

**Department of Science Education  
Institute of Education & Research  
University of the Punjab, Lahore  
Course Outline**



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| Programme                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | BS Science Education                                                                                                                     | Course Code | SE-312                                                                                                                                                              | Credit Hours | 3 |
| Course Title                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | CHEMISTRY-IV (Applied Chemistry)                                                                                                         |             |                                                                                                                                                                     |              |   |
| Course Introduction                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                          |             |                                                                                                                                                                     |              |   |
| This course introduces the fundamental concepts of applied and industrial chemistry, emphasizing major chemical industries, industrial unit operations, and manufacturing processes. It covers water treatment, water softening, and the production of important industrial chemicals and materials. The laboratory component develops practical skills in chemical analysis, instrumental techniques, and industrial product preparation, enabling students to relate theoretical knowledge to industrial applications. |                                                                                                                                          |             |                                                                                                                                                                     |              |   |
| Learning Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                          |             |                                                                                                                                                                     |              |   |
| On the completion of the course, the students will:<br>1. Explain major industrial chemical processes.<br>2. Describe manufacture of important industrial chemicals.<br>3. Apply water treatment and softening techniques.<br>4. Perform common industrial chemistry laboratory analyses.<br>5. Interpret industrial chemical operations safely.                                                                                                                                                                         |                                                                                                                                          |             |                                                                                                                                                                     |              |   |
| Course Content                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                          |             | Assignments/Readings                                                                                                                                                |              |   |
| Week 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Unit-I Chemical Industrial Unit Operations and Processes:<br><br>1.1 Brief introduction to Chemical Industry with reference to Pakistan. |             | Reading: Industrial Organic Chemicals, by H.A.Witcoff and B.J.Reuben, John Wiley & Sons Inc. New York.                                                              |              |   |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 1.2. Elementary treatment of general unit operations commonly used in Industry such as heat transfer.                                    |             | Assignment: Prepare a two-page report describing the chemical industry in Pakistan and explain the role of unit operations in chemical manufacturing.               |              |   |
| Week 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 1.3. Evaporation, size Reduction, Screening, Filtration and Distillation.                                                                |             | Reading Water Supply and Sewerage, T.J. McGhee, McGraw Hill Book Co. New York.(1991)                                                                                |              |   |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 1.4. Chemical and Unit processes: Sulphonation.                                                                                          |             | Assignment: Solve five application-based questions comparing different unit operations. Draw a flow diagram illustrating the sequence of industrial unit operations |              |   |
| Week 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 1.5. Chemical and Unit processes: Nitration.                                                                                             |             | Reading: Unit operations in Chemical Engineering, Chattopadhyay, Khanna Publishers, Delhi-6 (1993).                                                                 |              |   |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 1.6. Chemical and Unit processes: Halogenation; Hydration; Oxidation and Hydrogenation.                                                  |             | Assignment: Prepare reaction mechanisms for sulphonation, nitration, and halogenation with one industrial application of each process.                              |              |   |

