University of Kerala

Discipline	CHEMISTRY				
Course Code	**UK5DSECHE305**				
Course Title	**ANALYTICAL CHEMISTRY- IV**				
Type of Course	**DSE**				
Semester	5				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3hours	-	2	5
Pre-requisites	1. Prior knowledge of basic analytical chemistry principles, such as the interaction of analytes with different separation methods 2. Prior knowledge of electrochemical cells, electrode potentials, and the Nernst equation is necessary. 3. Understanding voltaic cells, anodes, cathodes, and cell voltages. 4. UK3DSECHE202, UK4DSECHE202, UK5DSECHE304				
Course Summary	In-depth understanding of various analytical Separation techniques and electrochemical methods used in analytical chemistry				

Detailed Syllabus:

Module	Unit	Content ANALYTICAL CHEMISTRY - IV	Hrs 75
I	**Electrochemical Methods of Analysis**		**9**
	1.1	Classification of Electrochemical Methods, Potentiometers & Potentiometric methods of analysis, Potentiometric Measurements: Potentiometric Electrochemical Cells, Potential and Concentration-The Nernst Equation, Liquid junction potential	3
	1.2	Reference Electrode: SHE, Saturated Calomel Electrode, Potentiometric Titrations: Principle, Detection of Endpoints, Derivative methods of locating end points.	2
	1.3	pH Meter, Standard Buffers Reference for pH Measurements, Working of pH meter.	2
	1.4	pH Measurements in Nonaqueous Solvents, Ion Selective electrodes: Glass membrane electrodes	2
II	**ANALYTICAL SEPARATION I**		**9**
	2.1	Classification of separation techniques (based on size, mass/density, change of state, partitioning between phases)	3

	2.2	Separation of Species by Distillation: Different distillation Techniques: Simple, fractional, Vacuum, Steam distillation	4
	2.3	Centrifugation: Principle, Types of centrifuges, Applications	2
III	**ANALYTICAL SEPARATION II**		**9**
	3.1	Supercritical Fluid Chromatography: Properties of Supercritical Fluids, Mechanism of Working of SFC, Comparison with Other Chromatography Techniques, Applications of Supercritical Fluid Chromatography. Supercritical Fluid Extraction (SFE), Applications of Supercritical Fluid Extraction	3
	3.2	Solvent Extraction: Factors favouring solvent extraction, Quantitative treatment of solvent extraction equilibria, Synergistic extraction, Batch Extraction, Craig's Technique of Liquid-liquid extraction.	4
	3.3	Solid Phase Extraction, SPE Cartridges, SPE Pipet Tips, SPE Disks, and other sorbents for SPE	2
IV	**ELECTRO ANALYTICAL METHODS**		**18**
	4.1	Electro gravimetry: Theory, Terms used in electro-gravimetric analysis, Completeness of deposition, Electrolytic separation of metals	4
	4.2	Conductometry: Introduction, Applications of conductometric measurements, The basics of conductometric titrations, Apparatus and Applications of conductometric titrations,	5
	4.3	Basics of Coulometry, Types of Coulometric Methods: controlled-potential (potentiostatic) coulometry and controlled-current coulometry, Applications of Coulometry Coulometric Titrations, Applications of Coulometric Titrations	5
	4.4	Voltammetry, Excitation Signals in Voltammetry, Voltammetric Instrumentation, Stripping Voltammetry, Cyclic voltammetry, Applications of Voltammetry	4
V	**ANALYTICAL CHEMISTRY PRACTICALS II**		**30**
	Section A (All experiments in section A are compulsory)		
	A	Separation of components from various Mixtures and check the purity of the components using TLC (a) Separation of components from a mixture of (i) Cinnamic acid/ p-nitro benzoic acid & Nitrobenzene, Ethyl benzoate, Acetophenone (ii) β-Naphthol & Nitrobenzene, Ethyl benzoate, Acetophenone (iii) p-toludine/m-nitro aniline/ aniline & Benzophenone /Naphthalene Paper chromatographic Separation of a mixture of inks or sugars	
	Section B & Section C (Any 5 experiments from B and C need to be done)		
	B	(i) Separation of metal ions by Solvent extraction using TOPO/TPPO/ crown ethers as the chelating agent and analyze the extraction efficiency using UV-Vis spectroscopy (ii) Separation of a mixture of two amino acids by ascending and horizontal paper chromatography	

