# School of Chemistry Faculty of Sciences University of the Punjab, Lahore Course Outline



	BS Chemistry Semester-VII				
Program	m BS Chemistry Course Code		Chem-446	Credit Hours	2
Course T	itle Electroanalytical Tec	Course Type	Major (Elective)		
	(	Course Introduct	tion		
including p Potentione glass and measureme membrane electrode. Conducton upon whic	The course is organized to provide an adequate knowledge about electroanalytical techniques including potentiometry and conductometry Potentiometry: Nernst equation; Electrode Potentials; different reference electrodes including glass and calomel electrode; working of a potentiometer and its applications including pH measurements and potentiometric titrations; ion-selective electrode systems; ion- exchange membrane electrode; gas-sensing electrode; solid-state membrane electrode and bio membrane electrode. Conductometry: Conductance in Solutions; Specific conductance; molar conductance; factors upon which the conductance of solution depends; Measurement of conductance / Instrumentation; cell constant; Analytical applications of conductance measurement.				
	upletion of the course, the stu	Learning Outcom			
<ol> <li>Learn t</li> <li>Gain k</li> <li>various</li> </ol>	tand advanced analytical tech he principles and theories in nowledge about measuremen species using a number of v ally apply the principle of co	volved in Potentie ts involving the persatile electrode	ometry and Cor potential and/or s.	nductometry.	of
	Course Con	tent		Assignments/Re	eadings
Week 1	Potentiometry, Nernst equ	ation, Electrode	Potentials	Class based Learn	ning/Test
Week 2	Different reference electroc calomel electrode, Class D	•••	ss and	Class based Learn	ning/Test
Week 3	Week 3Working of a potentiometer, Applications of a potentiometer including pH measurements and potentiometric titrationsClass based Learning/Test				
Week 4	Ion-selective electrode syst	ems, Quiz		Class based Learn	ning/Test
Week 5	wek 5     Ion- exchange membrane electrodes     Class based Learning/Test				ning/Test
Week 6	6 Class discussion, Gas-sensing electrodes Class based Learning/Test				
Week 7	Solid-state membrane elect electrodes	rode, Bio-membr	ane	Class based Learn	ning/Test
Week 8	Mid Term Assessment				

Week 9	Conductometry, Introduction of conductometry, Conductance in SolutionsClass based Learning/T			
Week 10	Specific conductance, Basic concepts of molar conductance	Class based Learning/Test		
Week 11	Factors affecting the conductance of solutions	Class based Learning/Test		
Week 12	Measurement of conductance/Instrumentation	Class based Learning/Test		
Week 13	Cell constant	Class based Learning/Test		
Week 14	Analytical applications of conductance measurement	Class based Learning/Test		
Week 15	Revision of analytical applications of conductance measurement	Class based Learning/Tes		
Week 16	5 Submission of assignments. If required, then discuss the whole chapter for final term exams preparation			
	<b>Textbooks and Reading Material</b>			
<ol> <li>Gul</li> <li>Kał and</li> <li>Néł thei</li> <li>Ska Inst</li> <li>Val</li> </ol>	<ol> <li>Recommended Books:         <ol> <li>Gulaboski, R. (2012). Electrochemical Dictionary.</li> <li>Kahlert, H. (2010). Potentiometry. Electroanalytical Methods: Guide to Experiments and Applications, 237-256.</li> <li>Néher-Neumann, E. (2010). Advanced potentiometry: potentiometric titrations and their systematic errors. Springer Science &amp; Business Media.</li> <li>Skoog, D. A., &amp; James, F. (2007). Holler, and Stanley R. Crouch. Principles of Instrumental.</li> <li>Valcárcel, M. (2012). Principles of analytical chemistry: a textbook. Springer Science &amp; Business Media.</li> </ol> </li> </ol>			
	Teaching Learning Strategies			
• • •	Lecturing using white/black board/Multimedia Written Assignments/presentations/ Task related to assigne Class activities and Discussion Quiz about last lecture Class Presentations Audio/visual Aids/ Tutorials	ed topics		
	Assignments: Types and Number with Calend	lar		
	Assignments, quiz, Tasks, Presentation etc.			

