

Course title: Advanced Analytical Techniques for Environmental Application				
Course code: NRE 114		No. of credits: 3	L-T-P: 28-06-16	Learning hours: 50
Pre-requisite course code and title (if any):				
Department: Energy and Environment				
Course coordinator: Dr Udit Soni			Course instructor: Dr Udit Soni	
Contact details: udit.soni@terisas.ac.in				
Course type: Core			Course offered in: Semester 2	
Course Description This course is to provide understanding of various analytical techniques and instrumental methods that students come across during their course work and research undertakings. This course begins with basic introduction of analytical technique and related terminologies. This course introduces analytical techniques along with working principal, common instrumentation and possible applications. This course will be beneficial to various fields including, environmental science, chemical science, material science and life science.				
Course objective				
<ul style="list-style-type: none"> The primary objectives of this course are to develop the skills to understand the basic principal of selected analytical techniques. To provide scientific understanding of analytical techniques, instrumentation, operation, interpretation of data and applications. 				
Course content				
Module	Topic	L	T	P
1.	Spectroscopy Techniques- Electromagnetic spectrum. Quantisation of energy, Electronic, vibrational and rotational transition. Jablonski diagram, Qualitative and quantitative analysis, Beer-Lambert's law and limitations. UV-Visible spectroscopy- Principals, instrumentation, sampling and application, Fluorescence Spectroscopy, IR/Raman Spectroscopy.	5	0	4
2.	Atomic Spectrometry- Atomic Absorption Spectrometry/Atomic Emission Spectroscopy-Principal, Instrumentation, sampling and application, Hydride generation technique, Flame Photometry, MP-AES, ICP-OES	4	1	4
3.	Chromatographic Techniques- Classification of chromatographic techniques, principles and theory of chromatography. Liquid Chromatography-HPLC, Instrumentation, solvent delivery system, isocratic and gradient elution, reversed phase and normal phase chromatography, Ion Chromatography and application. Gas Chromatography- Instrumentation, carrier gas, packed and capillary columns, different detectors and applications. Introduction to hyphenated techniques.	5	1	2
4.	X-Ray techniques- Solids, crystal, Bravais lattice, miller indices, X-rays production, X- ray diffraction, Bragg's law, PXRD. X-ray fluorescence-principle, instrumentation and application.	5	2	0
5.	Electroanalytical Methods- Redox process, electrode and electrode potentials, electrochemical cells, Potentiometry, Conductometry. Polarography-Principle, half wave potential, Ilkovic equation and application.	5	2	0
6.	Thermal Analysis Techniques-Heat, heat capacity, thermal conductivity Working principle, instrumentation and application of Thermogravimetric	4	0	6

	Analysis, Differential Scanning Calorimetry and Differential Thermal Analysis.			
		28	6	16
Evaluation criteria				
Test 1: 30 % Test 2: 30% Test 3: 40%				
Learning outcomes				
<ul style="list-style-type: none"> To be able to handle appropriate instrumental methods for analysis. Familiarity with working principals, tools and techniques of analytical techniques. To understand the strengths, limitations and creative use of techniques for problem-solving. 				
Pedagogical approach				
Classroom lectures, tutorials, demonstration of analytical techniques and Practical training/hand on training. Case studies based on peer reviewed research articles.				
Employability:				
Academic, NGO and industrial research organization.				
Materials				
Required text				
Suggested readings				
<ul style="list-style-type: none"> Keith A. Smith and Malcolm S. Cresse, "Soil and Environmental Analysis Modern Instrumental Techniques", Third Edition 2004, Marcel Dekker, Inc. Manahan, Stanley E. "Environmental Chemistry" Seventh Edition, Boca Raton: CRC Press LLC, 2000 D. Harvey, "Modern analytical chemistry" (McGraw-Hill, Boston, 2000) Clair Sawyer, Perry McCarty and Gene Parkin, "Chemistry for Environmental Engineering and Science" 5th Edition, McGraw-Hill Higher Education. G. H. Jeffery J. Bassett J. Mendham R C. Denney "Vogel's Textbook of Quantitative Chemical Analysis" Fifth Edition, 1989, Longman. G. Svehla "Vogel's Qualitative Inorganic Analysis" Seventh Edition, Longman. Paul Gabbott "Principles and Applications of Thermal Analysis" Wiley-Blackwell, 2007. P. J. Haines "Principles of Thermal Analysis and Calorimetry" RSC Paperbacks 2003. 				
Websites				
<ul style="list-style-type: none"> https://nptel.ac.in/ 				
Journals				
<ul style="list-style-type: none"> Environmental Science & Technology - ACS Publications Environmental Chemistry Letters Peer reviewed Science and Technology Journals 				
Advanced Reading Material				
Will be provided by instructor if require.				
Additional information (if any)				
Please keep in mind that this course, require hands on experience to strengthen the concepts; however, this course provides supplemental material in order to communicate this information.				
Student responsibilities				
<ol style="list-style-type: none"> Class attendance. Study of course materials as specified by the instructor. 				

3. Regular submission of given class assignments.

Course Reviewers:

1. Dr. Sanjeev Kumar Makin, Professor, Department of Chemistry, Director Research, Deenbandhu Chhotu Ram University of Science & Technology, Murthal-131 039.
2. Dr. Indrajit Roy, Associate Professor, Department of Chemistry, University of Delhi, Delhi-110007, India.
3. Dr. Anil K. Malik, Professor, Department of Physics, Ch. Charan Singh University, Meerut, India, Teachers' Fellow UGC, Govt. of India