		(iii) Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin-layer chromatography (TLC) Paper chromatographic separation of following metal ions: i. Ni (II) and Co (II) ii. Fe (III) and Al (III)	
	C	Perform the following conductometric titrations: i. Strong acid vs. strong base ii. Weak acid vs. strong base iii. Mixture of strong acid and weak acid vs. strong base iv. Strong acid vs. weak base Perform the following potentiometric titrations: i. Strong acid vs. strong base ii. Weak acid vs. strong base iii. Dibasic acid vs. strong base Potassium dichromate vs. Mohr's salt	

References

1. S.M. Khopkar, *Basic Concepts of Analytical Chemistry*, New Academic Science Limited, 3rd edition, 2012.
2. James W. Robinson, Eileen M. Skelly Frame, George M. Frame II, *Undergraduate Instrumental Analysis*, Marcel Dekker. Taylor & Francis e-Library, 6th edition, 2005.
3. B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell, *Vogel's Text Book of Practical Organic Analysis*, Longman, 5th edition, 1989.
4. D. A. Skoog, D. M. West and F. J. Holler, *Fundamentals of Analytical Chemistry*, Saunders College Publishing, 7th edition, 1996.
5. D. J. Holme and H. Perk, *Analytical Biochemistry*, 3rd edition, Prentice Hall, 1998.
6. B. K. Sharma, *Analytical Chemistry*, Krishna Prakashan Media (P) Ltd., 2nd Edition, 2006
7. Gary D. Christian, Purnendu K. Dasgupta, Kevin A. Schug, *Analytical Chemistry* –, Wiley, 7th edition, 2013.
8. D. A. Skoog and D. M. West, *Principles of Instrumental Analysis*, Saunders College Publishing, 5th edition, 1998.
9. Gurdeep R. Chatwal, Sham K. Anand, *Instrumental Methods of Chemical Analysis*, Himalaya Publishing House.
10. H. W. Nürnberg, *Electroanalytical Chemistry*, Wiley-Interscience, 1974.
11. H. H. Willard, L.L. Jr., J.A.Dean, F.A. Jr. Settle, *Instrumental Methods of Analysis*, CBS Publishers & Distributors, 7th Edition, 1986.
12. G. H. Jeffery, J. Bassett, J. Mendham, R. C. Denney, *Vogel's Text book of Quantitative Inorganic Analysis*, Longman, Fifth Edition, 1989.
13. Gurdeep Raj, *Advanced Practical Inorganic chemistry*; GOEL publishing House
14. D. V. Jahagirdar, *Experiments in Chemistry*, Himalaya Publishing House.
15. B. D Khosla, V. C.Garg, Gulati, *A. Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Mastery of potentiometric electrodes and redox titrations.	An	1
CO-2	Understanding the principles of separation efficiency and various separation techniques.	An	2
CO-3	Mastery of solvent extraction and solid-phase extraction techniques.	C	2
CO-4	Understand the theory of electro-gravimetric analysis, the application of conductimetry and coulometry as an analytical tool & attain knowledge about Kinetic Methods of Analysis	E	2
CO-5	Proficiency in performing Separation of components from mixtures, Conductometric and Potentiometric Experiments.	Ap	1,3

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

Name of the Course: ANALYTICAL CHEMISTRY IV

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	PO-1 PSO-1	An	F, C	L	
2	CO-2	PO-1 PSO-2	An	C	L	
3	CO-3	PO-1 PSO-2	C	C	L	
4	CO-4	PO-1 PSO-2	E	F, C	L	
5	CO-5	PO-2 & 6 PSO-1	Ap	P		P

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

Mapping of COs with PSOs and POs:

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