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| <b>Week 4</b>  | <b>Unit-II <u>Basic Chemical Industries</u></b><br>2.1 Introduction to industrial Raw materials;                                                    | <b>Reading:</b> Chemical Process Design, Robin Smith, McGraw Hill Book Co. New York. (1995).                                                                                                            |
|                | 2.2 Chemical processes involved industry: flow sheet diagrams with all the important parameters concerned with the manufacturing of Sulphuric acid. | <b>Assignment:</b> Draw and explain the flow sheet of sulphuric acid manufacturing (Contact Process) and discuss the role of each raw material.                                                         |
| <b>Week 5</b>  | 2.3 Manufacturing process of Hydrochloric acid, caustic Soda, Washing soda, Oxalic Acid.                                                            | <b>Reading:</b> Hand Book of Industrial Chemicals, By SIRI Board of Consultants and Engineers, Small Industries Research Institute, New Delhi (1995).                                                   |
|                | 2.4. Manufacturing process of Formic acid, Pthalic anhydride. Applications of all these chemicals in industry.                                      | <b>Assignment:</b> Prepare a comparative chart showing raw materials, manufacturing process, uses, and safety precautions for HCl, NaOH, Washing Soda, Oxalic Acid, Formic Acid, and Phthalic Anhydride |
| <b>Week 6</b>  | <b>Unit-III <u>Cement Industries:</u></b><br>3.1 Introduction to Cement raw materials used for cement manufacturing.                                | <b>Reading:</b> Small Medium and large Scale Industries, A.K. Sirivastawa, Small Industries Research Institute, New Delhi (1996).                                                                       |
|                | 3.2 Industrial dry process, wet process, semi wet process, special cement.                                                                          | <b>Assignment:</b> Write a report comparing the dry, wet, and semi-wet cement manufacturing processes. Include a labelled process flow diagram.                                                         |
| <b>Week 7</b>  | 3.3. Chemistry involved in hydration of cement, setting of cement, setting time.                                                                    | <b>Reading:</b> The Chemistry of Cement, H.F.W. Taylor, Academic Press, London, 1964.                                                                                                                   |
|                | <b>Unit-IV <u>Water Softening and Scale Removing:</u></b><br>4.1 Introduction to Water hardness; its measurement and removal.                       | <b>Assignment:</b> Solve case-based questions on cement hydration and explain the causes and effects of water hardness in industries.                                                                   |
| <b>Week 8</b>  | 4.2 Methods used for water softening including ion-exchange and reverse osmosis.                                                                    | <b>Reading:</b> Shereve's Chemical Process Industries, 5th Ed.1975, By G.T.Austin, McGraw Hill Book Co. New York.                                                                                       |
|                | 4.3 Methods used for water softening including Distillation and precipitation.                                                                      | <b>Assignment:</b> Compare ion-exchange, reverse osmosis, distillation, and precipitation methods using a comparison table highlighting advantages, disadvantages, and industrial applications.         |
| <b>Week 9</b>  | 4.4. Types of boiler scales.                                                                                                                        | <b>Reading:</b> Industrial chemistry, B. K. Sharma, Krishna Prakashan Media (P) Ltd., Ed-15 (2006).                                                                                                     |
|                | 4.5 Chemical and mechanical methods to eliminate the scaling.                                                                                       | <b>Assignment:</b> Prepare a case study describing industrial problems caused by boiler scales and recommend suitable chemical and mechanical removal methods.                                          |
| <b>Week 10</b> | <b>Unit-V <u>Glass Industries:</u></b><br>5.1 Introduction and History of glass,                                                                    | <b>Reading:</b> Chemistry of glass manufacturing, F.W. Hunter, Dower Publications, New York, 1950.                                                                                                      |

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|                | 5.2 Raw materials used for glass                                                                                    | <b>Assignment:</b> Draw the manufacturing process of glass and explain the functions of different raw materials used in glass production.                            |
| <b>Week 11</b> | 5.3. Introduction to various types of furnaces and crucibles used for the manufacture of glass.                     | <b>Reading:</b> Chemistry of glass manufacturing, F.W.Hunter, Dower Publications, New York, 1950.                                                                    |
|                | 5.4. Introduction and details of special types of glass, their manufacture and properties.                          | <b>Assignment:</b> Prepare a presentation on different types of industrial furnaces and special glasses, highlighting their industrial applications.                 |
| <b>Week 12</b> | <b>Unit-VI Soap and Detergent Industries:</b><br>6.1. Processes involved in soap manufacturing,                     | <b>Reading:</b> Small Medium and large Scale Industries, A.K. Sirivastawa, Small Industries Research Institute, New Delhi (1996).                                    |
|                | 6.2. Methods used for manufacture of laundry soap                                                                   | <b>Assignment:</b> Draw a flow chart of soap manufacturing and explain the chemistry of saponification with suitable examples.                                       |
| <b>Week 13</b> | 6.3. Methods used for manufacture of typical soaps.                                                                 | <b>Reading:</b><br>Hand Book of Industrial Chemicals, By SIRI Board of Consultants and Engineers, Small Industries Research Institute, New Delhi (1995).             |
|                | 6.4. Processes involved in Recovery of glycerin soap manufacturing process.                                         | <b>Assignment:</b> Write a short report comparing laundry soap, toilet soap, and detergent with emphasis on composition, preparation, and uses.                      |
| <b>Week 14</b> | 6.5. Manufacturing, Physical and chemical process of Detergents.                                                    | <b>Reading:</b> Hand Book of Industrial Chemicals, By SIRI Board of Consultants and Engineers, Small Industries Research Institute, New Delhi (1995).                |
|                | 6.6. Manufacturing, Physical and chemical process of surface active agents, cationic, anionic and non-ionic agents. | <b>Assignment::</b> Prepare a comparative table explaining cationic, anionic, non-ionic, and amphoteric surfactants with their industrial and domestic applications. |
| <b>Week 15</b> | Presentations on individual projects and assignments                                                                | <b>Presentation:</b> Present an individual project on any industrial chemical process studied during the semester and submit a written report (5–7 pages).           |

