b>Course Outcomes (COs):</b> <b>CO1:</b> Use chemical drawing software to create and edit molecular structures. <b>CO2:</b> Apply software tools for structure clean-up, visualization, and molecular representation. <b>CO3:</b> Generate and interpret molecular properties including IUPAC names, molecular formulae, and molecular weights. <b>CO4:</b> Utilize molecular visualization software to study molecular geometry and properties. |                                                                                                                                                                                                                                                     |               |                                                                 |
| Module No                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Topic/ Actual Content of syllabus                                                                                                                                                                                                                   | Contact hours |                                                                 |
| Unit-I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Interface Basics: Navigating the toolbar, drawing rings (benzene, cyclohexane), and adding heteroatoms (O, N, S). Tools: Using the bond tool, text tool (for labels), and eraser. Structure Clean-Up: Automatically fixing bond angles and lengths. | 10 hrs        |                                                                 |
| Unit-II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Structure Visualization: Use of software (e.g., Chem-Draw, PyMOL, Argus Lab) to design molecules and predict physical properties. Property Prediction: Generating IUPAC names, molecular weight, and chemical formulas from a drawn structure       | 10 hrs        |                                                                 |
| Unit-III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Molecular Dynamics (MD): Simulating the behavior of materials, polymers, and catalysts at the atomic level. QSAR: Quantitative Structure-Activity Relationship models used in industrial drug discovery and agrochemical design.                    | 10 hrs        |                                                                 |

Reference Books: 1. **Essentials of Computational Chemistry: Theories and Models:** Christopher J. Cramer.

2. **Molecular Modeling Basics** : Jan H. Jensen.

3. **Computational Drug Design: A Guide for Computational and Medicinal Chemists:** David C. Young.

4. **Molecular Modelling: Principles and Applications** — *Andrew R. Leach.*

| <b>Industrial Chemistry (AEC, VEC, IKS): Semester-III</b><br><b>Course Code: INC/AEC-3/ T/201</b><br><b>Credits-02</b><br><b>Maximum Marks-50</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                      |               | <b>Environmental studies-1</b><br><b>Total Contact Hours-30</b> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-----------------------------------------------------------------|
| <b>Learning Objectives:</b><br>After completing this unit, students will be able to: <ol style="list-style-type: none"> <li>1. Understand the basic principles and importance of Green Chemistry in sustainable development.</li> <li>2. Explain the concept of Atom Economy and its role in efficient chemical synthesis.</li> <li>3. Understand strategies for prevention of chemical waste generation.</li> <li>4. Identify methods for designing less hazardous and environmentally safe chemical processes.</li> <li>5. Select safer solvents and reaction conditions for green chemical processes</li> </ol> |                                                                                                                                                                                                                                                                                                                                                                      |               |                                                                 |
| <b>Course Outcomes (COs):</b> CO1: Explain the fundamental principles of Green Chemistry and its importance in sustainable chemical processes.<br>CO2: Apply the concept of atom economy to evaluate efficiency of chemical reactions.<br>CO3: Describe methods for prevention of chemical waste and reduction of hazardous substances.<br>CO4: Select safer solvents and energy-efficient methods for green chemical synthesis.<br>CO5: Interpret Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) in water quality analysis.                                                                     |                                                                                                                                                                                                                                                                                                                                                                      |               |                                                                 |
| Module No                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Topic/ Actual Content of syllabus                                                                                                                                                                                                                                                                                                                                    | Contact hours |                                                                 |
| Unit-I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Principles of Green Chemistry Atom Economy: Designing reactions so the maximum amount of starting materials ends up in the final product. Prevention: It is better to prevent waste than to treat or clean up waste after it is formed, Less Hazardous Chemical Syntheses: Using and generating substances with little or no toxicity to humans and the environment. | 10 hrs        |                                                                 |
| Unit-II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Safer Solvents: Avoiding auxiliary substances (like toxic organic solvents) or choosing harmless alternatives like water.<br>Design for Energy Efficiency: Running chemical reactions at room temperature and atmospheric pressure whenever possible to save power.                                                                                                  | 10 hrs        |                                                                 |
| Unit-III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | BOD & COD : The amount of dissolved oxygen needed by aerobic biological organisms to break down organic material in water. The amount of oxygen required to chemically oxidize all organic matter in water using a strong oxidizing agent (like potassium dichromate.                                                                                                | 10 hrs        |                                                                 |

Reference Books: 1. **Green Chemistry: Theory and Practice** -Paul T. Anastas & John C. Warner. 2. **Fundamentals of Environmental Chemistry**: Stanley E. Manahan.  
 3. **Introduction to Green Chemistry**: Albert Matlack.

