Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Empowered Autonomous Institute)

NAAC A+ Grade (4th Cycle) with 3.49 CGPA,
UGC-CPE (Phase-III) & DST-FIST Status

Structure and Curriculum of Certificate Course

in

Advanced Instrumentation

(Under PM-USHA)

For UG & PG Students

Approved by

Board of Studies in Chemistry

Rajarshi Shahu Mahavidyalaya, Latur
(Empowered Autonomous Institute)

w. e. f. December, 2025

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Empowered Autonomous Institute)

Department of Chemistry and

Analytical Chemistry

Under PM-USHA

Certificate Course in

Advanced Instrumentation

(30 Hours)

Academic year 2025-26

Sr. No.	Course Title	Marks	Credits	Hours (Theory and Practical)
1	Advanced Instrumentation	50	02	30

Shiv Chhatrapati Shikshan Sansth's

Rajarshi Shahu Mahavidyalaya, Latur

(Empowered Autonomous Institute)

Department of Chemistry & Analytical Chemistry

Course Type: Certificate Course
Course Title: Advanced Instrumentation
Lectures: 30 Hrs.

Learning Objectives:

LO 1: To understand the core principles of HPLC, spectroscopy, and TGA.

LO 2: To operate or simulate the operation of these instruments.

LO 3: To prepare samples and mobile phases correctly

LO 4: To interpret experimental data; and troubleshoot common issues.

Course Outcomes:

Upon successful completion of this course participants will be able to,

CO 1: Explain the core principles of HPLC, spectroscopy, and TGA.

CO 2: Handle the operation of these instruments.

CO 3: Prepare samples and mobile phases correctly

CO 4: Interpret experimental data; and troubleshoot common issues.

Unit No.	Title of Unit & Contents	Hours
I	**Introduction to Analytical Techniques & Lab Safety**	02
	1.1 Overview of Analytical Chemistry: Classical vs instrumental methods. **1.2 Method Selection:** Accuracy, precision, and error analysis. **1.3 Laboratory Safety:** General guidelines for handling reagents and operating equipment. **Unit Outcomes:** UO 1. Know the concepts of Classical vs Instrumental methods. UO 2. Become familiar with SDS/MSDS.	
II	**High-Performance Liquid Chromatography (HPLC)**	12
	2.1 Theory and Principles: Definition of chromatography, stationary and mobile phases, separation mechanisms (adsorption, partition, etc.). **2.2 Instrumentation:** Detailed look at key components: pumps, injectors, columns, column ovens, and detectors (UV-Vis, PDA). **2.3 Method Development & Optimization:** Mobile phase preparation and selection (isocratic vs. gradient elution,	

Unit No.	Title of Unit & Contents	Hours
	solvent effects), Stationary phases and column selection, Sample preparation for HPLC analysis, Chromatographic parameters (retention time, resolution, capacity factor, Van Deemter equation). **2.4 Operation & Maintenance:** Instrument qualification and calibration (IQ, OQ, PQ), preventive maintenance, and troubleshooting common problems. **2.5 Applications:** Qualitative and quantitative analysis in pharmaceuticals, environmental monitoring, etc. **Unit Outcome:** UO1. Know the Basic Concepts, Principle and Mechanism of Chromatography. UO2. Apply the Knowledge for Practical Chromatographic Work.	
III	**Spectroscopy**	**08**
	3.1 Principles: Electromagnetic spectrum, Beer-Lambert's Law and its limitations. **3.2 Instrumentation:** Light sources, monochromators, sample cells, and detectors. **3.3 Operational Procedures:** Calibration, choice of solvents, and sample handling. **3.4 Interpretation & Applications:** Qualitative identification and quantitative analysis, Determining concentration of unknown samples using calibration curves, Introduction to other types of spectroscopy (brief mention of IR, NMR principles, Fluorescence Spectroscopy). **Unit Outcomes**: UO 1. Know the Principle and Instrumentation of Spectrometers.. UO 2. Apply the Knowledge for Practical Analysis.	
IV	**Thermogravimetric Analysis (TGA)**	**08**
	4.1 Fundamentals: Definition, principle (measuring mass change as a function of temperature). **4.2 Instrumentation:** Components including furnace, balance mechanism, and atmosphere control. **4.3 Measurement and Data Interpretation:** TGA curves, decomposition temperatures, and identification of mass loss stages (moisture content, volatile components, decomposition, residue). **4.4 Applications:** Composition analysis, thermal stability assessment of materials (e.g., polymers).	

Unit No.	Title of Unit & Contents	Hours
	Unit Outcomes:	
	UO.1 Know the Principle and Instrumentation of TGA.	
	UO.2 Apply the Knowledge for TGA handling & TGA Curve Analysis.	

Note: Practical sessions (hands-on or virtual simulations) should be integrated throughout units II, III, and IV to provide practical knowledge of the techniques.

Reference:

1. Fundamentals of Analytical Chemistry, **Douglas A. Skoog, Donald M. West, F. James Holler, and Stanley R. Crouch**.

2. Analytical Chemistry, **Gary D. Christian, Purnendu K. Dasgupta, and Kevin A. Schug.**

3. Practical High-Performance Liquid Chromatography, **Veronika R. Meyer.**

4. Practical HPLC Method Development, Lloyd R. Snyder, Joseph J. Kirkland, and John W. Dolan.

5. Principles of Instrumental Analysis, Douglas A. Skoog, F. James Holler, and Stanley R. Crouch.

6. Spectroscopy: Theory, Experiment and Applications, M. Z. Kassaee.

7. Thermal Analysis: From Introductory Fundamentals to Advanced Applications, El-zeiny Ebeid, Mohamed Barakat Zakaria.

8. Instrumental Methods of Chemical Analysis, Anand and Chatwal.

Dr. D.G.Palke
Chairman
Board of Studies in Chemistry
Rajarshi Shahu Mahavidyalaya, Latur
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Dr. Mahadev Gavhane
Principal
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