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|                | Presentations on individual projects and assignments | <b>Presentations</b>                                                                                        |
| <b>Week 16</b> | Presentations on individual projects and assignments | <b>Presentations</b>                                                                                        |
|                | <b>6.5. Revision and Quiz</b>                        | Complete a comprehensive review worksheet covering all six course units and participate in a revision quiz. |

### Textbooks and Reading Material

#### Recommended Books:

1. Industrial Organic Chemicals, by H.A.Witcoff and B.J.Reuben, John Wiley & Sons Inc. New York.
2. Water Supply and Sewerage, T.J.McGhee, McGraw Hill Book Co. New York.(1991)
3. Unit operations in Chemical Engineering, Chattopadhyay, Khanna Publishers, Delhi-6 (1993).
4. Chemical Process Design, Robin Smith, McGraw Hill Book Co. New York. (1995).
5. Hand Book of Industrial Chemicals, By SIRI Board of Consultants and Engineers, Small Industries Research Institute, New Delhi (1995)
6. Small Medium and large Scale Industries, A.K. Sirivastawa, Small Industries Research Institute, New Delhi (1996).
7. The Chemistry of Cement, H.F.W. Taylor, Academic Press, London, 1964.
8. Shereve's Chemical Process Industries, 5th Ed.1975, By G.T.Austin, McGraw Hill Book Co. New York.
9. Industrial chemistry, B. K. Sharma, Krishna Prakashan Media (P) Ltd., Ed-15 (2006).
10. Chemistry of glass manufacturing, F.W.Hunter, Dower Publications, New York, 1950.
11. Journal Articles/ Reports

#### Note:

1. It is preferable to use latest available editions of books. Mention the publisher & year of publication.
2. The References/ bibliography may be in accordance with the typing manual of the concerned faculty/subject. Preferably follow APA 7<sup>th</sup> Edition publication manual.

### Teaching Learning Strategies

1. Lectures with Visual Aids
2. Problem-Solving Sessions
3. Group Discussions and Peer Learning
4. Hands-On Computational Exercises
5. Case Studies and Real-World Applications

### Assignments: Types and Number with Calendar

#### 1. Types of Assignments:

- 1.1. **Numerical Problem-Solving:** Application-based problems.
- 1.2. **Short Reports:** Writing brief explanations or summaries.
- 1.3. **Derivations and Mathematical Proofs:** Step-by-step understanding of the concepts with models.
- 1.4. **Real-World Applications:** Researching and reporting on practical uses of chemistry principles
- 1.5. **Comparative Analysis:** Comparing theoretical and experimental results,

#### 2. Number of Assignments:

- 2.1. **Before Midterm:** 2 Major assignments.
- 2.2. **After Midterm:** 2 Major assignments.

This approach ensures a balance of theoretical understanding and applied learning throughout the course.