**B.Sc. Industrial chemistry AEDP IV<sup>th</sup> Semester:**

| Course type                                                                                                         | Course Code        | Course Name                                | Teaching Scheme (Hrs/week) |           | Credits Assigned |           | Total Credits |
|---------------------------------------------------------------------------------------------------------------------|--------------------|--------------------------------------------|----------------------------|-----------|------------------|-----------|---------------|
|                                                                                                                     |                    |                                            | Theory                     | Practical | Theory           | Practical |               |
| Industrial Chemistry (Major) Mandatory SUB/DSC                                                                      | INC/DSC-9/ T/250   | Unit operation-II                          | 2                          |           | 2                |           | 2+2+2+2=08    |
|                                                                                                                     | INC /DSC-10/T/25 1 | Chemical Reaction Engineering-I            | 2                          |           | 2                |           |               |
|                                                                                                                     | INC /DSC-11/P/ 276 | Practical based on Ind.Chem/DSC-9/T/2 00   |                            | 4         |                  | 2         |               |
|                                                                                                                     | INC /DSC-12/P/ 277 | Practical based on Ind.Chem./DSC-10/T/ 201 |                            | 4         |                  | 2         |               |
| Industrial Chemistry (Minor)                                                                                        | INC/Mn-3/T/ 250    | Organic Molecular Design                   | 2                          |           | 2                |           | 2+2= 04       |
|                                                                                                                     | INC /Mn-4/T/ 251   | Chemistry of Named reaction                | 2                          |           | 2                |           |               |
| Generic/Open elective (GE/OE)                                                                                       | INC/GE/O E-4/T/250 | Material Science & Heavy Organic Chemicals | 2                          |           | 2                |           | 02            |
| SEC (Skill Enhancement Courses) (Choose any one from SUB/SEC/T/2 50and SUB/SEC/T/ 251) and corresponding Practicals | INC/ SEC-3/T/ 250  | Industrial Water Treatments                | 1                          |           | 1                |           | 1+1=02        |
|                                                                                                                     | INC/ SEC-3/T/ 251  | Industrial Wastes & Treatments             | 1                          |           | 1                |           |               |
|                                                                                                                     | INC/ SEC-4/P/ 276  | Practicals based on Ind.Chem/SEC-3/T/ 200  |                            | 2         |                  | 1         |               |
|                                                                                                                     | INC/VSC/P / 277    | Practicals based on Ind.Chem /SEC-3/T/ 201 |                            | 2         |                  | 1         |               |
| AEC, VEC, IKS                                                                                                       | INC/VEC-4/ T/250   | Enzyme chemistry                           | 2                          |           | 2                |           | 2+2=04        |
|                                                                                                                     | INC/VEC-4/ T/251   | Pharmaceutical Chemistry                   | 2                          |           | 2                |           |               |
| OJT/ FP/CEP/CC/RP                                                                                                   | INC/CEP-1/ 276     | Community Engagement Service               |                            | 4         |                  | 2         | 02            |
|                                                                                                                     | CC-4               | Visual Pollution                           |                            | 4         |                  | 2         |               |
|                                                                                                                     |                    |                                            | <b>13</b>                  | <b>18</b> | <b>13</b>        | <b>09</b> | <b>22</b>     |

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| <b>B.Sc. Industrial Chemistry (Major) : Semester IV</b><br><b>Course Code: INC/DSC/T/250 ; Unit Operation-2 Examn. Code : SAC00142504T</b><br><b>Total Credits : 2 Total Contact Hours : 30 Hrs</b><br><b>Maximum Marks : 50</b>                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |               |
| <b>Learning Objectives of the Course:</b><br>The students are expected to learn- <ol style="list-style-type: none"> <li>1. Design towers of gas absorption, Principles of absorption &amp; Types of Evaporators, Performance</li> <li>2. Principles of Crystallization, Purity of Product,</li> <li>3. Principles of Drying- Temperature Pattern in dryers,</li> </ol> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |               |
| <b>Learning Outcomes of the Course:</b> The students know the- <b>CO1:</b> Design towers of gas absorption, Principles of absorption & Types of Evaporators, Performance. <b>CO2:</b> Principles of Crystallization, Purity of Product. <b>CO3:</b> Principles of Drying- Temperature Pattern in dryers.                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |               |
| Module No.                                                                                                                                                                                                                                                                                                                                                             | Topics / actual contents of the syllabus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Contact Hours |
| Unit - I                                                                                                                                                                                                                                                                                                                                                               | <b>Gas Absorption &amp; Evaporation-</b> Introduction, Design Towers, Contact between Liquid & Gas, Pressure drop & limiting now rates, Principles of absorption material balances, Limiting gas-liquid ratio, Temperature variations in packed towers, Rate of absorption, Calculation of tower height, Number of Transfer units.<br><b>Evaporation-</b> Introduction, Liquid Characteristics, Types of Evaporators, Performance of Tubular Evaporators, Evaporator Capacity, Boiling Point Elevation and Duhring Rule, Effect of liquid head & friction on temperature drop, Heat Transfer Coefficient, Overall Coefficient, Evaporator economy, Enthalpy balance for single effect evaporator, Enthalpy balance with negligible heat of dilution, Single effect calculations, Multiple effect evaporators, Methods of feeding. | 10 Hrs        |
| Unit - II                                                                                                                                                                                                                                                                                                                                                              | <b>Crystallization</b> -Importance of Crystal Size. Crystal Geography, Crystallographic systems, Invariant Crystals, Principles of Crystallization, Purity of Product, Equilibria & its yields, Enthalpy Balances, Super Saturation, Units of Super Saturation, Temperature differential as a potential, Nucleation-Origins of Crystals in crystallizers, Primary nucleation, Homogeneous nucleation, Equilibrium, Kelvin Equation, Rate of nucleation, Heterogeneous nucleation, Secondary nucleation, Contact nucleation, Crystal Growth-Individual & overall Growth Coefficients, Growth Rate, Mass Transfer Coefficient, Surface Growth Coefficient, AL law of crystal growth, Crystallization Equipment-variations in crystallizers, Vacuum Crystallizers, Draft Tube Baffle Crystallizer, Yield of Vacuum Crystallizer.     | 10 Hrs        |
| Unit - III                                                                                                                                                                                                                                                                                                                                                             | <b>Drying of Solids</b> - Introduction, classification of dryers, Principles of Drying- Temperature Pattern in dryers, Heat Transfer in dryers, Heat duty, Heat Transfer Coefficient, Heat Transfer Units, Mass Transfer in Dryers, Phase Equilibria-equilibrium moisture and free moisture, Bound & unbound water, Cross circulating drying-constant drying conditions, Rate of drying, Constant rate period, Critical Moisture Content & Falling Rate Period, Calculation of Drying Time under constant drying conditions, Drying Equipments- Dryers for Solids & Pastes, Dryers for Solutions & Slurries.                                                                                                                                                                                                                      | 10 Hrs        |
| <b>TextBooks:</b> Unit Operations of Chemical Engineering- W.L.McCabe, J.C.Smith, PierHarriott 2. Mass Transfer Operations- Robben E.Treybal                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |               |

