A Charutar Vidya Mandal's Institution
V.P. & R.P.T.P. SCIENCE COLLEGE
(AUTONOMOUS – GRANT – IN – AID)
Affiliated to Sardar Patel University
VALLABH VIDYANAGAR-388120

Bachelor of Science (B.Sc.) **Industrial Chemistry** **Undergraduate**

B. Sc. (UG) Semester – IV (Effective from JUNE 2025)

Course Code (Major)	US04MAICH01	**Title of the Course**	Energy Balance, Heat Transfer, and Industrial Drying
Total Credits of the Course	4	**Hours per Week**	4

Course Objectives:	This course aims to: 1. Provide fundamental knowledge of process and chemical engineering calculations. 2. Develop an understanding of various unit operations involved in industrial processes. 3. Familiarize students with energy balance, heat transfer, adsorption, and drying techniques.

Course Content		
Unit	**Description**	**Weightage**
1.	Energy Balance and Combustion: Forms of energy and the law of conservation of energy, General energy balance procedure for batch and continuous processes, Heat capacity, specific heat, combustion, and calorific value of fuels, Combustion calculations and efficiency.	**25%**
2.	Heat Transfer: Modes of heat transfer- Conduction, convection, radiation, Fourier's law and thermal conductivity of materials, Steady-state one-dimensional heat conduction equations for different wall structures (plane, cylindrical, spherical, composite); Types of convection, Individual and overall heat transfer coefficients, Fouling factor	**25%**
3.	Heat Exchange Equipment: Classification, Double-pipe heat exchangers, Shell and tube heat exchangers & their classification, Extended surface exchanger, Plate-type heat exchanger, Graphite block heat exchanger, Flow arrangements in heat exchangers, Concept of log mean temperature difference	**25%**
4.	Drying & Industrial Drying Equipment: Introduction to drying, general definitions, equilibrium moisture content, Concepts of humidity, dry and wet bulb temperatures, drying equilibrium, Drying periods: Constant rate and falling rate period, Industrial drying equipment: Tray dryer, rotary dryer, drum dryer, spray dryer, fluidized bed dryer, tunnel dryer, pneumatic (flash) dryer.	**25%**

Teaching-Learning Methodology	The teaching will be delivered through conventional blackboard-based classroom instruction supported by ICT tools including PowerPoint presentations, audio-visual content, e-resources, and practical demonstrations. Learning will be enhanced through interactive seminars, workshops, and hands-on model-based learning, ensuring inclusivity and engagement as per NEP-2020 guidelines.

Evaluation Pattern

Sr. No.	Details of the Evaluation	Weightage
1.	**Internal Theory Examination** [Continuous Evaluation System (CES) (Attendance, Quizzes, Active Participation) (As per NEP-2020)]	**50%**
2.	**External Theory Examination** [University Theory Examination] (as per NEP-2020)	**50%**

Course Outcomes

Upon successful completion of the course, students will be able to:
1. Apply fundamental energy balance principles in chemical processes. Understand adsorption mechanisms and their industrial applications.
2. Analyze heat transfer operations and the working of heat exchangers. Demonstrate practical skills in drying operations and industrial drying techniques.

Suggested References:

Sr. No.	References
1.	**"Unit Operations – Volume I & II"** by K. A. Gavhane, Nirali Prakashan.
2.	**"Introduction to Chemical Engineering"** by W. L. Badger & J. I. Banchero, McGraw Hill.
3.	**"Chemical Engineering – Volume II: Unit Operations"** by J. M. Coulson & J. F. Richardson, Butterworth-Heinemann.
4.	**"Industrial Chemistry"** by B. K. Sharma, Krishna Prakashan.
5.	**"Basic Principles and Calculations in Chemical Engineering"** by D. M. Himmelblau, Prentice Hall.
6.	**"Perry's Chemical Engineers' Handbook"** by R. H. Perry & D. W. Green, McGraw Hill.
7.	**"Cement Chemistry"** by H. F. W. Taylor, Thomas Telford Publishing.
8.	**"Introduction to Ceramics"** by W. D. Kingery, H. K. Bowen & D. R. Uhlmann, Wiley-Interscience.
9.	**"Introduction to Glass Science and Technology"** by J. E. Shelby, The Royal Society of Chemistry.

Online Resources:

- Google Books: https://books.google.com
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Bachelor of Science (B.Sc.) **Industrial Chemistry** **Undergraduate**

B. Sc. (UG) Semester – IV (Effective from JUNE 2025)

Course Code (Major)	US04MAICH02	**Title of the Course**	Analytical Chemistry
Total Credits of the Course	4	**Hours per Week**	4

Course Objectives:	This course aims to: 1. Basic concepts, techniques, and principles of analytical chemistry. 2. The principles of the most important liquid and gas chromatographic.

