Subject: Chromatographic techniques-MSCAC11503

Type of course: Major

Prerequisite: Students should have basic knowledge of general, organic and physical chemistry, including mole concept, preparation and concentration of solutions, acid–base chemistry, chemical equilibrium, polarity, solubility, adsorption, partitioning, basic laboratory techniques, and elementary mathematical and statistical calculations. This knowledge will help students understand the principles, operation and interpretation of analytical and chromatographic techniques.

Rationale: The knowledge provides a strong conceptual and practical foundation for learning Analytical Chemistry and Chromatographic Techniques. Students can progress from basic chemical principles to quantitative analysis, separation, identification, and instrumental methods. In particular, knowledge of solution chemistry, polarity, adsorption, partitioning, equilibrium, and basic mathematics enables students to understand why different components separate and how analytical results are measured and interpreted.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks					Total Marks
				Theory Marks		Practical Marks		CA	
CI	T	P	C	ESE	MSE	V	P	ALA	
4	0	0	4	60	30	10	00	50	150

Legends: CI-Class Room Instructions; T – Tutorial; P - Practical; C – Credit; ESE - End Semester Examination; MSE- Mid Semester Examination; V – Viva; CA - Continuous Assessment; ALA- Active Learning Activities.

Course Content:

Unit No.	Course content	Hrs	% Weightage
1	**Acid- Base Titrations:** Introduction,The Arrhenius theory of acid and bases, the bronsted- lowry theory of acid and bases,The lewis theory of acid and bases, strong and weak acids and bases,pH solution,Common ion effect,-Buffer solution, acid base indicators.	12	25
2	**Theory of Dilute solutions:** Colligative properties: lowering of vapor pressure: Raoult's law Derivation of Raoult s law, determination of molecular mass from lowering of vapor pressure, measurement of lowering of vapor pressure: barometric method, manometric method, O'stwald and walker's dynamic method, boiling point elevation, relation between boiling-point elevation and vapor-pressure lowering, determination of molecular mass from elevation of boiling point Freezing-point depression: determination of molecular weight from depression of freezing point, colligative properties of electrolytes, abnormal molecular masses of electrolyte.	16	25
3	**Basics of Chromatography** Introduction, core principles of chromatography, Stationary Phase, Mobile Phase, Separation, Differential migration, Classification of chromatography on the basis of stationary and mobile phase, Paper chromatography with proper illustration. Basic introduction of advanced chromatography, Thin Layer Chromatography (TLC), Basic component use in TLC like tlc plate, tlc chamber, solvent, mobile phase, stationary phase, sample, Capillary etc. Procedure and analysis of tlc,calculation, Applications of TLC Advantages and disadvantages.	16	25
4.	**Advanced Chromatography** Column chromatography-Principle of operation, separation process, Applications of column chromatography, Advantages and disadvantages. Principle of Gas chromatography (GC),	16	25

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	Suitable analytes, Separation mechanism, Carrier gas, Sample injector, Column, Detector, Applications. High-Performance Liquid Chromatography (HPLC) Principle of operation, Key components of an HPLC system, Applications.		
	Total	60	100

Continuous Assessment:

Sr. No	Active Learning Activities	Marks
1.	**Concept Map Challenge** Students have to take readings of given solutions Connect vapor Pressure-> Boiling point-> Freezing point-> Molecular Mass. Students have to prepare a report regarding applications of advanced chromatography and uploaded the same to the GMIU Web Portal.	10
2.	**Chemistry in the News** Instruct students to find recent news articles related to chemistry. They can explore topics like new discoveries, environmental issues, or advancements in technology. Make a report and upload it on GMIU Web Portal.	10
3.	**Natural Indicators** Students will identify the natural indicators around their surroundings and then will write the name, use, and drawback and will also draw the structure of that indicator and will upload on the GMIU web Portal.	10
4.	**Literature review** Students have read and critically analyzed a published research paper that uses advanced chromatography (e.g., GC-MS or LC-MS/MS). Students have prepared a review paper regarding applications of advanced chromatography and uploaded the same to the GMIU Web Portal.	10
5.	**Interactive simulations** Faculty provide different types of parameter to students, Students use a virtual chromatography lab simulation (e.g., from Labster) to allow stude... to manipulate method validation/parameters like the mobile phase o...	10

	stationary phase and students make their report upload the same on GMIU Web Portal.	
	Total	**50**

Suggested Specification table with Marks (Theory):60

Distribution of Theory Marks (Revised Bloom's Taxonomy)						
Level	Remembrance (R)	Understanding (U)	Application (A)	Analyze (N)	Evaluate (E)	Create (C)
Weightage	30%	30%	20%	20%	00	00

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcome:

After learning the course the students should be able to:	
CO1	Students will be able to determine and interpret pH, common-ion effect, buffer action, and acid–base indicator behaviour, and apply these concepts to acid–base titrations and analytical chemistry problems.
CO2	Students will be able to explain and compare the Arrhenius, Brønsted–Lowry, and Lewis concepts of acids and bases and distinguish between strong and weak acids and bases using appropriate chemical principles.
CO3	Students will be able to explain the fundamental principles of chromatography, including stationary phase, mobile phase, differential migration, separation mechanisms, and classification of chromatographic techniques.
CO4	Students will be able to perform and interpret paper chromatography and Thin Layer Chromatography (TLC), including selection of stationary/mobile phases, sample application, development, visualization, calculation of Rf value, and analysis of chromatograms.

Instructional Method:

The course delivery method will depend upon the requirement of content and the needs of students. The teacher in addition to conventional teaching methods by black board, may also use any tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.

From the content 10% topics are suggested for flipped mode instruction.

Students will use supplementary resources such as online videos, NPTEL/SWAYAM videos, e-courses, Virtual Laboratory

The internal evaluation will be done on the basis of Active Learning Assignment

Practical/Viva examination will be conducted at the end of semester for evaluation of performance of students in the laboratory.

Reference Books:

[1] Principles of Instrumental Analysis by Skoog, Holler, and Crouch. Cengage India Private Limited

[2] Chromatography: Concepts and Contrasts by James M. Miller. Wiley-Interscience

[3] Chromatography and Spectroscopy techniques-Jan Fleming. McGraw

[4] Spectroscopic Methods in Organic Chemistry by Dudley H. WIR NOVADVE Hill Publishing Co.

[5] Spectroscopy of Organic Compounds by P.S. Kalsi. New Age International Pvt Ltd

[6] Introduction to Spectroscopy by Donald L. Pavia, Gary M. Lampman, George A. Kriz, and James R. Vyvyan, Brooks/Cole Pub Co.