Teaching Plan 2024

B.Sc. Chemistry (H) CBCS, VI Semester

Instrumental Methods of Chemical Analysis: Dr YUKTI MONGA

Week	Dates From – To	Topic
1.	18/01/2024 - 20/01/2024	Introduction to analytical methods of data analysis Treatment of analytical data, including error analysis.
2.	22/01/2024 - 27/01/2024	Classification of analytical methods and the types of instrumental methods. Consideration of electromagnetic radiations.
3.	29/01/2024 - 03/02/2024	Molecular spectroscopy Infrared spectroscopy: Interaction of radiations with molecules: absorption and scattering. Means of excitation (light sources), separation of spectrum (wavelength dispersion, time resolution), detection of the signal (heat, differential detection).
4.	05/02/2024 - 10/02/2024	Interpretation of spectrum (qualitative, mixtures, resolution), advantages of Fourier-Transform Infrared (FTIR) spectroscopy.
5.	12/02/2024 - 17/02/2024	Applications: Issues of quality assurance and quality control, special problems for portable instrumentation and rapid detection
6.	19/02/2024- 24/02/2024	UV-Visible/ Near IR Spectroscopy Emission, absorption, fluorescence and photoacoustic. Excitation sources (lasers, time resolution), wavelength dispersion (gratings, prisms, interference filters, laser, placement of sample relative to dispersion, resolution),
7.	26/02/2024 - 02/03/2024	Detection of signal (photocells, photomultipliers, diode arrays, sensitivity and S/N), Single and double beam instruments, Interpretation (quantification, mixtures, absorption vs. fluorescence and the use of time, photoacoustic, fluorescent tags).
8.	04/03/2024 - 09/03/2024	Separation techniques Chromatography: Gas chromatography, liquid chromatography, Importance of column technology (packing, capillaries),
9.	11/03/2024 - 16/03/2024	Electrophoresis (plates and capillary) and use with DNA analysis. Immunoassays and DNA techniques
10.	18/03/2024 - 23/03/2024	Making the gaseous molecule into an ion (electron impact, chemical ionization), Making liquids and solids into ions (electrospray, electrical discharge, laser desorption, fast atom bombardment),
11.	24/03/2024 - 31/03/2024	Mid- semester break
12.	1/04/2024 - 06/04/2024	Test for unit 1 to 4, presentations for internal assessment, Separation of ions on basis of mass to charge ratio, Magnetic, Time of flight, Electric quadrupole. Resolution, time and multiple separations, detection and interpretation.
13.	08/04/2024 - 13/04/2024	Elemental analysis, Atomic spectroscopy: Atomic absorption, atomic emission, and atomic fluorescence.). detection of radiation interpretation (errors due to molecular and ionic species, matrix effects, other interferences). detection of radiation (simultaneous/scanning, signal noise), interpretation (errors due to molecular and ionic species, matrix effects, other interferences).

14.	15/04/2024 - 20/04/2024	NMR spectroscopy: Principle, Instrumentation, Factors affecting chemical shift, Spin-coupling, Applications.
15.	22/04/2024 - 27/04/2024	Electroanalytical Methods: Potentiometry & Voltammetry
16.	29/04/2024 - 04/05/2024	Radiochemical Methods, X-ray analysis and electron spectroscopy (surface analysis)
17.	06/04/2024 – 11/04/2024	Tests / Assignments.

Teaching Learning Process:

- Conventional chalk and board teaching.
- Visit to chemical industries to get information about the technologies, methods to check pollutants and its treatment.
- ICT enabled classes.
- Power point presentations.
- Interactive sessions.
- To get recent information through the internet.

Assessment Methods:

Assessmentwill be done on the basis of regular class test, presentations and assignments as a part of internal assessment during the course as per the curriculum. End semester university examination will be held for both theory and practical. In practical, assessment will be done based on continuous evaluation, performance in the experiment on the date of examination and viva voce.

Keywords:

Air pollution,Biocatalysis,Environment,Green chemistry, Industrial gases, Inorganic chemicals, Metals, Ultrapure metals,Sources of energy,Water pollution.

Course Code: CHEMISTRY –DSE-10
Course Title: Instrumental Methods of Chemical Analysis
Total Credits: 06 **(Credits: Theory-04, Practical-02)**
(Total Lectures: Theory- 60, Practical-60)

Objectives:

This course aims to provide knowledge on various spectroscopic techniques for chemical analysis along with the basic principles of instrumentation.

Learning Outcomes:

By the end of the course, the students will be able to:

- Handle analytical data.
- Understand basic components of IR, FTIR, UV-Visible and Mass spectrometer.
- Interpret of IR, FTIR, UV-visible spectra and their applications.
- Understand the use of single and double beam instruments.
- Learn separations techniques like Chromatography.
- Learn elemental analysis, NMR spectroscopy, Electroanalytical Methods, Radiochemical Methods, X-ray analysis and electron spectroscopy.

Unit 1:

Introduction to analytical methods of data analysis

Treatment of analytical data, including error analysis. Classification of analytical methods and the types of instrumental methods. Consideration of electromagnetic radiations.

(Lectures: 4)

Unit 2:

Molecular spectroscopy

Infrared spectroscopy: Interaction of radiations with molecules: absorption and scattering. Means of excitation (light sources), separation of spectrum (wavelength dispersion, time resolution), detection of the signal (heat, differential detection), interpretation of spectrum (qualitative, mixtures, resolution), advantages of Fourier-Transform Infrared (FTIR) spectroscopy.

