



Syllabus
Ph.D. Course Work
(Chemistry)



DEPARTMENT OF CHEMISTRY
KRISHNAGURU ADHYATMIK VISVAVIDYALAYA

2026

Course Structure:

Course Code	Course Title	Credit	Nature of course (T/P)	Marks Allotted		
				Internal	End Semester	Total
PHD-CHEM-5044	Techniques in Experimental Analysis	04	T	20	80	100
PHD-CHEM-5044	Environmental Chemistry	04	T	20	80	100
Total		08		40	160	200

Course Code: PHD-CHEM-5044
Course Title: Techniques in Experimental Analysis

Marks: 20+80=100
Total Credits: 04

Objective: This course aims to develop a foundational understanding of both classical and instrumental analytical techniques, focusing on the interpretation of analytical data, chemical equilibria, and the application of statistical and thermodynamic principles for solving analytical problems and evaluating real-world applications.

Course outcome: After successful completion of this course, students will be able to:

1. Evaluate and compare analytical techniques for accuracy, precision, and suitability.
2. Understand the theoretical foundation of gravimetric and volumetric analysis.
3. Apply chemical equilibrium concepts in complexometric, redox, and acid-base titrations.
4. Explain the principles behind spectroscopic, electrochemical, and chromatographic methods.

Content:

Unit I: Basic Concepts and Errors in Chemical Analysis

Introduction to analytical chemistry and its classification, Concepts of accuracy, precision, significant figures, and errors (systematic and random), Methods of error minimization, Statistical treatment of analytical data, Mean, median, standard deviation.

Unit II: Classical Methods of Analysis

- A. Gravimetric Analysis:** Principles, precipitation techniques, solubility product, co-precipitation, post-precipitation, peptization.
- B. Volumetric Analysis:** Principles of titrimetry, Types of titrations: acid-base, redox, complexometric, precipitation, Indicators and their selection.

Unit III: Spectroscopic Techniques

- A. **UV-Visible Spectroscopy:** Principles, Beer-Lambert law, instrumentation, Quantitative analysis.
- B. **Atomic Absorption and Emission Spectroscopy:** Principles, instrumentation, applications.
- C. **NMR Spectroscopy:** C-13 NMR: Basic difference with ^1H NMR, Chemical shift (aliphatic, olefinic, alkynes, aromatic, hetero-aromatic, carbonyl carbon); two-dimensional NMR spectroscopy
- D. **IR Spectroscopy:** Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols, amines; detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acid anhydrides, lactones, lactams, conjugated carbonyl compounds).

Unit IV: Electroanalytical Methods

Conductometry and conductometric titrations, Potentiometry and redox electrodes, Ion-selective electrodes and pH-metry, Coulometry and voltammetry: principles and applications.

References/ Textbooks:

1. Analytical Chemistry" by G. D. Christian and P. K. Sharma; *(Adapted Indian edition; Sharma is Indian contributor)* Publisher: Wiley India.
2. "Instrumental Methods of Chemical Analysis" by B.K. Sharma; Publisher: Krishna Prakashan Media *(Comprehensive book with both theoretical and instrumental details)*.
3. "Analytical Chemistry: Principles" by S. M. Khopkar; Publisher: New Age International Publishers *(Well-known for Indian university syllabi)*
4. "Textbook of Analytical Chemistry" by A. I. Vogel, adapted by G. H. Jeffery, J. Bassett, and Indian adaptations by S. S. Mendham and D. A. Sethi *(Classic text, often used in Indian universities; Indian edition available)*.
5. "Fundamentals of Analytical Chemistry" by D. K. Sahu; Publisher: Narosa Publishing House
6. "Analytical Chemistry" by G. Chatwal and S. Anand; Publisher: Himalaya Publishing House.
7. Introduction to Spectroscopy: by Donald L. Pavia, Cengage India Private Limited, **(2015)**.
8. 2. Fundamentals of Molecular Spectroscopy: by Colin N. Banwell, McGraw Hill Education, **(2017)**.

Course Code: PHD-CHEM-5054
Course Title: Environmental Chemistry

Marks: 20+80=100
Total Credits: 04

Course Objective: To introduce students to the fundamental concepts of environmental chemistry, focusing on the chemical processes in the atmosphere and water, pollution control, and the environmental impact of human activities.

Course Outcome: Upon successful completion of the course, students will be able to:

1. Understand the structure and components of the environment and the interdisciplinary nature of environmental science.
2. Explain atmospheric composition, structure, and chemical processes, including photochemical reactions.
3. Identify major air pollutants and describe their roles in climate change, acid rain, and global warming.
4. Analyze sources and effects of water pollution, understand eutrophication, and discuss relevant control and remediation strategies.

Contents:

Unit I: Introduction to Environmental Chemistry

Definition, scope, and importance, Segments of the environment (atmosphere, hydrosphere, lithosphere, biosphere), Interdisciplinary nature of environmental science.

Unit II: Atmospheric Chemistry

Understanding the Atmosphere-Definition and Importance, Composition of the Atmosphere-Major Gases (Nitrogen, Oxygen, Argon, CO₂), Variable Components (Water Vapor, Ozone, Dust Particles), Structure of the Atmosphere, Chemical and photochemical reactions in the atmosphere, Atmospheric Pressure and Temperature.

Unit III: Air Pollution and Climate Change

Overview of Air Pollution and Climate Change, Primary vs. secondary pollutants, Major air pollutants: CO₂, SO₂, NO_x, particulate matter, ozone, Greenhouse gases and global warming, Acid Rain, Chemical reactions leading to acid rain (SO₂ and NO_x with water).

Unit IV: Water Pollution

Different water pollutants along with their chemistry, Probable health effects of drinking water pollutants-WHO's guideline values. Eutrophication- Definition and process, Role of nutrients, Ecological consequences: oxygen depletion, fish kills, Control measures and remediation.

References/ Textbooks:

1. Environmental Chemistry: by Anil Kumar Dey and Arnab Kumar De, New Age International Private Limited, Edition: Eleventh, 2023.
2. Textbook of Environmental Chemistry: by Balaram Pani, TechSar Pvt. Ltd, 2017.
3. Fundamentals of Environmental Chemistry: by Fouzia Ishaq and Amir Khan, Discovery Publishing House, 2015.
4. Textbook of Environmental Chemistry: by Dr. Reetu Singh, Wave Books, 2019.
5. A Textbook of Environmental Chemistry: by V. Subramanian, Dreamtech Press, 2020.
6. Baird, C. *Environmental Chemistry*. 5th Edition, W.H. Freeman, 2017.
7. Schwarzenbach, R. P., Gschwend, P. M., Imboden, D. M. *Environmental Organic Chemistry*. 2nd Edition, Wiley, 2003.