Course Content		
Unit	**Description**	**Weightage**
1.	Redox Titrations: Introduction, Redox systems, Redox potential, Nernst equation, Equilibrium constant, Titration curve &Feasibility, Redox indicators, Iodometric and iodometric titrations. Complexometric Titrations: Introduction, Stability constant, Ways of detecting endpoint, Titration curves, Equilibrium involved in EDTA titration, Types of EDTA titrations, Titration of mixture; Selectivity, Masking and demasking, Metallochromic indicators, Applications.	**25%**
2.	Precipitation Titrations: Introduction, Feasibility and end point detection, Indicators, Volhard, Fajan and Mohr's methods, Factors affecting solubility of precipitates. Gravimetric Methods of Analysis - Principle of gravimetry, Requirements of precipitates, Formation and properties of precipitates, Coagulation &peptization, Co-precipitation and occlusion, Washing, drying and ignition of precipitate.	**25%**
3.	pH-metry: Introduction, determination of pH & applications. Potentiometric titrations - Introduction, Types of titrations & Advantages of potentiometric titrations. Conductometric measurements - Introduction, Some important laws, Definition and relations, Effect of dilution, Applications of conductance measurements, Types of titrations, Advantages and disadvantages.	**25%**
4.	Chromatography - Introduction, Classification and applications. Paper chromatography - Introduction, Experimental details for qualitative analysis. Thin layer chromatography - Introduction, Superiority of TLC over the other techniques, Experimental techniques, Scope & limitations. Column chromatography - Introduction, Experimental details, Theory of development, factors affecting column efficiency. GC & HPLC - Introduction, Instrumentation, Sampling methods, Experimental and applications.	**25%**

Teaching-Learning Methodology	The teaching will be delivered through conventional blackboard-based classroom instruction supported by ICT tools including PowerPoint presentations, audio-visual content, e-resources, and practical demonstrations. Learning will be enhanced through interactive seminars, workshops, and hands-on model-based learning, ensuring inclusivity and engagement as per NEP-2020 guidelines.

Evaluation Pattern

Sr. No.	Details of the Evaluation	Weightage
1.	**Internal Theory Examination** [Continuous Evaluation System (CES) (Attendance, Quizzes, Active Participation) (As per NEP-2020)]	**50%**
2.	**External Theory Examination** [University Theory Examination] (as per NEP-2020)	**50%**

Course Outcomes

Upon successful completion of the course, students will be able to:
1. To acquire knowledge on basic concepts of redox and complexometric titrations.
2. To acquire knowledge on the basic principles of precipitation titration sand gravimetric analysis.
3. To acquire skills in the operation of pH meter and conductometric titration.
4. To understand various chromatography methods in the separation and identification of organic compounds

Suggested References:

Sr. No.	References
1.	**"Instrumental Methods of Chemical Analysis"** by Chatwal & Anand, Himalaya Publishing House.
2.	**"Instrumental Methods of Chemical Analysis"** by B. K. Sharma, Krishna Publication Media (P) Ltd., Meerut.
3.	**"Analytical Chemistry"** by Gary D. Christian, Wiley & Sons, Inc.
4.	**"Instrumental Methods of Analysis"** by Willard, Merritt, Dean & Settle, CBS Publishers & Distributors, New Delhi.
5.	**"Principles of Instrumental Analysis"** by Skoog, Holler & Nieman, Thomson Asia Pvt. Ltd., Singapore.
6.	**"Instrumental Methods of Chemical Analysis"** by Galen W. Ewing, McGraw-Hill Book Company.
7.	**"Fundamentals of Analytical Chemistry"** by Douglas A. Skoog, West, Holler & Crouch, Thomson-Brooks/Cole.

Online Resources:

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Bachelor of Science (B.Sc.) **Industrial Chemistry** **Undergraduate**

B. Sc. (UG) Semester – IV (Effective from JUNE 2025)

Course Code (Minor)	US04MAICH03	**Title of the Course**	Industrial Chemistry Practical
Total Credits of the Course	4	**Hours per Week**	8

Course Objectives:	This course aims to: 1. To operate Heat Transfer and Drying unit operations. 2. To analyze and identify the materials and semi micro analysis of inorganic compounds, its testing chemicals and Chromatography. 3. To understand the scientific method of calibrating the glassware, preparation and standardization of analytical solutions, performing experiments for titrimetric analysis, complex preparation and gravimetric analysis.

Course Content

Part I: Heat Transfer Equipment (2 Credit, 4 Hours Per Week)
Experiments base on Heat Transfer and Drying unit operations.