	Assessment			
Sr. No.	Elements	Weightage	Details	
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.	
2.	Formative Assessment	25%	Continuous assessment includes classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.	
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.	

BS Chemistry Semester-VII						
Program	BS Chemistry	Course Code	Chem-447	Credit Hour	1	
Course Title	Electroanalytical Technic	ques-1 (Lab I)	Course Typ	e Major (Elect	tive)	
	Co	urse Introductio	n			
and determ conductome Potentiomet Determine t Determine t Determine t Simple acid Conductome Determine t	The course is organized to provide an adequate knowledge about electroanalytical techniques and determination of equivalence points for various types of acid-base titrations using conductometry and potentiometry. Potentiometry: Determine the amount of HCl by using strong base (NaOH) potentiometrically. Determine the amount of HCl by using weak base (NH4OH) potentiometrically. Determine the amount of CH <sub>3</sub> COOH by using strong base (NaOH). Determine the amount of HCl & CH <sub>3</sub> COOH conductometrically by using strong base NaOH. Simple acid base titrations using potentiometer. Conductometry: Determine the amount of HCl conductometrically by using strong base NaOH. Determine the amount of HCl conductometrically by using strong base NaOH.					
	he amount of NaOH conducto					
	Le	arning Outcome	es			
<ol> <li>Lean</li> <li>Gair vario</li> <li>Determined</li> </ol>	erstand advanced analytical to in the principles and theories in knowledge about measurem ous species using a number of ermine the equivalence points luctometry and potentiometry	involved in Poter ents involving th f versatile electro for various types	ntiometry and e potential and des.	Conductometry. I/or the conductan	ice of	
	Course Conte	ent		Assignments/R	eadings	
Week 1	Potentiometry, Determine the amount of HC (NaOH) potentiometrically.	I by using strong	g base	Lab based Performance/La reports	ab	
Week 2	Determine the amount of HC (NH <sub>4</sub> OH) potentiometrically		base	Lab based Performance/La reports	b	
Week 3	Determine the amount of CH (NaOH).	I <sub>3</sub> COOH by using	g strong base	Lab based Performance/La reports	b	
Week 4					b	
Week 5	Determine the amount of HC conductometrically by using		θH.	Lab based Performance/La reports	b	

Week 6	Simple acid base titrations using potentiometer.	Lab based
		Performance/Lab
		reports
Week 7	Simple acid base titrations using potentiometer.	Lab based
		Performance/Lab
		reports
Week 8	MID TERM EXAMS	<u> </u>
Week 9	Conductometry,	Lab based
		Performance/Lab
	Determine the amount of HCl conductometrically by using strong base NaOH.	reports
Week 10	Determine the amount of HCl conductometrically by using	Lab based
	strong base NaOH.	Performance/Lab
		reports
Week 11	Determine the amount of base NH <sub>4</sub> OH conductometrically	Lab based
	by using strong acid.	Performance/Lab
		reports
Week 12	Determine the amount of base NH <sub>4</sub> OH conductometrically	Lab based
	by using strong acid.	Performance/Lab
		reports
Week 13	Determine the amount of NH <sub>4</sub> OH by using weak acid	Lab based
	CH <sub>3</sub> COOH conductometrically.	Performance/Lab
		reports
Week 14	Determine the amount of NH <sub>4</sub> OH by using weak acid	Lab based
	CH <sub>3</sub> COOH conductometrically.	Performance/Lab
		reports
Week 15	Determine the amount of NaOH conductometrically by	Lab based
	using weak acid CH <sub>3</sub> COOH.	Performance/Lab
		reports
Week 16	FINAL TERM EXAMS	
	Textbooks and Reading Material	
	nded Books:	
1.	Gulaboski, R. (2012). Electrochemical Dictionary.	. Cuido to Exponimento
2.	Kahlert, H. (2010). Potentiometry. Electroanalytical Methods and Applications, 237-256.	s: Guide to Experiments
3.	Skoog, D. A., & James, F. (2007). Holler, and Stanley R. Cro	ouch. Principles of
2.	Instrumental.	
4.	Valcárcel, M. (2012). Principles of analytical chemistry: a ter	xtbook. Springer Science
	& Business Media.	-
5.	J. Mendham, R. C. Denney, J. D. Barnes, & M. Thomas. (20)	00). Vogel's textbook of
	quantitative chemical analysis. Prentice Hall.	