| <p align="center"><b>B.Sc. Industrial Chemistry (Major) : Semester IV</b></p> <p align="center"><b>Course Code:INC /DSC/T/ 251: Chemical Reaction Engineering-2 Exam. Code : SAC00142514T</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                              |
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| Total Credits : 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Total Contact Hours : 30 Hrs |
| Maximum Marks : 50                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                              |
| <p><b>Learning Objectives of the Course:</b> The students are expected to learn-</p> <ol style="list-style-type: none"> <li>1. Broad Classification of Reactor Types &amp; types of Ideal Reactors,</li> <li>2. Single Reactors, Batch Reactor, Mixed versus Plug flow Reactors,</li> <li>3. Multiple reactions &amp; Basics of Non-Ideal Flow.</li> </ol> <p><b>Learning Outcomes of the Course:</b> The students know the-</p> <p>CO1: Reactor Types &amp; Types of Ideal Reactors,<br/> CO2: Types Batch Reactor, Mixed versus Plug flow Reactors,<br/> CO3: Multiple reactions &amp; Basics of Non-Ideal Flow.</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                              |
| Module No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Topics / actual contents of the syllabus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Contact Hours                |
| Unit - I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>Introduction to Reactor Design &amp; Ideal Reactors for a Single Reaction</b> - Broad Classification of Reactor Types, Material balance for an element of Volume of the reactor, Energy balance for an element of Volume. Three types of Ideal Reactors, Ideal Batch Reactor, Space Time & Space Velocity, Steady State Mixed Flow Reactor, (Example 5.1, Example 5.3), Steady State Plug Flow Reactor, (Example 5.5), Holding Time & Space Time for flow reactors.                                                                                                     | 10 Hrs                       |
| Unit - II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>Design for Single Reactions -</b><br>Size Comparison of Single Reactors, Batch Reactor, Mixed versus Plug flow Reactors, First & Second Order Reactions. Multiple- Reactor Systems-Plug flow reactors in series and or in parallel, (Example 6.1), Equal size Mixed Flow Reactors in Series, First Order Reaction, Mixed Flow Reactors of Different sizes in Series, finding the conversion in a given system, Determining the Best System for a given conversion, Maximization of Rectangles, Reactors of types in series, Recycle Reactor & its performance equation. | 10 Hrs                       |
| Unit - III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Design for Parallel Reactions &amp; Basics of Non-Ideal Flow -</b><br>Introduction to Multiple Reactions-Qualitative Discussions about Product Distribution. The Residence Time Distribution (RTD), E, The Age Distribution of Fluid, Relation among F, C and E curve and 'mean time' for closed vessel.                                                                                                                                                                                                                                                                | 10 Hrs                       |
| <p><b>TextBooks:</b> Unit Operations of Chemical Engineering- W.L.McCabe, J.C.Smith, PierHarriott 2.<br/> Mass Transfer Operations- Robben E.Treybal</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                              |

| <p align="center"><b>B.Sc. Industrial Chemistry (Major) : Semester IV</b><br/> <b>Course Code: INC/DSC/P/ 276 : Practical based on Ind.Chem/DSC/T/ 250</b><br/> <b>Examn. Code : SAC00142764P</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                              |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|
| Total Credits : 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Total Contact Hours : 60 Hrs |
| Maximum Marks : 50                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                              |
| <p><b>Learning Objectives of the Course:</b><br/> The students are expected to learn experimentally -<br/> 1. General Principles of mass transfer operations, types of mass transfer operations &amp; their importance.<br/> 2. Distillation, typical distillation equipment, principles of stage processes, material balance &amp; enthalpy balances<br/> 3. Types of distillation &amp; material balances in plate column &amp; liquid-liquid extraction, Applications of Liquid-Liquid Extraction, Principles of Liquid-liquid equilibria, Triangular diagrams, Types of extraction system.</p>                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                              |
| <p><b>Course Outcomes ( COs ) :</b> After completion of the course, students will be able to -<br/> <b>CO1:</b> The students understood about types of mass transfer operations. The students acquire knowledge of application of different types Distillation, typical distillation equipment.<br/> <b>CO2:</b> The students understood about Types of distillation &amp; material balances in plate Column. The students understood about applications of Liquid-Liquid Extraction, Principles of liquid-liquid equilibria, Triangular diagrams, Types of extraction system.<br/> <b>CO3:</b> The students are knowing Principles of Comminution, Criteria for comminution, Characteristics of comminuted Products, Energy &amp; Power requirements.</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                              |
| Module No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Topics / actual contents of the syllabus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Contact Hours                |
| <b>Unit - I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <p>Selection of Solvent for Recrystallization-</p> <ol style="list-style-type: none"> <li>Find &amp; report boiling point, Freezing point, Water soluble, Dielectric /constant, Flammable, Specific gravity of different solvents use for recrystallization like-Water, Ethanol, Methanol, Petroleum ether, Cyclohexane, Toluene, Diethyl ether, Tetrahydrofuran, 1- Dioxane, Dichloromethane, Chloroform, Carbontetrachloride, Ethyl acetate, Acetone, Acetic Acid.</li> </ol> <p>1 Crystallization &amp; Recrystallization of Impure Solids. 1. Benzoic acid 2. Acetanilide 3. Naphthalene, 4. CuSO<sub>4</sub> 5. Alum</p> <p>2. Sublimation</p> <p>Drying:</p> <ol style="list-style-type: none"> <li>To study the <b>Rate of Drying</b> of solid substances ( Saw dust or CardBoard)</li> <li>To study the Rate of Drying/ Evaporation of Liquid substances.</li> <li>To study the rate of drying in Tray Dryer.</li> </ol> | 60 Hrs                       |
| <p><b>TextBooks:</b> 1 Unit Operations-II-K.A.Gavhane 2. Systematic Experimental Physical Chemistry-S.W.Rajbhoj &amp; T.K.Chondhekar, 3. Practical Chemistry-S.Umar, J.Sardar &amp; A.Muley, 4. Experiments and Calculations in Engineering Chemistry- S.S.Dara. 5. Experimental Industrial Chemistry - P.S.Mane</p>                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                              |
| <p><b>Reference Books:</b> 1. University Practical Chemistry, Vishal Publishing Co., Jalandhar -I.C.Kamboj -</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                              |