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| Programme                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | BS Science Education<br>(1-8)                                                                                                                                     | Course Code | SE-312A | Credit Hours               | 3 |
| Course Title                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Physics – IV: Electricity and Magnetism                                                                                                                           |             |         |                            |   |
| Course Introduction                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                   |             |         |                            |   |
| This course provides a fundamental understanding of electricity and magnetism, essential components of classical physics. It covers the principles and applications of electric and magnetic fields, electrostatics, circuits, and electromagnetism.                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                   |             |         |                            |   |
| Learning Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                   |             |         |                            |   |
| By the end of this course, students will be able to:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                   |             |         |                            |   |
| <div><div></div><div><div>1.</div><div>Explain fundamental principles of electricity and magnetism, including electrostatics, electric fields, and magnetic forces.</div></div><div><div>2.</div><div>Analyze and solve problems related to electric and magnetic fields using mathematical methods.</div></div><div><div>3.</div><div>Apply concepts of capacitance, resistance, and inductance to real-world electrical systems and circuits.</div></div><div><div>4.</div><div>Connect theoretical principles to practical technologies such as electromagnetic waves and devices.</div></div></div> |                                                                                                                                                                   |             |         |                            |   |
| Course Content                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                   |             |         | Assignments/Readings       |   |
| Week 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Unit-I Electrostatics<br>1.1 Electric charge<br>1.2 Conductors and insulators<br>1.3 Coulomb’s law,                                                               |             |         | Resnick & Halliday, Ch. 21 |   |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 1.4 Electric Field due to<br>1.4.1 A point Charge<br>1.4.2 An electric dipole                                                                                     |             |         | Resnick & Halliday, Ch. 22 |   |
| Week 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1.4.3 Continuous charge distributions (cases of uniform line, ring and disk of charge),                                                                           |             |         | Resnick & Halliday, Ch. 22 |   |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 1.5 Electric dipole in an electric field                                                                                                                          |             |         | Resnick & Halliday, Ch. 22 |   |
| Week 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1.6 Electric flux, Gauss’ law<br>1.6.1 Applications in planar, cylindrical, and spherical symmetry                                                                |             |         | Resnick & Halliday, Ch. 23 |   |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Unit-II Electric Potential<br>2.1 Equipotential surfaces<br>2.2 Potential due to<br>2.2.1 A point charge and a group of point charges<br>2.2.2 An electric dipole |             |         | Resnick & Halliday, Ch. 24 |   |
| Week 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 2.3 Electric potential of continuous charge distributions                                                                                                         |             |         | Resnick & Halliday, Ch. 24 |   |

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|                | 2.4 Relation between electric field and electric potential energy.                                                           | Resnick & Halliday, Ch. 24      |
| <b>Week 5</b>  | <b>Unit-III Capacitance and Dielectrics</b><br>3.1 Calculating the capacitance<br>3.2 Capacitors in series and parallel      | Resnick & Halliday, Ch. 25      |
|                | 3.3 Energy stored in an electric field                                                                                       | Resnick & Halliday, Ch. 25      |
| <b>Week 6</b>  | 3.4 dielectrics and Gauss' law                                                                                               | Resnick & Halliday, Ch. 25      |
|                | <b>Unit-IV Electric Current and Resistance</b><br>4.1. Ohm's law<br>4.2. Electric current and current density                | Resnick & Halliday, Ch. 26      |
| <b>Week 7</b>  | 4.3. Resistance and resistivity<br>4.4. Resistors in series and parallel                                                     | Resnick & Halliday, Ch. 26      |
|                | 4.5. Microscopic view of Ohm's law<br>4.6. Semiconductors and superconductors                                                | Resnick & Halliday, Ch. 26      |
| <b>Week 8</b>  | 4.7. Microscopic view of Ohm's law                                                                                           | Resnick & Halliday, Ch. 26      |
|                | 4.8. Semiconductors and superconductors                                                                                      | Resnick & Halliday, Ch. 26      |
| <b>Week 9</b>  | <b>Unit-V Magnetic Forces and Fields</b><br>5.1 Magnetic force on:<br>5.1.1 A moving charge<br>5.1.2 A current-carrying wire | Resnick & Halliday, Ch. 28 & 29 |
|                | 5.2 Torque on a current loop<br>Magnetic dipole moment                                                                       | Resnick & Halliday, Ch. 28 & 29 |
| <b>Week 10</b> | 5.4 Magnetic field due to a current                                                                                          | Resnick & Halliday, Ch. 28 & 29 |
|                | 5.5 Force between two parallel currents                                                                                      | Resnick & Halliday, Ch. 28 & 29 |
| <b>Week 11</b> | 5.6 Ampere's law                                                                                                             | Resnick & Halliday, Ch. 28 & 29 |
|                | 5.7 Biot-Savart law                                                                                                          | Resnick & Halliday, Ch. 28 & 29 |
| <b>Week 12</b> | 5.8 Magnetic field due to a current carrying<br>5.8.1 Solenoid<br>5.8.2 Toroid                                               | Resnick & Halliday, Ch. 28 & 29 |
|                | 5.9 Current carrying coil as a magnetic dipole                                                                               | Resnick & Halliday, Ch. 28 & 29 |
| <b>Week 13</b> | <b>Unit-VI Electromagnetic Induction</b><br>6.1 Faraday's law of induction                                                   | Resnick & Halliday, Ch. 30      |
|                | 6.2 Lenz's law<br>6.3 Motional EMF                                                                                           | Resnick & Halliday, Ch. 30      |
| <b>Week 14</b> | 6.4 Induced electric fields<br>6.5 Energy stored in a magnetic field                                                         | Resnick & Halliday, Ch. 30      |