### **Teaching Learning Strategies**

- Lecturing using white/black board/Multimedia
- Written Assignments/presentations/ Task related to assigned topics
- Class activities and Discussion
- Quiz about last lecture
- Class Presentations Audio/visual Aids/ Tutorials
- Laboratory performance

## Assignments: Types and Number with Calendar

Assignments, quiz, Tasks, Presentation etc.

#### Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

	BS Chemistry Semester-VII						
Program	Image: BS ChemistryCourse Course CodeChem-448Credit Hours						
Course Ti	Course Title         Molecular Absorption Spectroscopy         Course Type         Major (Elective)						
		<b>Course Intro</b>	duction				
of molec spectrosco determinat in chemica Introduction absorption Deviations UV/Vis Sp Atomic En Wavelengt application FTIR/Ram coordinate	on to Spectroscopy/Spect in UV and Visible range; s; Instrumentation and appl bectroscopy, The Nature of hergy Levels, molecular Ele th Selection, Cells and	scopic techni o be able to ap ne students wil trophotometry, Basic principle ications. Electromagne ectronic Energy Sampling D of Infrared Sp Symmetry of m n gaseous ph	ques like UV pply the acquire l learn these tec Introduction e of Spectropho tic Radiation, T y Levels, Instru- evices, Detecto pectra; Differen formal vibration ase and inert g	V-Visible, IR and ed knowledge for the hniques and their app to Molecular spec tometry; Beer-Lamb he Electromagnetic S mentation, Radiation ors, Readout Mode t vibrational modes as and selection rule gas matrices; Comp	Raman e spectral plications troscopy, ert's law; Spectrum, Sources, ules and , Normal e, Raman arison of		
	nstrumentation details and		for quantativ	e and quantitative	chemicai		
		Learning Ou	tcomes				
1. 2.	npletion of the course, the Understand the princip spectroscopic techniques I Apply the acquired knowl Learn these techniques and	bles and ins ike UV-Visibl edge for the sp	trumentations e, IR and Rama ectral determina	n spectroscopies. ation by these technic	orption ques.		
	Course C	ontent		Assignments/I	Readings		
Week 1	Introduction to Spectrosc Introduction to Molecula	1. 1		Class based Learning/Test			
Week 2	Absorption in UV and Vi Spectrophotometry	isible range, Ba	asic principle of	Class based Learning/Test			
Week 3	Yeek 3Beer-Lambert's law; Deviations; Instrumentation and applicationsClass based Learning/Test						
Week 4	UV/Vis Spectroscopy, The Nature of ElectromagneticClass basedRadiation, The Electromagnetic SpectrumLearning/Test						
Week 5	Atomic Energy Levels, Molecular Electronic Energy       Class based         Levels       Learning/Test						
Week 6	Instrumentation, Radiatio	on Sources, Wa	velength Select	ion Class based Learning/Test			

Week 7	Cells and Sampling Devices, Detectors, Readout Modules	Class based				
	and application Learning/Test					
Week 8	MID TERM ASSESSMENT					
Week 9	FTIR / Raman Spectroscopy, Origin of Infrared Spectra	Class based				
		Learning/Test				
Week 10	Different vibrational modes, Normal coordinate and normal	Class based				
	vibrations	Learning/Test				
Week 11	Symmetry of normal vibrations and selection rule	Class based				
		Learning/Test				
Week 12	Raman Spectroscopy	Class based				
		Learning/Test				
Week 13	Vibrational Spectra in gaseous phase and inert gas	Class based				
	matrices	Learning/Test				
Week 14	Comparison of Raman with Infrared spectroscopy	Class based				
		Learning/Test				
Week 15	Applications for qualitative and quantitative chemical	Class based				
	analysis; Instrumentation details and their function	Learning/Test				
Week 16	FINAL TERM ASSESSMENT					
	<b>Textbooks and Reading Material</b>					
1. Parl	<b>ided Books:</b> ker, F. (2012). Applications of infrared spectroscopy in bioche licine. Springer Science & Business Media	mistry, biology, and				
	istian, G. D. (2020). Evolution of Analytical Sciences in the torical Account. Annual Review of Analytical Chemistry, 13					
3. Adv	vances in Infrared Group Frequencies by L.J. Bellacy, Ma					
	sterdam (1968). ota, P., Das, S. S., & Singh, N. B. (2023). Spectroscopy. Jenny	Stanford Publishing				
5. Kup	otsov, A. H., & Zhizhin, G. N. (1998). Handbook of Fourier tra	-				
infr	ared spectra of polymers. Elsevier.					
•	Teaching Learning Strategies           Lecturing using white/black board/Multimedia					
<ul> <li>Written Assignments/presentations/ Task related to assigned topics</li> </ul>						
•	Class activities and Discussion					
•	Quill doodd fabt footale					
•	Class Presentations Audio/visual Aids/ Tutorials Assignments: Types and Number with Calend	ar				