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| <p align="center"><b>B.Sc. Industrial Chemistry (Major) : Semester IV</b><br/> <b>Course Code:INC /DSC/P/ 277: Practical based on Ind.Chem/DSC/T/ 251</b><br/> <b>Examn. Code : SAC00142774P</b></p>                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |               |
| <p>Total Credits : 2<br/> Maximum Marks : 50<br/> Total Contact Hours : 60 Hrs</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |               |
| <p><b>Learning Objectives of the Course:</b><br/> The students are expected to learn experimentally-<br/> Typical Chemical Process, Classification of reactions, Therateequation, Concentration-Dependent Term ofarateequation, Single &amp;multiple Reactions, Temperature-Dependent Term of a Rate Equation, Introduction ofBatchReactor.Constant-Volume BatchReactor, First Order Reversible Reactions, Second Order Reversible Reactions,</p>                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |               |
| <p><b>Course Outcomes ( COs) :</b> After completion of the course, students will be able to -<br/> The students are learned typical Chemical Process, Classification of<br/> Reactions. The students can explain the rate equation, Concentration-Dependent term of a rate equation, Single &amp; multiple Reactions, The students can solve the problems on Material Balances without chemical Reaction. The students can solve the problems/examples on rate of reaction. Students knows the first order reversible reactions, Second order reversible reactions.</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |               |
| Module No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Topics / actual contents of the syllabus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Contact Hours |
| Unit - I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <ol style="list-style-type: none"> <li>1. To study the Performance of Batch Reactor :To study the Saponification of Ethyl acetate with NaOH in order to determine Order of reaction (n) &amp; Rate constant(K) using Batch reactor.</li> <li>2. To study the residence time distribution in Mixed Flow Reactor (MFR).</li> <li>3. To study the Performance of Plug Flow Reactor (PFR): To study the Performance of plug flow reactor used and to calculate theoretical &amp; practical conversion for a second order reaction between Ethyl acetate &amp; NaOH.</li> <li>4. To find out Residence time distribution in Plug Flow Reactor or Tubular reactor.</li> <li>5. To study the Performance equation of Coil Tube Reactor (CTR): To study the Performance of coil tube reactorfor second order reaction between Ethyl acetate &amp; NaOH.</li> <li>6. To study the First Order Reaction: Hydrolysis of Ester ( Methyl Acetate in presence of (HCL).</li> <li>7. To study the Zero Order Reaction: Investigate the kinetics of Iodination of Acetone.</li> <li>8. To Study the Autocatalytic reaction: Reaction between Potassium Permanganate &amp; Oxalicacid.</li> <li>9. To study the Rate of reaction (rA) between Ethyl bromoacetate &amp; Sodium thiosulphate kinetically usingBatch Reactor.</li> <li>10.To determine the Order of reaction (n) of given reaction Kinetics by using Substitution method, Fractional change method and Differential method,</li> <li>11.To determine the Rate Constnt (K) of the reaction between Potassium Persulphate &amp;Potassium Iodide having equal concernmion of reacting species(n-b) by using Mixed Reactor,</li> <li>12. To determine the Rate Constant (K) of the reaction between Potassium Persulphate &amp;Potassium Iodidehaving unequal concnrration ofreacting species(a=b) byusing Mixed Reactor.</li> <li>13. To determine rate constant (K) of the reaction between Bromic acid and Hydroiodic acid having equal concentration of reacting species (a=b) using Batch reactor.</li> <li>14.To determine the Energy of Activation (Ea.) of hydrolysis of Ethylacetate in presence of NaOH.</li> <li>15.To determine the Energy of Activation (Ea.) of the reaction between Potassium Persulphete &amp; Potassium Iodide.</li> </ol> | 60 Hrs        |
| <p><b>TextBooks:</b> 1. Chemical Reaction Engineering -K.A.Gavhane<br/> 2. Systematic Experimental PhysicalChemistry-S.W.Rajbhoj &amp; T.K.Chondhekar</p>                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |               |

| Industrial Chemistry (Minor): Semester-IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                      | Organic Molecular Design |
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| Course Code: INC/Mn-3/T/ 250                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                      | Total Contact Hours-30   |
| Credits-02                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                      |                          |
| Maximum Marks-50                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                      |                          |
| <b>Learning Objectives:</b><br>After studying this unit, students will be able to:<br>1.Understand the basic logic and planning of organic synthesis.<br>2.Differentiate between linear and convergent synthetic strategies.<br>3.Apply retrosynthetic analysis for designing synthetic routes of target molecules.<br>4.Identify synthons and synthetic equivalents in organic synthesis.<br>5.Use molecular symmetry to simplify synthetic pathways.                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                      |                          |
| <b>Course Outcomes (COs):</b> <b>CO1:</b> Explain the fundamental concepts of synthetic design and retrosynthetic analysis. <b>CO2:</b> Differentiate between linear and convergent synthesis based on efficiency and step economy. <b>CO3:</b> Apply retrosynthetic disconnection strategies for designing organic synthesis routes. <b>CO4:</b> Identify and use synthons and synthetic equivalents in planning organic reactions. <b>CO5:</b> Design synthetic pathways for alcohols, ethers, alkyl halides, and organometallic-based products. <b>CO6:</b> Explain chemo-, regio-, and stereoselectivity in organic synthesis with suitable examples. |                                                                                                                                                                                                                                                                                                                                                                                      |                          |
| Module No                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Topic/ Actual Content of syllabus                                                                                                                                                                                                                                                                                                                                                    | Contact hours            |
| Unit-I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Introduction to Synthetic Design: The Logic of Synthesis:</b> Linear vs. convergent synthesis, yields, and step-economy. <b>Retrosynthetic Approach:</b> Review of target molecules, disconnections, synthons, and synthetic equivalents. <b>Symmetry and Simplification:</b> Exploiting molecular symmetry to reduce synthetic steps.                                            | 10 hrs                   |
| Unit-II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Disconnection Strategies:</b> One-Group C-X Disconnections: Synthesis of alkyl halides, ethers, alcohols, and sulfides. One-Group C-C Disconnections: Alcohols via organometallic reagents (Grignard, organolithium)Two-Group C-X Disconnections: 1,1-1,2- and 1,3-difunctionalized compounds (e.g., acetals, carbonyls).                                                         | 10 hrs                   |
| Unit-III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>Selectivity in Synthesis:</b> Chemo selectivity: Reducing one functional group in the presence of another (e.g. NaBH <sub>4</sub> vs LiAlH <sub>4</sub> .) Regioselectivity: Controlling the orientation of a reaction (e.g., Markovnikov vs. anti-Markovnikov additions). Stereoselectivity: Basics of controlling diastereomers and enantiomers in carbon-carbon bond formation | 10 hrs                   |

