GUJARAT TECHNOLOGICAL UNIVERSITY

CHEMICAL ENGINEERING (30)
ADVANCED ANALYTICAL TECHNIQUES
SUBJECT CODE: 2733006
M.E. 3rd SEMESTER

Type of course: Chemical Engineering.(MAJOR ELECTIVE-IV)

Prerequisite: Basic Chemistry

Rationale: The Advanced analytical techniques allows students to undertake advanced study of analytical techniques using highly specialized instrumentation. In present scenario, for highly complex and precise system, advanced analytical techniques are demanded and for that reason this subject is introduced in post graduation course to provide firm foundation in the same.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
				Theory Marks		Practical Marks				
L	T	P	C	ESE (E)	PA (M)	ESE (V)		PA (I)		
						ESE	OEP	PA	RP	
3	2#	2	5	70	30	20	10	10	10	150

Content:

Sr. No.	Topic	Teaching Hours	Module Weightage (%)
1	**Complexometric titrations:** Complexes-formation constants, chelates-EDTA, Chelon Effect, EDTA equilibria, effect of pH on EDTA equilibria, Effect of pH on EDTA equilibria, EDTA titration curves, endpoint-detection and indicators, importance of complexometric titrations.	7	14
2	**Solvent Extraction** Distribution law, extraction process, factors effecting extraction, technique for extraction, quantitative treatment of solvent extraction equilibria, classification of solvent extraction systems. Advantages and application of solvent extraction.	8	15
3	**Chromatography:** Introduction & classification of chromatography. Theory, instrumentation & applications of the following chromatographic techniques: (i) Column chromatography (ii) TLC (iii) Paper chromatography (iv) GC (v) HPLC	8	15
4	**IR Spectroscopy:** Origin, rigid rotor model, harmonic oscillator model, principle, modes of vibration of atoms in polyatomic molecules, instrumentation, selection rules, identification of organic compounds on the basis of infrred spectra.	8	15
5	**UV-Vis Spectroscopy :** Introduction, laws of absorption, origin of spectra, types of transitions, selection rules, identification of organic compounds using UV-VIS spectroscopy.	8	14
6	**Nuclear Magnetic Resonance spectroscopy:** Principle, chemical shift, spin- spin coupling shift reagents,	8	14

	instrumentation, spectra and molecular structure, identification of organic compounds on the basis of NMR		
7	**Thermo analytical methods:** Theory, Instrumentations and applications of Thermo gravimetric Analysis (TGA) and Differential Thermal Analysis (DTA). Differential Scanning Calorimetry, Thermometric titrations	7	13

Reference Books:

1. Skoog, D.A. & West D.M.: Principles of Instrumental Analysis, 5th Edition, Saunders College Publishers, USA.
2. Skoog, D.A. & West D.M. : Fundamentals of Analytical Chemistry, 7th Edition, Saunders college Publishers, USA.
3. Willard, Meritt, Dean & Settle: Industrial Methods of Analysis, 7th Edition.
4. Galen W. Ewing. : Industrial Methods of Analysis, 5th Edition.
5. Silverstein R.M & Webster F.X : Spectrometric identification of organic compounds, 6th Edition,John Wiley and Sons, Inc., USA.
6. E. W. Ewing, Instrumental Methods of Chemical Analysis, McGraw Hill, NewYork. 4th Ed, 1975.
7. Mann, C.K., et al., Instrumental Analysis Harper & Row.
8. Stothers, J.B., Carbon-13 NMR.Spectroscopy, Academic.
9. Giddings, J.C., Principles and Theory- Dynamics of Chromatography, Marcel Dekker.
10. Robert D. Braun, Introduction to Instrumental Analysis.
11. Mendham, J., Dennay, R.C., Barnes, J.D., & Thomas, M.J.K. :
12. Vogel's quantitative Chemical Analysis, 6th Edition. 2000

Course Outcome:

After learning the course the students should be able:

1. To built advanced concepts of analytical techniques used in chemical industries.
2. To understand the principles and functioning of instruments required for the analytical studies in indusrties.
3. To utilize the advanced analytical techniques in problem solving for complex and precise systems.
4. To understand the applications of advanced analytical instruments as per industrial requirement..
5. To recognize the selection criteria between different analytical instruments and techniques.

List of Experiments

Any five practicals performance of advanced analytical techniques:

1. Conductometry: Acid-Base titration, Effect of concentration on equivalent conductance of a given electrolyte
2. pH metry: Acid-Base titration
3. Water Analysis: Determination of physico-chemical parameters of water
4. Purification and separation techniques: Crystallization of various compounds and their TLC study.

Open Ended Project:

The practical work at masters must be largely consisting of OEP. In each case a sample set may be provided and the faculty member may be empowered to select appropriate problems for practical work. At the end of semester before submission of marks of PA and term work, the faculty member will upload the three best problems done by the students during the practical hours. The title area of project with practical problems along with the

complete details and names of the students and name of the supervisor, branch and name of the college be specified so that this information can be published from GTU website.

Open Ended projects in Advanced analytical techniques may include:

1. Physicochemical study of any synthesized compound
2. Chromatographic study of green pigments like chlorophyll.
3. Thermo gravimetric study of any compound, etc.

Major Equipments:
Spectrophotometer, pH-meter, conductivity meter, nephelo- turbidity meter etc.

List of Open Source Software/learning website:

- **S**tudents can refer to video lectures available on various websites including NPTEL
- Students can refer to the CDs which are available with some reference books for the solutions of problems using software. Students can develop their own programs for the solutions using excel, Chemical and other simulation software.

Review Presentation (RP): The concerned faculty member shall provide the list of peer reviewed Journals and Tier-I and Tier-II Conferences relating to the subject (or relating to the area of thesis for seminar) to the students in the beginning of the semester. Every student or a group of students shall critically students shall critically study two paper, integrate the details and make presentation in the last two weeks of the semester. The GTU marks entry portal will allow entry of marks only after uploading of the best 3 presentations. A unique id number will be generated only after uploading the presentations. Thereafter the entry of marks will be allowed. The best 3 presentations of each college will be uploaded on GTU website.