University of Kerala

Discipline	CHEMISTRY				
Course Code	**UK4DSECHE202**				
Course Title	**ANALYTICAL CHEMISTRY- II**				
Type of Course	**DSE**				
Semester	4				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2	5
Pre-requisites	1. Basic Chemistry 2. Mathematical Skills 3. Familiarity with laboratory techniques, safety procedures, and basic equipment handling is necessary for conducting experiments and analyses in the course. 4. UK3DSECHE202 (preferable)				
Course Summary	Theoretical concepts & experimental procedures in quantitative analysis, and data analysis techniques				

Detailed Syllabus:

Module	Unit	Content ANALYTICAL CHEMISTRY- II	Hrs 75
I		**ERRORS & THEIR MINIMIZATION IN CHEMICAL ANALYSES**	**9**
	1	Characterizing Measurements and Results: Measures of Central Tendency (Mean, Median) & Measures of Spread (Range, Standard Deviation, Variance). Characterizing Experimental Error: Accuracy & Precision, Classification of errors: Determinate & Indeterminate Errors, Minimization of errors.	4
	2	Significant figures, Absolute and relative uncertainty, Propagation of uncertainty	2
	3	Rules of Computing, Problems, Ways of expressing accuracy	3
II		**STATISTICAL DATA TREATMENT AND EVALUATION**	**9**
	4	Statistical Analysis of Data: Standard Deviation, Confidence Limit, Tests of Significance, Rejection of a Result: *Q* Test, F-test.	3

University of Kerala

	5	Linear Least Squares, Correlation Coefficient and Coefficient of Determination, Detection Limits.	2
	6	Statistics of Sampling, Distribution of Measurements and Results: Probability Distributions and Confidence Intervals for Populations and samples.	4
III		**GRAVIMETRIC ANALYSIS**	**9**
	7	Introduction to gravimetric analysis, Precipitation methods, Quantitative separations based upon precipitation methods: Fractional precipitation, Organic precipitants, Volatilisation or evolution methods. The colloidal state, Supersaturation and precipitate formation, The purity of the precipitate: Co-precipitation.	3
	8	Conditions of precipitation: Precipitation from homogeneous solution. Washing the precipitate, Drying and Ignition of the precipitate.	3
	9	Common Mistakes and minimization of Errors, Applications of Gravimetric analysis, Organic Precipitating agents (Oxime, Dimethyl Glyoxime.	3
IV		**TITRIMETRIC METHODS OF ANALYSIS**	**18**
	10	Titrimetric analysis, Classification of reactions in titrimetric analysis, Standard solutions, Equivalents, normality and oxidation number, Preparation of standard solutions, Primary and secondary standards.	4
	11	Neutralisation Titrations: Neutralisation Indicators, Neutralization curves, Choice of indicators in neutralisation reactions- (can be Briefly mentioned).	2
	12	Redox titrations: Electrode potential, Change of the electrode potential during redox titration, Detection of the endpoint in redox titrations. Oxidation with $KMnO_4$, $K_2Cr_2O_7$, Cerium (IV) Sulphate, Redox Process involving iodine.	4
	13	Complexation Titrations: Introduction, Types of EDTA titrations, Titration of mixtures, selectivity, masking and demasking agents, Metal ion indicators, Standard EDTA solutions, Some practical considerations: pH, concentration of metal ion, amount of indicator, endpoint and colour change.	4
	14	Precipitation titrations: Precipitation reactions, Determination of endpoints in precipitation reactions.	4
V		**ANALYTICAL CHEMISTRY PRACTICAL**	**30**
		PART A (All experiments in section A are compulsory)	
	1	Calibration of Analytical Glassware.	
	2	Cleaning & Safe Handling of Glassware.	
	3	Estimation of acetic acid content in vinegar.	

University of Kerala

PART B (Any 5 experiments from B and C need to be done)		
1	Titrimetric estimation of Ascorbic acid in orange juice, Vitamin C tablets.	
2	Excel Basics for Statistical Analysis of Laboratory Data.	
PART C		
1.	Estimation of carbonate and hydroxide present together in mixture.	
2.	Estimation of carbonate and bicarbonate present together in a mixture.	
3.	Estimation of free alkali present in different soaps.	
4.	Estimation of Fe(II) using standardized $KMnO_4$ solution.	
5.	Estimation of oxalic acid using standardized $KMnO_4$ solution.	
6.	Estimation of Fe(II) with $K_2Cr_2O_7$ using internal indicator.	
7.	Estimation of Fe(II) with $K_2Cr_2O_7$ using external indicator.	
8.	Iodimetric Titration of Vitamin C.	
9.	Estimation of Magnesium (or Zinc) ions by complexometry.	
10.	Determination of Total Hardness of Water by complexometry.	

References

1. G. H. Jeffery, J. Bassett, J. Mendham, R. C. Denney, *Vogel's Text book of Quantitative Inorganic Analysis*, Longman, Fifth Edition, 1989.
2. D. A. Skoog, D. M. West and F. J. Holler, *Fundamentals of Analytical Chemistry*, Saunders College Publishing, 7th edition, 1996.
3. D. J. Holme and H. Perk, Analytical Biochemistry, 3rd edition, Prentice Hall, 1998.
4. Gary D. Christian, Purnendu K. Dasgupta, Kevin A. Schug, *Analytical Chemistry –*, Wiley, 7th edition, 2013.
5. D. A. Skoog and D. M. West, *Principles of Instrumental Analysis*, Saunders College Publishing, 5th edition, 1998.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Analyse the limitations of analytical methods by examining the sources and nature of errors. Distinguish between different types of errors and evaluate strategies for minimizing their impact. Analyse the use of significant figures and the rules for computation, and compare absolute and relative uncertainties.	An	PSO-1 & 2
CO-2	Analyse statistical data to identify trends, deviations, and	An	PSO-2

University of Kerala

	patterns, and evaluate the suitability of statistical methods for small data sets and detection limits. Examine the criteria for rejection of analytical results and justify the rejection based on statistical reasoning and critical evaluation.			
CO-3	Evaluate the principles of gravimetric analysis and critically judge the reliability and efficiency of quantitative separations based on gravimetry for different analytical applications.	E	PSO-1	
CO-4	Design integrated titrimetric procedures using neutralisation, redox, complexometric, and precipitation methods, selecting appropriate standards, indicators, and conditions to solve complex analytical problems.	C	PSO-1	
CO-5	Design accurate and efficient calibration procedures to enhance the reliability of analytical measurements and develop titrimetric procedures to solve different analytical problems. Evaluate the effectiveness of Excel-based statistical tools in analysing laboratory data, identifying patterns, errors, and data quality issues.	C, E	PSO-2 & 4	

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: ANALYTICAL CHEMISTRY II

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	CO-1	PSO-1 & 2	An	F	L	
2	CO-2	PSO-2	An	F, C	L	
3	CO-3	PSO-1	E	F, C	L	
4	CO-4	PSO-1	C	C	L	
5	CO-5	PSO-2 & 4	C, E	P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

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	PSO 1	PSO 2	PSO 3	PSO 4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	2	-	-	-	-	2	2	-	-	-	-	-
CO 2	1	3	-	-	-	-	3	3	-	-	-	-	-
CO 3	2	-	-	-	-	-	2	2	-	-	-	-	-
CO 4	2		-	-	-	-	2	-	-	-	-	-	-
CO 5	-	2	-	3	-	-	-	-	-	-	-	1	2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	√	√		√
CO 2	√	√		√
CO 3	√	√	✓	√
CO 4	√		✓	√
CO 5	√			

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