

**Subject Code: 02CY0354****Subject Name: Analytical Spectroscopic Techniques****B.Sc. Sem - VI****Objectives:**

- To study the characterization technique i.e. UV spectroscopy.
- To make students capable of understanding IR spectroscopy.
- To study the introduction, and principle of NMR spectroscopy.
- To study the mass spectrometry.

**Credits Earned:** 6 Credits**Course Outcomes:** After completion of this course, student will be able to

- Understand the concepts of analytical technique UV spectroscopy.
- Obtain the information regarding the IR spectroscopy.
- Be aware of the basics of NMR spectroscopy.
- Understand the basic of Mass spectrometry and their uses in construction of the molecules.

**Pre-requisite of course:** Superficial knowledge regarding spectroscopy is needed.**Teaching and Examination Scheme**

Teaching Scheme (Hours)			Credits	Theory Marks			Tutorial/ Practical Marks		Total Marks
Theory	Tutorial	Practical		ESE (E)	IA	CSE	Viva (V)	Term Work (TW)	
5	-	2	6	50	30	20	25	25	150

**Contents**

<b>Unit</b>	<b>Topics</b>	<b>Contact Hours</b>
1	<b>UV spectroscopy:</b> Introduction, Absorption law: Lambert's law and Beer's law, Lambert – Beer's law. Electromagnetic radiation, Wave length, Wave number, Frequency, Energy, Distribution of energy in atoms and molecules, Translational energy, Nuclear energy, Rotational energy, Vibrational energy, Electronic energy, Interaction of radiation with matter, Types of spectra, UV-Visible spectroscopy, Theory, Absorption bands, Types of electronic transition, Absorption shifts and intensity effects, UV absorption by some organic molecules, Applications, Numericals.	<b>15</b>
2	<b>IR Spectroscopy:</b> Introduction, Various types of energies (Translational energy, Rotational energy, Vibrational and electronic energy), Instrumentation of IR spectrophotometer, Normal modes of vibration (Stretching and bending vibrations), Coupled vibrations and Fermi resonance, Electronic effect, Intramolecular hydrogen bonding, intermolecular hydrogen bonding, Selection rule, Theory of IR absorption spectroscopy, Theory of vibrational rotational spectra, P-Q-R bands, Force constant, Franck-Condon principle, Vibrational coupling, Fermi resonance, Finger print region, Relation between frequency and bond in IR spectra, Numericals.	<b>15</b>
3	<b>NMR Spectroscopy:</b> Introduction, Principle, Nuclear quantum number, equivalence and nonequivalent protons with illustrations, Enantiomeric and Diastereomeric protons, shielding and de shielding proton, Chemical Shift, Paramagnetic anisotropic effect, Relative intensity of signals, Spin-spin coupling and coupling constant, Deuterium labelling, Numericals.	<b>15</b>
4	<b>Mass Spectrometry:</b> Introduction, Classification of spectroscopy origin and basic principles, Instrumentation, General Fragmentation modes, important features for mass spectra of alkanes. Numericals based on UV, IR, NMR and Mass spectral data for structure elucidation of organic molecules.	<b>15</b>
<b>Total Hours</b>		<b>60</b>

**References:**

1. A Textbook of Physical Chemistry; K. L. Kapoor
2. An Introduction to Chemical Thermodynamics; R. P. Rastogi, R. R. Misra, 6<sup>th</sup> Edition, Vikas Pub. Pvt. Ltd.
3. Physical Chemistry; G. W. Castellan, 3<sup>rd</sup> Edition, Narosa Publishing House, New Delhi.
4. Physical Chemistry; Arun Bahl & J. D. Tuli, S. Chand Publishing.
5. Organic Reactions and their Mechanisms; P. S. Kalsi, New Age International Publishers.
6. Organic Chemistry; R. T. Morrison and R. N. Boyd, 6<sup>th</sup> Edition, Prentice Hall of India.
8. Concise Inorganic Chemistry; J. D. Lee, 5<sup>th</sup> Edition, Blackwell Science, London.
9. Basic Inorganic Chemistry; F. A. Cotton, G. Wilkinson
10. Principles of Inorganic Chemistry; B. R. Puri, L. R. Sharma, K. C. Kalia, Vallabh Publications, Delhi
11. Organic Chemistry; Morrison and Boyd
12. Organic Chemistry (Volume I, II & III); S. M. Mukherji, S. P. Singh, R. P. Kapoor.
13. Principles of physical chemistry; B.R. Puri, L.R. Sharma, M.S. Pathania.

**Suggested Theory distribution:**

The suggested theory distribution as per Bloom's taxonomy is as per follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery and evaluation					
Remember	Understand	Apply	Analyze	Evaluate	Create
20%	30%	25%	15%	10%	-

**Chromatography:**

1. To determine R<sub>f</sub> value of the given sample of amino acids and its mixture by ascending paper chromatography.
2. To determine R<sub>f</sub> value of the given sample of amino acids and its mixture by circular paper chromatography.
3. To determine R<sub>f</sub> value of the given metal ions (Ni<sup>+2</sup>, Cu<sup>+2</sup>, Co<sup>+2</sup>) mixture by ascending paper chromatography.
4. To determine R<sub>f</sub> value of the given metal ions (Ni<sup>+2</sup>, Cu<sup>+2</sup>, Co<sup>+2</sup>) mixture by circular paper chromatography.
5. To determine R<sub>f</sub> value of the given sample of organic mixture by thin layer chromatography.
6. To separate chlorophyll from tree leaves sample by using paper chromatographic technique.
7. To determine the molecular weight of nitrobenzene by steam distillation.
8. To isolate nicotine from tobacco and analyse it.

**Reference Books**

1. An Advanced Course in Practical Chemistry, A. K. Nad, B. Mahapatra and A. Ghoshal, New Central Book Agency (P) Ltd.
2. Practicals in Physical Chemistry, P S Sindhu, Macmillan.
3. Experimental Physical Chemistry: A Laboratory Textbook, Arthur Halpern, George McBane, W. H. Freeman.

**Instructional Method:**

1. The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.
2. The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and class-room.
3. Practical examination will be conducted at the end of semester for evaluation of performance of students in laboratory.
4. Students will use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory
5. Use of hazardous/toxic chemicals should be avoided as far as possible in laboratory.
6. All students in the laboratory must wear safety goggles and lab coats during lab session.

**Supplementary Resources:**

1. <http://nptel.ac.in/course.php?disciplineId=104>
2. <http://ocw.mit.edu/courses/chemistry/>
3. <http://vlab.amrita.edu/index.php?sub=2>
4. [http://www.vlab.co.in/ba\\_labs\\_all.php?id=9](http://www.vlab.co.in/ba_labs_all.php?id=9)
5. <https://www.youtube.com/user/TMPChem>
6. <https://www.youtube.com/playlist?list=PL166048DD75B05C0D>
7. <https://www.youtube.com/channel/UCqk-dmk3AOfrikaFDpsZorg>
8. <https://www.youtube.com/user/PradeepKshetrapal>