Applications: Issues of quality assurance and quality control, special problems for portable instrumentation and rapid detection.

(Lectures: 8)

Unit 3:

UV-Visible/ Near IR Spectroscopy

Emission, absorption, fluorescence and photoacoustic. Excitation sources (lasers, time resolution), wavelength dispersion (gratings, prisms, interference filters, laser, placement of sample relative to dispersion, resolution), Detection of signal (photocells, photomultipliers, diode arrays, sensitivity and S/N), Single and double beam instruments, Interpretation (quantification, mixtures, absorption vs. fluorescence and the use of time, photoacoustic, fluorescent tags).

(Lectures: 8)

Unit 4:

Separation techniques

Chromatography: Gas chromatography, liquid chromatography. Importance of column technology (packing, capillaries), Separation based on increasing number of factors (volatility, solubility, interactions with stationary phase, size, electrical field), Detection: simple vs. specific (gas and liquid), Detection as a means of further analysis (use of tags and coupling to IR and MS), Electrophoresis (plates and capillary) and use with DNA analysis. Immunoassays and DNA techniques.

(Lectures: 8)

Unit 5:

Mass spectroscopy

Making the gaseous molecule into an ion (electron impact, chemical ionization). Making liquids and solids into ions (electrospray, electrical discharge, laser desorption, fast atom bombardment). Separation of ions on basis of mass to charge ratio. Magnetic, Time of flight, Electric quadrupole. Resolution, time and multiple separations, detection and interpretation.

(Lectures: 8)

Unit 6:

Elemental analysis

Mass spectrometry (electrical discharges).
Atomic spectroscopy: Atomic absorption, atomic emission, and atomic fluorescence. Excitation and getting sample into gas phase (flames, electrical discharges, plasmas), wavelength separation and resolution (dependence on technique), detection of radiation (simultaneous/scanning, signal noise), interpretation (errors due to molecular and ionic species, matrix effects, other interferences).

(Lectures: 8)

NMR spectroscopy: Principle, Instrumentation, Factors affecting chemical shift, Spin-coupling, Applications.

(Lectures: 4)

Electroanalytical Methods: Potentiometry & Voltammetry **(Lectures: 4)**

Radiochemical Methods.**(Lectures: 4)**

X-ray analysis and electron spectroscopy (surface analysis).**(Lectures: 4)**

Practical:

(Credits: 2, Laboratory periods: 60)

Chemistry Lab: Instrumental methods of chemical analysis

At least 10 experiments to be performed

1. Determination of the isoelectric pH of a protein.
2. Titration curve of an amino acid.
3. Determination of the void volume of a gel filtration column.
4. Determination of a mixture of cobalt and nickel (UV-visible spectroscopy).
5. Study of electronic transitions in organic molecules (i.e., acetone in water).
6. IR absorption spectra (study of aldehydes and ketones).
7. Determination of calcium, iron, and copper in food by atomic absorption spectroscopy.
8. Quantitative analysis of mixtures by gas chromatography (i.e., chloroform and carbon tetrachloride)
9. Separation of carbohydrates by HPLC.
10. Determination of caffeine in beverages by HPLC.
11. Potentiometric titration of a chloride-iodide mixture.
12. Cyclic voltammetry of the ferrocyanide/ferricyanide couple.
13. Use of nuclear magnetic resonance instrument and to analyse the spectra of methanol and ethanol
14. Use of fluorescence to do "presumptive tests" to identify blood or other body fluids.

15. Use of "presumptive tests" for anthrax or cocaine.
16. Collection, preservation, and control of blood evidence being used for DNA testing.
17. Use of capillary electrophoresis with laser fluorescence detection for nuclear DNA (Y chromosome only or multiple chromosome).
18. Use of sequencing for the analysis of mitochondrial DNA.
19. Laboratory analysis to confirm anthrax or cocaine.
20. Detection in the field and confirmation in the laboratory of flammable accelerants or explosives.
21. Detection of illegal drugs or steroids in athletes.
22. Detection of pollutants or illegal dumping.
23. Fibre analysis.

References:

Theory:

1. Willard, H.H.; Merritt, L.L. Jr.; Dean, J.A.; Settle, F.A. Jr.(2004). **Instrumental methods of analysis**, 7th edition, CBS Publishers.
2. Christian, G.D.(2004),**Analytical Chemistry**, 6th Edition, John Wiley & Sons, New York.
3. Skoog, D.A.; Holler, F. J.; Crouch, S.(2006),**Principles of Instrumental Analysis**,Thomson Brooks/Cole.
4. Barwell, C.N. (2006),**Fundamentals of Molecular Spectroscopy**,Tata McGraw-Hill Education

Practical:

1. Skoog, D. A.; Holler, F. J.; Crouch, S.(2006),**Principles of Instrumental Analysis**, Cengage Learning.

Teaching Learning Process:

- Conventional chalk and board teaching.
- Class interactions and group discussions
- Power point presentation on important topics.

Assessment Methods:

Assessmentwill be done on the basis of regular class test, presentations and assignments as a part of internal assessment during the course as per the curriculum. End semester university examination will be held for both theory and practical. In practical, assessment will be done based on continuous evaluation, performance in the experiment on the date of examination and viva voce.

Keywords:

Analytical methods of data analysis, Infrared spectroscopy, UV-Visible spectroscopy, Chromatographic techniques, Mass spectra, Elemental analysis methods, NMR spectroscopy, Electroanalytical methods, Radiochemical methods, X-ray analysis, Electronic spectroscopy.