Reference books:

1. Organic Synthesis: The Disconnection Approach: Stuart Warren and Paul Wyatt.
2. Organic Chemistry: Jonathan Clayden, Nick Greeves, and Stuart Warren
3. Advanced Organic Chemistry: Part B – Reactions and Synthesis: Francis A. Carey and Richard J. Sundberg.

| Industrial Chemistry (Minor): Semester-IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                |               |
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| Course Code: INC/Mn-4/T/ 251                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Chemistry of Named reaction                                                                                                                                                                                                                                                                                                                                                                                                    |               |
| Credits-02                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Total Contact Hours-30                                                                                                                                                                                                                                                                                                                                                                                                         |               |
| Maximum Marks-50                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                |               |
| Learning Objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                |               |
| After studying this unit, students will be able to:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                |               |
| <ol style="list-style-type: none"><li>1. Understand important carbon-carbon bond forming reactions in organic synthesis.</li><li>2. Explain mechanisms and applications of Aldol, Claisen-Schmidt, Perkin, Knoevenagel, and Benzoin condensations.</li><li>3. Describe important molecular rearrangements such as Pinacol-Pinacolone, Beckmann, Hoffmann, Curtius, and Lossen rearrangements.</li><li>4. Understand oxidation and reduction methods such as Oppenauer oxidation and MPV reduction.</li><li>5. Apply these reactions in the synthesis of simple organic molecules.</li></ol>                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                |               |
| <b>Course Outcomes (COs):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                |               |
| <b>CO1:</b> Explain the mechanisms of major carbon-carbon bond forming reactions such as Aldol and Claisen-Schmidt condensations. <b>CO2:</b> Describe Perkin, Knoevenagel, and Benzoin condensation reactions with suitable examples. <b>CO3:</b> Analyze the mechanism of Pinacol-Pinacolone and Beckmann rearrangements. <b>CO4:</b> Explain Hoffmann, Curtius, and Lossen rearrangements and their synthetic importance. <b>CO5:</b> Apply Oppenauer oxidation and MPV reduction in organic transformations. <b>CO6:</b> Predict products of carbonyl condensation and rearrangement reactions. <b>CO7:</b> Correlate oxidation-reduction reactions with catalytic systems in organic synthesis. |                                                                                                                                                                                                                                                                                                                                                                                                                                |               |
| Module No                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Topic/ Actual Content of syllabus                                                                                                                                                                                                                                                                                                                                                                                              | Contact hours |
| Unit-I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Carbon-Carbon Bond Formation: Aldol Condensation & Claisen-Schmidt Reaction: Self and cross-condensation of aldehydes/ketones. Perkin Reaction: Synthesis of alpha-beta-unsaturated aromatic acids using aromatic aldehydes and acid anhydrides. Knoevenagel Condensation: Condensation of aldehydes/ketones with active methylene compounds. Benzoin Condensation: Cyanide-catalyzed self-condensation of aromatic aldehydes. | 10 hrs        |
| Unit-II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Rearrangements: Pinacol-Pinacolone Rearrangement: Acid-catalyzed conversion of 1,2-diols to ketones. Beckmann Rearrangement: Conversion of oximes to substituted amides. Hoffmann, Curtius, and Lossen Rearrangements: Degradation of amides, azides, and hydroxamic acids to primary amines.                                                                                                                                  | 10 hrs        |
| Unit-III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Oxidation & Reduction: Oppenauer Oxidation: Aluminum-catalyzed oxidation of secondary alcohols to ketones. Meerwein-Ponndorf-Verley (MPV) Reduction: Aluminum-catalyzed reduction of ketones to secondary alcohols.                                                                                                                                                                                                            | 10 hrs        |

Reference books:

1. Advanced Organic Chemistry: Reactions and Mechanisms: Francis A. Carey and Richard J. Sundberg.
2. Organic Chemistry: Jonathan Clayden, Nick Greeves, and Stuart Warren
3. Organic Chemistry: Paula Yurkanis Bruice
4. Organic Reactions and Mechanisms — Ahluwalia & Parashar
5. Organic Synthesis: The Disconnection Approach: Stuart Warren and Paul Wyatt

