CHE-304-MJ-T: ANALYTICAL CHEMISTRY II

Course Type: Major Theory **Credits: 2**

A. Course Objectives:

1. To provide fundamental knowledge of gravimetric and thermal analytical techniques.
2. To familiarize students with chromatographic methods for separation and analysis.
3. To introduce principles of instrumental techniques such as HPLC and GC.
4. To develop understanding of analytical procedures and quantitative estimations.
5. To promote insight into modern analytical methods and their applications

B. Course Outcomes (COs):

CO No.	Course Outcome Statement (COs) *After learning the course, the students are able to -*
CO-1	Recall concepts of gravimetric analysis, thermal methods, and chromatographic techniques.
CO-2	Explain principles and instrumentation of analytical methods.
CO-3	Apply analytical techniques for quantitative determination and separation.
CO-4	Analyze data from gravimetric, thermal, and chromatographic methods.
CO-5	Evaluate accuracy, efficiency, and applications of analytical techniques.
CO-6	Illustrate working principles and methodologies of instrumental analysis.

C. Contents:

Prerequisites	
Students should have basic knowledge of analytical chemistry, chemical equilibrium, and solution chemistry. Familiarity with basic laboratory techniques, stoichiometry, and elementary instrumentation concepts is required.	
Chapter 1: Gravimetric Analysis	**06 Hours**
Introduction to gravimetric analysis; Precipitation methods; The colloidal state; Super saturation and precipitate formation; The purity of the precipitate: Co-precipitation; Conditions of precipitation; Precipitation from homogeneous solution; Washing the precipitate; Ignition of the precipitate: quantitative separations based upon precipitation methods: Fractional precipitation; Organic precipitants (8-hydroxyquinoline, DMG, Cupferron, Nitron, and Benzoin-alfa oxime, Anthranilic acid), Gravimetric Calculations-How Much Analyte is there (Ref-3) Applications of Gravimetry: Determination of Al(III) by 8-hydroxyquoline, Determination of calcium as oxalate, Numericals, Key Ref.-1: 417-428,	

433-444, 446, 451, 464, 485; [Supplementary Ref-2: Pp-342 to 362]	
Chapter 2: Thermal Methods of Analysis	**06 Hours**
General discussion, Thermogravimetry, Experimental factors affecting TG analysis, Instruments for thermogravimetry, Applications: Thermogravimetric analysis of CaC_2O_4 H_2O, $CuSO_4$ $5H_2O$, Differential Thermal Analysis: Introduction, instrumentation for DTA and DSC, experimental and instrumental factors, applications: DTA of copper sulphate pentahydrate, Purity of Pharmaceutical by DSC. Key Reference-2: 503-522, [Supplementary reference, Ref-4: 884-890, Ref-1: 428-433].	
Chapter 3: Column Chromatography	**07 Hours**
Introduction, HETP, Match Box Model, Principle of Column Chromatography, **Ion Exchange Chromatography**: Ion exchange resins, action of ion exchange resin (Ion exchange equilibria, Ion exchange capacity), Experimental technique, **Application**: i) Separation Metal ions / non-metal ions on Ion Exchange Chromatography (Zn(II) and Mg(II), Cl- and Br-), ii) Purification of water, (Ref-5: 186-192, 205-209) **Adsorption Chromatography Liquid solid chromatography**: Introduction, the technique of conventional chromatography, column packing materials, Selection of solvent for adsorption chromatography, Adsorption column preparation and loading, **Application:** Purification of anthracene (Ref-6: 209-215, 221).	
Chapter 4: High Performance Liquid Chromatography	**07 Hours**
Introduction, Types of liquid chromatography (liquid-solid, liquid-liquid), Choice of mode of separation, Equipment for HPLC: mobile phase, sample injection and column design (mobile phase, optimization of mobile phase, gradient elution, solvent delivery and sample injection, sample injection system, the column (effect of column length and column diameter), Choosing the Detector, Ultraviolet detector, Luminescence detector, electrochemical detector, Column efficiency, HPLC chromatogram and its characteristics (retention time, peak height, peak area), Method of quantitative analysis by HPLC, Example: Determination of aspirin, phenacetin and caffeine in a mixture, Numericals, Key Ref-2: 289-315, [Supplementary reference - Ref-3: 649-724, Ref-3: 1-325 -relevant part, Ref-7].	
Chapter 5: Gas Chromatography	**04 Hours**
Gas Chromatography:- Introduction, Apparatus: A supply of carrier gas from a high-pressure cylinder, Sample injection system and derivatization, The column (Packed columns, Open tubular columns), Detectors (TCD, FID, ECD), Quantitative analysis by GC (Area normalization method and internal standard addition method), Elemental analysis, numerical	

Key. Ref. 2. And Ref. 8

References:

1. Vogel's Textbook of Inorganic Quantitative Analysis, G. H. Jeffery, J. Bassett, J. Mendham, R. C. Denney, Longman Scientific & Technical, 5th Edition, 1989.
2. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R. C. Denney, J. D. Barnes, M. J. K. Thomas, Pearson Education, 6th Edition, 2000.
3. Analytical Chemistry, G. D. Christian, Wiley, 6th Edition, 2004.
4. Principles of Instrumental Analysis, D. A. Skoog, F. J. Holler, S. R. Crouch, Thomson Brooks/Cole, 6th Edition, 2007.
5. Vogel's Textbook of Quantitative Chemical Analysis, G. H. Jeffery et al., Longman Scientific & Technical, 5th Edition, 1989.
6. Vogel's Textbook of Practical Organic Chemistry, A. I. Vogel, Longman Scientific & Technical, 5th Edition, 2004.
7. Principles of Instrumental Analysis, D. A. Skoog, F. J. Holler, S. R. Crouch, Thomson Publication, 6th Edition, 2007.
8. Instrumental Methods of Chemical Analysis, Gurdeep Chatwal, Sham Anand, Himalaya Publishing House, Latest Edition.