Part II: Inorganic Qualitative analysis (2 Credit, 4 Hours Per Week)
Calibration of Volumetric Glassware; Experiments based on estimation of raw materials and semi micro analysis of inorganic compounds; Chromatography based experiments; complex preparation; gravimetric analysis.

Teaching-Learning Methodology	Hands-on laboratory work guided by demonstrative sessions, Use of ICT tools: PowerPoint presentations, visual simulations, and e-resources, Engagement through lab manuals, model-based learning, and peer discussion, Compliance with inclusive education and NEP-2020 guidelines for laboratory pedagogy.

Evaluation Pattern

Sr. No.	Details of the Evaluation	Weightage
1.	**Internal Practical Examination:** [Continuous Evaluation System (CES) (Attendance, Journals, Quizzes, Practical Records, Active Participation) (As per NEP-2020)]	**50%**
2.	**External Examination** [University Practical Examination] (as per NEP-2020)	**50%**

Note: Assessment will be maintained through observation of performance, attendance, viva voce, and record submission.

Course Outcomes
Upon successful completion of the course, students will be able to: 1. To acquire basic knowledge of some unit operations like Heat Transfer and Drying unit operations. 2. To develop skills to analyze and identify the materials and semi micro analysis of inorganic compounds, its testing chemicals and Chromatography. 3. To understand the scientific method of calibrating the glassware, preparation and standardization of analytical solutions, performing experiments for titrimetric analysis, complex preparation and gravimetric analysis.

Suggested References:	
Sr. No.	**References**
1.	**"Vogel's Textbook of Practical Organic Chemistry"** by Brian S. Furniss, John Wiley & Sons.
2.	**"Organic Syntheses Based on Name Reactions"** by A. Hassner, Elsevier Publishing Company.
3.	**"Vogel's Textbook of Quantitative Chemical Analysis"** by G. H. Jeffery, J. Bassett, J. Mendham & R. C. Denny, John Wiley & Sons.

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Bachelor of Science (B.Sc.) **Industrial Chemistry** **Undergraduate**

B. Sc. (UG) Semester – IV (Effective from JUNE 2025)

Course Code (Minor)	US04MIICH01	**Title of the Course**	Unit Operations
Total Credits of the Course	2	**Hours per Week**	2

Course Objectives:	This course aims to: 1. Develop an understanding of various unit operations involved in industrial processes. 2. Familiarize students with energy balance, heat transfer, adsorption, and drying techniques.

Course Content		
Unit	**Description**	**Weightage**
1.	Heat Transfer: Modes of heat transfer- Conduction, convection, radiation, Fourier's law and thermal conductivity of materials, Steady-state one-dimensional heat conduction equations for different wall structures (plane, cylindrical, spherical, composite); Types of convection, Individual and overall heat transfer coefficients, Fouling factor	**50%**
2.	Heat Exchange Equipment: Classification, Double-pipe heat exchangers, Shell and tube heat exchangers & their classification, Extended surface exchanger, Plate-type heat exchanger, Graphite block heat exchanger, Flow arrangements in heat exchangers, Concept of log mean temperature difference	**50%**

Teaching-Learning Methodology	The teaching will be delivered through conventional blackboard-based classroom instruction supported by ICT tools including PowerPoint presentations, audio-visual content, e-resources, and practical demonstrations. Learning will be enhanced through interactive seminars, workshops, and hands-on model-based learning, ensuring inclusivity and engagement per NEP-2020 guidelines.

Evaluation Pattern		
Sr. No.	**Details of the Evaluation**	**Weightage**
1.	**Internal Theory Examination** [Continuous Evaluation System (CES) (Attendance, Quizzes, Active Participation) (As per NEP-2020)]	**50%**
2.	**External Theory Examination** [University Theory Examination] (as per NEP-2020)	**50%**

Course Outcomes
Upon successful completion of the course, students will be able to: 1. Analyze heat transfer operations and the working of heat exchangers. Demonstrate practical skills in drying operations and industrial drying techniques.

Suggested References:	
Sr. No.	**References**
1.	**"Unit Operations: Volume I & II"** by K. A. Gavhane, Nirali Prakashan.
2.	**"Principles of Chemical Engineering"** by Richard M. Felder and Ronald W. Rousseau, Wiley.
3.	**"Industrial Instrumentation & Process Control"** by A. P. Kulkarni, Nirali Prakashan.
4.	**"Essentials of Chemical Reaction Engineering"** by H. Scott Fogler, Prentice Hall.
5.	**"Vogel's Textbook of Quantitative Chemical Analysis"** by G. H. Jeffery, J. Mendham, R. C. Denney, Longman Scientific & Technical.
6.	**"Analytical Chemistry"** by G. D. Christian, John Wiley & Sons, 3rd Edition.
7.	**"Analytical Chemistry: Principles"** by J. H. Kennedy, Saunders College Publishers, 2nd Edition, 1990.

