Gyanmanjari Innovative University

Course Syllabus
Gyanmanjari Science College
Semester-5 (B.Sc)

Subject: Structural Chemistry- BSCCM15315

Type of course: Major

Prerequisite: A basic understanding of atomic structure, bonding, quantum mechanics, and organic functional groups is essential for studying spectroscopy.

Rationale: This syllabus provides a comprehensive understanding of spectroscopy for molecular analysis. It covers fundamental principles, instrumentation, and spectral interpretation of UV-Vis, mass, and NMR spectroscopy. Students will learn how different spectroscopic techniques are used to determine molecular structures, electronic transitions, and functional groups. The course integrates theoretical concepts with practical applications in research, pharmaceuticals, and material sciences. It equips students with essential analytical skills for advanced chemical investigations.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks					Total Marks
				SEE		CCE			
CI	T	P	C	Theory	Practical	MSE	LWA/V	ALA	
3	0	2	4	75	25	30	20	50	200

Legends: CI-Class Room Instructions; T – Tutorial; P - Practical; C – Credit; SEE - Semester End Evaluation; MSE- Mid Semester Examination; LWA - Lab Work Assessment; V – Viva voce; CCE-Continuous and Comprehensive Evaluation; ALA- Active Learning Activities.

3 Credits * 25 Marks = 75 Marks (each credit carries 25 Marks) Theory
1 Credits * 25 Marks = 25 Marks (each credit carries 25 Marks) Practical
SEE 100 Marks will be converted in to 50 Marks
CCE 100 Marks will be converted in to 50 Marks
It is compulsory to pass in each individual component.

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Course Content:

Unit No	Course Content	Hrs	% Weightage
1	**General introduction to spectroscopy:** Spectroscopy, spectrometry and spectrum. Electromagnetic radiation, wavelength, wave numbers and frequency, electromagnetic spectrum. Regions of electromagnetic spectrum and types of molecular spectrums. Types of molecular spectroscopy IR, microwave, UV, visible, NMR, ESR and mass.	10	25%
2	**Ultraviolet spectroscopy :** Various spectral regions of electromagnetic spectrum in terms of frequency and wave number, Electronic excitation, Simple chromophoric groups, oxochromic groups, Conjugated systems, systems of extended conjugation, aromatic systems, Red and blue shifts, Hyperchromic and Hypsochromic effects.	15	25%
3	**Visible Spectroscopy**: Visible spectra of transition metal complexes, Selection rules and intensities of the transitions, spectrum for d1 and d9 (Ti^{3+} and Cu^{2+}) systems, Orgel diagram, hole formation.	10	25%
4	**Mass Spectroscopy:** Introduction and principle of mass spectroscopy, working of mass spectrometer, Various types of ions produced in mass spectrum, Interpretation of mass spectrum, Nitrogen rule, Unsaturated site, Mass spectrum of some organic functional group, applications of mass spectroscopy.	10	25%

Continuous Assessment:

Sr. No	Active Learning Activities	Marks
1	**Review paper of Spectroscopic Applications** Faculty will Assign different real-world applications of spectroscopy (e.g., forensic analysis, drug identification, environmental monitoring) among group of students (maximum three students). Students have to make a review paper and will upload it on GMIU Web Portal.	10
2	**Spectroscopy in Everyday Life** Ask students to research and write about real-life examples where spectroscopy is used, such as in medical diagnostics, food quality control, or environmental monitoring. Make their report and will upload the same on GMIU Web Portal.	10

3	**Virtual Lab Simulations** Use online spectroscopy simulations where students can manipulate experimental parameters and observe spectral changes and will upload their photos in GMIU Web Portal.	10
4	**Flipped Classroom Discussion** Assign pre-reading on spectroscopy principles and use class time for problem-solving discussions and make application and will upload the same in GMIU Web Portal.	10
5	**Attendance**	10
Total		50

List of Practical:

Sr. No	Descriptions	Unit No	Hrs
1.	Determination of refractive index of given percentage mixtures of liquids A and B, and determination of percentage composition of unknown mixture by Refractometer.	All Unit	3
2.	Separation of amino acids by ascending paper chromatography.		3
3.	To determine the temperature coefficient and energy of activation of hydrolysis of methyl acetate by calculation and potassium iodide.		3
4.	To investigate the reaction between potassium per sulphate and potassium iodide.		3
5.	Determination of solubility and solubility-product of given sparingly soluble salt by conductometry.(using $Pb(NO_3)_2$ and K_2SO_4 solution)		6
6.	Determination of degree of hydrolysis of given salt ammonium chloride from its given standard solution by p^H-metry.		3
7.	Determination of amount of Ni^{+2} ion in given solution by colourimeter.		6
8.	Determination of strength of $FeSO_4$ $(NH4)_2SO_4$ $6H_2O$ solution by using standard $K_2Cr_2O_7$ solution by potentiometric method.		3
		Total	30

Suggested Specification table with Marks (Theory):75

Distribution of Theory Marks **(Revised Bloom's Taxonomy)**						
Level	Remembrance (R)	Understanding (U)	Application (A)	Analyze (N)	Evaluate (E)	Create (C)
Weightage	30%	30%	30%	10%	00	00

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcome:

After learning the course the students should be able to:	
CO1	Explain the fundamental principles, types, and applications of various spectroscopic techniques.
CO2	Interpret UV- spectra to determine structural and functional details of organic molecules.
CO3	Analyze spectroscopic rules of Visible and analytical techniques for Inorganic molecular identification and problem-solving.
CO4	Examine spectroscopic rules of Mass Spectroscopy and find out different types of molecular mass of organic compounds.

Instructional Method:

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.
From the content 10% topics are suggested for flipped mode instruction.
Students will use supplementary resources such as online videos, NPTEL/SWAYAM videos, e-courses, Virtual Laboratory
The internal evaluation will be done on the basis of Active Learning Assignment
Practical/Viva examination will be conducted at the end of semester for evaluation of performance of students in laboratory.

Reference Books:

[1]Introduction to Spectroscopy by S.M.Khopkar
[2] Spectroscopy of Organic Compounds by P.S. Kalsi
[3] Organic Spectroscopy by J. R. Dyer
[4] Principles of Instrumental Analysis by Douglas A. Skoog, F. James Holler, and Stanley R. Crouch