| <b>Industrial Chemistry /Generic/Open Elective: Semester-IV</b><br><b>Course Code: INC/GE/O E-4/T/250 (GE/OE): Material Science &amp; Heavy Organic Chemicals</b><br><b>Credits-02</b><br><b>Maximum Marks-50</b><br><b>Total Contact Hours-30</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                            |               |
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| <b>Learning Objectives:</b><br>After studying this unit, students will be able to: <ol style="list-style-type: none"> <li>1. Understand the nomenclature and classification of industrial organic and inorganic chemicals.</li> <li>2. Explain the principles, types, mechanisms, and applications of catalysis.</li> <li>3. Describe enzyme-catalyzed reactions and factors affecting catalyst performance.</li> <li>4. Understand the classification and industrial importance of heavy organic chemicals.</li> <li>5. Explain the sources of industrial feedstocks from petroleum, coal tar, and natural gas.</li> <li>6. Understand the Fischer–Tropsch process for synthetic fuel production.</li> </ol> <b>Course Outcomes (COs):</b> <b>CO1:</b> Classify industrial organic and inorganic chemicals using generic and trade nomenclature. <b>CO2:</b> Explain the principles, mechanisms, and industrial applications of homogeneous, heterogeneous, and enzyme catalysis. <b>CO3:</b> Analyze factors affecting catalyst efficiency and reaction rates in industrial processes. <b>CO4:</b> Differentiate between heavy (bulk) chemicals and fine (specialty) chemicals. <b>CO5:</b> Describe the industrial feedstocks obtained from petroleum, coal tar, and natural gas. <b>CO6:</b> Explain the Fischer–Tropsch synthesis for the production of hydrocarbons and synthetic fuels. |                                                                                                                                                                                                                                                                                                                                                                            |               |
| Module No                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Topic/ Actual Content of syllabus                                                                                                                                                                                                                                                                                                                                          | Contact hours |
| Unit-I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>Nomenclature and Catalysis:</b> Classification, generic and trade names of organic and inorganic chemicals. Catalysis- Introduction, types, basic principles, mechanism, factors affecting the performance, enzyme catalysed reactions, rate model, industrially important reactions.                                                                                   | 10 hrs        |
| Unit-II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Introduction to Heavy Organic Chemicals:</b> Commercial Classification: Distinction between heavy (bulk/commodity) chemicals and fine (specialty) chemicals. Feedstocks: Raw material sourcing from petroleum fractions, coal tar, and natural gas. Fischer-Tropsch Synthesis: Production of synthetic hydrocarbons and liquid fuels from carbon monoxide and hydrogen. | 10 hrs        |
| Unit-III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>Heterocyclic Heavy Chemicals:</b> Large-scale synthesis of essential nitrogen-based industrial rings: <b>Pyridines and quinolines:</b> Chichibabin reaction of pyridine.                                                                                                                                                                                                | 10 hrs        |
| Reference Books:<br>1. Heterocyclic Chemistry: John A. Joule and Keith Mills.<br>2. Industrial Chemistry — <i>B.K. Sharma</i><br>3. Shreve's Chemical Process Industries — <i>George T. Austin</i><br>4. Industrial Organic Chemistry — <i>Klaus Weissermel &amp; Hans-Jürgen Arpe</i><br>5. Catalysis in Industrial Chemistry — <i>G. Hagen</i> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                            |               |

| <p align="center"><b>B.Sc. Industrial Chemistry ( Major ) : Semester IV</b><br/> <b>Course Code: INC /SEC/T/250: Water Pollution &amp; Pollutant Analysis</b><br/> <b>Examn. Code : SEC00142504T</b><br/> Total Credits : 1<br/> Maximum Marks : 50<br/> Total Contact Hours : 15 Hrs</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |               |
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| <p><b>Learning Objectives of the Course:</b><br/> The students are expected to learn -</p> <ol style="list-style-type: none"> <li>1. Sources of Pollution, Sewage &amp; Domestic Wastes, Organic wastes, Harmfull effects of Sewage and Domestic Waste, Industrial Effluents, Harmful Effects of Industrial Pollutants , Agricultural Disharges, , Fertilizers-Effect of Fertilizers, , Detergents, Toxic Metals, Thermal Pollutants, Effect of thermal Pollution 9. Radioactive Materials in water, Effects of radio active pollutants .</li> <li>2. Water Pollutant Analysis technics/Skills.</li> </ol> <p><b>Course Outcomes ( COs) :</b> After completion of the course -<br/> <b>CO1 :</b> Sewage &amp; Domestic Wastes, Organic wastes, Harmfull effects of Sewage and Domestic Waste, Industrial Effluents, Harmful Effects of Industrial Pollutants , Agricultural Disharges, , Fertilizers-Effect of Fertilizers, , Detergents, Toxic Metals, Thermal Pollutants, Effect of thermal Pollution<br/> <b>CO2 :</b> Water Pollutant Analysis technics/Skills.</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |               |
| Module No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Topics / actual contents of the syllabus                                                                                                                                                                                                                                                                                                                                                                                                                                    | Contact Hours |
| Unit - I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Sources of Water Pollution-</b> Introduction, Sources of Pollution, 1. Sewage & Domestic Wastes, Organic wastes, Harmfull effects of Sewage and Domestic Waste, 2. Industrial Effluents, Harmful Effects of Industrial Pollutants 3. Agricultural Disharges, 4. Fertilizers-Effect of Fertilizers, 5.Detergents, 6. Toxic Metals, 7. Siltation, 8. Thermal Pollutants, Effect of thermal Pollution 9. Radioactive Materials in water, Effects of radio active pollutants | 5 Hrs         |
| Unit - II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>Water Pollutant Analysis-</b> Introduction, Sampling , Pre-Concentration methods-1. Carbon Absorption method, 2. Freez Concentration method, 3. Solvent Extraction method, 4. Ion Exchange method, Water Pollution Measurement of quality, the analytical Procedures used in water pollutant analysis                                                                                                                                                                    | 5Hrs          |
| Unit III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | water pollutant analysis – Turbidity, Colour, Free chlorine, Chlorine demand, Ammonia, Nitrate and Nitrite , Chloride, Alkalinity, Total acidity, Free Carbon Dioxide, Dissolved Solids, Fluoride, Dissolved oxygen.                                                                                                                                                                                                                                                        | 5Hrs          |
| <p>TextBooks: 1 Industrial Chemistry- B.K.Sharma, Goel publishing House, Meerut. Environmental Chemistry- B.K.Sharma, Goel publishing House, Meerut</p> <p><b>Reference Books:</b> 1. Industrial Chemistry- B.K.Sharma, Goel publishing House, Meerut. 2. Environmental Chemistry- B.K.Sharma, Goel publishing House, Meerut Stocchi, E.(1990), <b>Industrial Chemistry</b>, Vol-</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |               |