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Bachelor of Science (B.Sc.) **Industrial Chemistry** **Undergraduate**

B. Sc. (UG) Semester – IV (Effective from JUNE 2025)

Course Code (Minor)	US04MIICH02	**Title of the Course**	Industrial Chemistry - Practical
Total Credits of the Course	2	**Hours per Week**	4

Course Objectives:	This course aims to: 1. Develop the skill to analyze the concept of unit operations like Heat transfer and drying.

Course Content
(02 Credit; 04 Hours per week) 1. Experiments base on Heat Transfer and Drying unit operations.

Teaching-Learning Methodology	Hands-on laboratory work guided by demonstrative sessions, Use of ICT tools: PowerPoint presentations, visual simulations, and e-resources, Engagement through lab manuals, model-based learning, and peer discussion, Compliance with inclusive education and NEP-2020 guidelines for laboratory pedagogy.

Evaluation Pattern

Sr. No.	Details of the Evaluation	Weightage
1.	**Internal Practical Examination** [Continuous Evaluation System (CES) (Attendance, Journals, Quizzes, Practical Records, Active Participation) (As per NEP-2020)]	**50%**
2.	**External Examination** [University Practical Examination] (as per NEP-2020)	**50%**

Note: Assessment will be maintained through observation of performance, attendance, viva voce, and record submission.

Course Outcomes

Upon successful completion of the course, students will be able to:
1. To acquire basic knowledge of some unit operations like Heat Transfer and Drying unit operations.

Suggested References:	
Sr. No.	**References**
1.	**"Unit Operations of Chemical Engineering"** by W. L. McCabe, J. C. Smith & P. Harriott, McGraw-Hill Education.
2.	**"Transport Processes and Separation Process Principles"** by C. J. Geankoplis, Pearson Education.
3.	**"Mass-Transfer Operations"** by R. E. Treybal, McGraw-Hill Education.
4.	**"Chemical Engineering – Volume 1: Fluid Flow, Heat Transfer and Mass Transfer"** by J. M. Coulson & J. F. Richardson, Butterworth-Heinemann.

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Bachelor of Science (B.Sc.) **Industrial Chemistry** **Undergraduate**

B. Sc. (UG) Semester – IV (Effective from JUNE 2025)

Course Code (Minor)	US04SEICH01	**Title of the Course**	Introduction to Green Chemistry
Total Credits of the Course	2	**Hours per Week**	2

Course Objectives:	This course aims to: 1. Basic of Green Chemistry and its principles. 2. Concepts of Green Catalyst and green techniques. 3. Introduction to application of Green Chemistry in day-to-day life.

Course Content

Unit	Description	Weightage
1.	Introduction to the concepts of Green Chemistry, Principles of Green Chemistry, Steps to Design Green synthesis, Choice of starting material, reagents, catalyst, solvents for green synthesis, Concept of Atom economy. Study of Green Catalyst (Viz.Acidic, Basic, Polymer supported catalyst, Biocatalyst) phase transfer catalyst.	**50%**
2.	Introduction and Application to various green techniques of Green Synthesis viz. Electrochemical, Photochemical, Microwave, Ultrasound. Aqueous phase reaction and solid phase reaction. Synthesis of: Adipic Acid, Ibuprofen, Paracetamol. Application of Green Chemistry in day-to-day life. Dry cleaning of clothes, versatile bleaching agent, Ionic liquids as versatile green solvent.	**50%**

Teaching-Learning Methodology	The teaching will be delivered through conventional blackboard-based classroom instruction supported by ICT tools including PowerPoint presentations, audio-visual content, e-resources, and practical demonstrations. Learning will be enhanced through interactive seminars, workshops, and hands-on model-based learning, ensuring inclusivity and engagement per NEP-2020 guidelines.

Evaluation Pattern

Sr. No.	Details of the Evaluation	Weightage
1.	**Internal Theory Examination** [Continuous Evaluation System (CES) (Attendance, Quizzes, Active Participation) (As per NEP-2020)]	**50%**
2.	**External Theory Examination** [University Theory Examination] (as per NEP-2020)	**50%**

Course Outcomes
Upon successful completion of the course, students will be able to: 1. Learn Concepts of Green Chemistry and its Applications in day-to-day life.

Suggested References:	
Sr. No.	**References**
1.	**"Green Chemistry"** by V. K. Ahluwalia.
2.	**"Principles of Green Chemistry"** by V. K. Ahluwalia & M. Kidwai.

Online Resources:

- Google Books: https://books.google.com
- INFLIBNET: https://inflibnet.ac.in
- NPTEL Courses: https://nptel.ac.in
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