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| <b>Week 15</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 7.3 Magnetization, magnetic materials<br>7.3.1 Diamagnetism<br>7.3.2 Paramagnetism<br>7.3.3 Ferromagnetism                       | Resnick & Halliday, Ch. 32 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 7.4 Hysteresis                                                                                                                   | Resnick & Halliday, Ch. 32 |
| <b>Week 16</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Unit-VIII Maxwell's Equations and Displacement Current</b><br>8.1 Induced magnetic fields<br>8.2 Displacement Currents        | Resnick & Halliday, Ch. 32 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 8.3 Electromagnetism<br>8.4 Maxwell's equations.                                                                                 | Resnick & Halliday, Ch. 32 |
| <b>Textbooks and Reading Material</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                  |                            |
| <b>3. Fundamentals of Physics</b> (Extended), by D. Halliday, R. Resnick, and J. Walker, Wiley, 10th Edition, 2013.<br><b>4. Physics Vol. II</b> (Extended), by R. Resnick, D. Halliday, and K. Krane, 5th Edition, Wiley, 2001.<br><b>5. Electricity and Magnetism</b> , by E. M. Purcell and D. J. Morin, Cambridge, 3rd Edition, 2013.<br><b>6. University Physics with Modern Physics</b> , by R. A. Freedman, H. D. Young, and A. L. Ford (Sears and Zeemansky), Addison-Wesley, 13th Edition, 2010.<br><b>7. Physics for Scientists and Engineers</b> , by R. A. Serway and J. W. Jewett, 8th Edition, Golden Sunburst Series, 2010.<br><b>8. Physics for Scientists and Engineers with Modern Physics</b> , by D. C. Giancoli, Addison-Wesley, 4th Edition, 2008. |                                                                                                                                  |                            |
| <b>Teaching Learning Strategies</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                  |                            |
| 6. Lectures, interactive discussions, and problem-solving sessions.<br>7. Laboratory experiments for practical understanding.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                  |                            |
| <b>Assignments: Types and Number with Calendar</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                  |                            |
| 1. <b>Problem Set 1:</b> Solve problems related to electrostatics, electric fields, and Coulomb's law (End of Week 3).<br>2. <b>Conceptual Questions:</b> Short-answer questions on electric potential, capacitance, and energy storage (Start of Week 5).<br>3. <b>Numerical Problems:</b> Analyze resistance, current density, and applications of Ohm's law (End of Week 7).<br>4. <b>Problem Set 2:</b> Problems on magnetic forces, torque, and Biot-Savart law (End of Week 10).<br>5. <b>Group Assignment/Presentation:</b> Research and present findings on the applications of Maxwell's equations in modern technology (End of Week 14).                                                                                                                       |                                                                                                                                  |                            |