| <p align="center"><b>B.Sc. Industrial Chemistry ( Major ) : Semester IV</b><br/> <b>Course Code: INC /SEC/T/251 : Pollution Monitoring &amp; Control Examn. Code : SEC00142514T</b><br/> <b>Total Credits : 1</b><br/> <b>Maximum Marks : 50</b></p>                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |               |
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| <p><b>Learning Objectives of the Course:</b><br/> The students are expected to learn –<br/> 1. <b>Pollution and its measurements.</b><br/> 2. <b>Sewage and sewage Treatment &amp; Industrial wastes and treatment processes:</b><br/> <b>Course Outcomes ( COs ) : After completion of the course student known -</b><br/> <b>CO1: Pollution and its measurements.</b><br/> <b>CO2: Sewage and sewage Treatment &amp; Industrial wastes and treatment processes</b></p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |               |
| Module No.                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Topics / actual contents of the syllabus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Contact Hours |
| Unit - I                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Pollution and its measurements:</b> Nature of industrial effluents, gaseous and liquid effluents, methods of gas analysis, analysis of CO, SO <sub>2</sub> , NO <sub>x</sub> , S, Cl <sub>2</sub> in the gaseous effluents. Methods of removal of pollutants from gaseous effluents, particulate matter, and particle size analysis. AAS applications process for waste water.                                                                                                                                                                                                                                                                                                                                                                                                  | 5 Hrs         |
| Unit - II                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Sewage and sewage Treatment:</b> Municipal waste water, important definitions, sewage and its composition, bacteriology of sewage and treatment, stabilization, properties of sewage, purpose of sewage treatment, methods of sewage treatment, method of sewage treatment, removal of phosphorous and nitrogen from waste water, filtration of sewage, types of aerobic oxidation plant, anaerobic biological oxidation plant, miscellaneous method of sewage treatment, cycle of decomposition, self-cleaning velocity, system of sewerage, analysis of sewage, sludge disposal, methods of sludge disposal, methods of sewage disposal, sewage sickness, selfpurification of natural water, methods of sewage disposal, waste water and its treatment (recycling of sewage). | 5 Hrs         |
| Unit III                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Industrial wastes and treatment processes:</b> Introduction, the problem of sustenance and the chemical industry, characteristics of industrial wastes, types of industrial waste, solid industrial wastes, principles of industrial waste treatment, protection of biosphere, basic trends in biosphere protection for industrial wastes, protection of surface waters from pollution with industrial sewage, treatment and disposal of industrial wastes                                                                                                                                                                                                                                                                                                                      | 5 Hrs         |
| <p><i>TextBooks:</i><br/> 1. S P Mahajan: Pollution control in process industry, 2. M Sitting: Resources recovery recycling handbook and industrial waste, 3.A K Dey: Environmental chemistry 4. S.M. Khopkar: Environmental pollution analysis 5. Industrial chemistry B.K Sharma.</p>                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |               |
| <p><b>Reference Books:</b> 1. Industrial Chemistry- B.K.Sharma, Goel publishing House, Meerut. 2.</p>                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |               |



| <p align="center"><b>B.Sc. Industrial Chemistry ( Major ) : Semester IV</b><br/> <b>Course Code:</b> INC/SEC/P/ 277: <b>Practicals</b> based on Ind.Chem./SEC/T/ 251<br/> <b>Examn. Code :</b> SEC00142774P</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |               |
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| <p>Total Credits : 1<br/> Total Contact Hours : 30 Hrs<br/> Maximum Marks : 50</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |               |
| <p><b>Learning Objectives of the Course: student learn techniques / skills in water analysis</b><br/> Water Pollutant Analysis- Introduction, Sampling , Pre-Concentration methods-1. Carbon Absorption method, 2. Freez Concentration method, 3. Solvent Extraction method, 4. Ion Exchange method, Water Pollution Measurement of quality, the analytical Procedures used in water pollutant analysis – Turbidity, Colour, Free chlorine, Chlorine demand, Ammonia, Nitrate and Nitrite , Chloride, Alkalinity, Total acidity, Free Carbon Dioxide, Dissolved Solids, Fluoride, Dissolved oxygen.<br/> <b>Course Outcomes ( COs) :</b> After completion of the course , the students are able to know the analysis skills related to waste water treatments.</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |               |
| Module No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Topics / actual contents of the syllabus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Contact Hours |
| Unit - I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <ol style="list-style-type: none"> <li>1. Determination of Colour &amp; Turbidity of water &amp; waste water sample.</li> <li>2. Determination of free Chlorine in the water sample. .</li> <li>3. Determination of Chlorine Demand of give waste water sample.</li> <li>4. Determination or Monitor of Nitrate &amp; Nitrite in water sample.</li> <li>5. Determination of Chloride in a Freshly filtered water sample titrimetrically.</li> <li>6. Determination of Alkalinity of water sample.</li> <li>7. Determination of Total acidity , Free mineral acids, free carbon dioxide and suspended solids,</li> <li>8. Determination of Dissolved Solids in a Gooch Crucible .</li> <li>9. Determination Fluoride content in water by using Zirconium Alizarin reagent.</li> </ol> | 30Hrs         |
| <p><b>TextBooks:</b> 1 . Industrial Chemistry- B.K.Sharma, Goel publishing House, Meerut. 2 . Environmental Chemistry- B.K.Sharma, Goel publishing House, Meerut Systematic Experiments in Engineering Chemistry-S.S.Dara</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |               |
| <p><b>Reference Books:</b>1 . Industrial Chemistry- B.K.Sharma, Goel publishing House, Meerut. 2 . Environmental Chemistry- B.K.Sharma, Goel publishing House, Meerut Stocchi,E.(1990), <b>Industrial Chemistry</b>, Vol-I, Ellis Horwood Ltd. UK. Kent, J.A. (ed) (1997), <b>Riegel's Handbook of Industrial Chemistry</b>, CBS Publishers, New Delhi. Pani, B. (2017), <b>Textbook of Environmental Chemistry</b>, I.K. International Publishing House. De, A.K. (2012), <b>Environmental Chemistry</b>, New Age International Pvt, Ltd, New Delhi. Khopkar, S.M. (2010), <b>Environmental Pollution Analysis</b>, New Age International Publisher.</p>                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |               |

| Industrial Chemistry (AEC, VEC, IKS): Semester-IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                         |                        |
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| Course Code: INC/VEC-4/ T/250                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                         | Enzyme chemistry       |
| Credits-02                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                         | Total Contact Hours-30 |
| Maximum Marks-50                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                         |                        |
| <b>Learning Objectives:</b><br>After studying this unit, students will be able to: <ol style="list-style-type: none"> <li>1. Understand the structure, growth, and industrial importance of microorganisms.</li> <li>2. Explain microbial biotransformation processes used in chemical and pharmaceutical industries.</li> <li>3. Understand enzyme systems involved in biotransformation reactions.</li> <li>4. Describe the industrial production of compounds such as prednisolone and ephedrine through biotransformation.</li> <li>5. Understand the IUBMB classification and nomenclature of enzymes.</li> <li>6. Explain the mechanism of enzyme action and substrate binding models.</li> </ol> <b>Course Outcomes (COs):</b> <b>CO1:</b> Describe the structure, growth, and applications of microorganisms in industrial processes. <b>CO2:</b> Explain microbial biotransformation processes and their role in pharmaceutical manufacturing. <b>CO3:</b> Discuss enzyme-catalyzed transformations involved in the production of industrially important chemicals. <b>CO4:</b> Classify enzymes according to the IUBMB system and identify their catalytic functions. <b>CO5:</b> Explain the active site concept and characteristics of enzyme-substrate interactions. |                                                                                                                                                                                                                                                                                         |                        |
| Module No                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Topic/ Actual Content of syllabus                                                                                                                                                                                                                                                       | Contact hours          |
| Unit-I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Brief idea of microorganisms</b> - their structure, growth and usefulness. Biotransformation processes – for prednisolone, 11-hydroxylation in steroids. Enzyme systems - useful for transformation, microbial products, enzyme catalysed transformation - manufacture of ephedrine. | 10 hrs                 |
| Unit-II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Nomenclature and Classification: IUBMB System:</b> Systematic classification into six major classes based on the reaction catalysed: Oxidoreductases, Transferases, Hydrolases, Lyases, Isomerases, Ligases.                                                                         | 10 hrs                 |
| Unit-III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Mechanism of Enzyme Action: Active Site:</b> Features and characteristics. <b>Substrate Binding Models:</b> Lock and Key Hypothesis (Fischer), Induced Fit Model (Koshland). <b>Transition State Theory:</b> Lowering activation energy to speed up reactions.                       | 10 hrs                 |

Reference books:

1. Industrial Microbiology — *A.H. Patel*
2. Biotechnology — *U. Satyanarayana & U. Chakrapani*
3. Principles of Biochemistry — *Lehninger, Nelson & Cox*
4. Fundamentals of Enzymology — *Nicholas C. Price & Lewis Stevens*
5. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry — *Trevor Palmer*.

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| INC/VEC-4/ T/251                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                      | Pharmaceutical Chemistry |
| <b>Industrial Chemistry (AEC, VEC, IKS): Semester-IV</b><br><b>Course Code: INC/VEC-4/ T/251</b><br><b>Credits-02</b><br><b>Maximum Marks-50</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                      |                          |
| <b>Pharmaceutical Chemistry</b><br><b>Total Contact Hours-30</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                      |                          |
| <b>Learning Objectives:</b><br>After studying this unit, students will be able to: <ol style="list-style-type: none"> <li>1. Understand the historical development of the pharmaceutical industry and pharmacopoeias.</li> <li>2. Explain the role and significance of major pharmacopoeias in drug standardization.</li> <li>3. Understand different pharmaceutical formulations and routes of drug administration.</li> <li>4. Describe the importance of aseptic conditions and sterilization techniques in pharmaceutical manufacturing.</li> <li>5. Understand the classification, cultivation, collection, and storage of medicinal plants.</li> <li>6. Identify major phytochemical constituents present in medicinal plants.</li> </ol> <b>Course Outcomes (COs):</b> <b>CO1:</b> Describe the historical development of the pharmaceutical industry and pharmacopoeias in India. <b>CO2:</b> Explain the importance and applications of major pharmacopoeias such as IP, BP, USP, EP, and NF. <b>CO3:</b> Classify pharmaceutical formulations and routes of drug administration. <b>CO4:</b> Explain the principles and methods of sterilization used in pharmaceutical industries. <b>CO5:</b> Describe the cultivation, collection, processing, and storage of medicinal plants. |                                                                                                                                                                                                                                                                                                                                                                                                                      |                          |
| <b>Module No</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Topic/ Actual Content of syllabus</b>                                                                                                                                                                                                                                                                                                                                                                             | <b>Contact hours</b>     |
| Unit-I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>Pharmaceutical industry and Pharmacopoeias:</b> Historical background and development of pharmaceutical industry in India in brief, development of Indian pharmacopoeia and introduction to B.P., U.S.P., E.P., N.F. and other important pharmacopoeias, introduction to various types of formulations and routes of administration, aseptic conditions, need for sterilization, various methods of sterilization | 10 hrs                   |
| Unit-II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Phytochemicals:</b> Introduction to plant classification and crude drugs, cultivation, collection, preparation for the market and storage of medicinal plants.                                                                                                                                                                                                                                                    | 10 hrs                   |
| Unit-III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Chemical constitution of plants:</b> including carbohydrates, amino acids, proteins, fats, waxes, volatile oils, terpenoids, steroids, saponins, flavonoids, tannins, glycosides, alkaloids                                                                                                                                                                                                                       | 10 hrs                   |

**Reference books:**

1. Textbook of Pharmacognosy — C.K. Kokate, A.P. Purohit & S.B. Gokhale
2. Pharmacognosy — Trease & Evans
3. Pharmacognosy and Phytochemistry — Vinod D. Rangari
4. Pharmaceutical Chemistry — G. Chatwal & S. Anand
5. Medicinal Natural Products: A Biosynthetic Approach — Paul M. Dewick.