	Assessment			
Sr. No.	Elements	Weightage	Details	
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.	
2.	Formative Assessment	25%	Continuous assessment includes classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.	
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.	

BS Chemistry Semester-VII						
Program	n BS Chemistry	<b>Course Code</b>	Chem-449	Cr	edit Hour	1
Course Ti	tle Molecular Absorpti	on Spectroscopy	(Lan I)	ourse Sype	Major (Electiv	ve)
		Course Intro	luction			
characteris To determi To determi To determi To determi To determi To determi To determi	The course is organized to apply theoretical knowledge about molecular spectroscopy, determine the characteristic wavelength and then application of the Beer's law for quantitative determination. To determine $\lambda_{max}$ of KMNO <sub>4</sub> using spectrophotometer. To determine the concentration of KMNO <sub>4</sub> in the given sample using spectrophotometer. To determine $\lambda_{max}$ of K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> using spectrophotometer. To determine the concentration of K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> in the given sample using spectrophotometer. To determine the concentration of K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> in the given sample using spectrophotometer. To determine the concentration of Iron (II) using 1, 10-phenanthroline method. To determine the concentration of Iron (III) using thiocyanate method. To determine the concentration of chromium by diphenylcarbazide method. To determine the concentration of Ni by DMG method spectrophotometrically. Determination of mixtures of complexes of Iron with Thiocyanide and 1, 10, phenanthroline					
		Learning Ou	tcomes			
1. 2. 3.	Apply theoretical knowled Determine the characterist Apply the Beer's law for of Interpret the FTIR spectra	lge about molecul tic wavelength. quantitative detern	ar spectroscop	у.		
	Course	Content			Assignments/I	Readings
Week 1	To determine $\lambda_{max}$ of KM		-	1	Lab based Performance/L reports	ab
Week 2	To determine the concenusing spectrophotometer		4 in the given s	ample	Lab based Performance/L reports	ab
Week 3	To determine the concenusing spectrophotometer		. C	ample	Lab based Performance/L reports	ab
Week 4	$\begin{array}{c c} \textbf{I} & \text{To determine } \lambda_{max} \text{ of } K_2 Cr_2 O_7 \text{ using spectrophotometer.} & \textbf{Lab based} \\ & \text{Performance/Lab} \\ & \text{reports} \end{array}$				ab	
Week 5	To determine $\lambda_{max}$ of $K_2Cr_2O_7$ using spectrophotometer.Lab based Performance/Lab reports					
Week 6	To determine the concentration of K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> in the given sample using spectrophotometer.       Lab based         Performance/Lab reports					ab
Week 7	To determine the concen phenanthroline method.	tration of Iron (II)	using 1, 10-		Lab based Performance/L reports	ab
Week 8	MID TERM EXAMS				-	

	method.	Performance/Lab reports
	To determine the concentration of chromium by diphenylcarbazide method.	Lab based Performance/Lab reports
	To determine the concentration of Ni by DMG method spectrophotometrically.	Lab based Performance/Lab reports
	To determine the concentration of Ni by DMG method spectrophotometrically.	Lab based Performance/Lab reports
	Determination of mixtures of complexes of Iron with Thiocyanide and 1, 10, phenanthroline.	Lab based Performance/Lab reports
Week 14	FTIR analysis of various organic molecules.	Lab based Performance/Lab reports
Week 15	FTIR analysis of various organic molecules.	Lab based Performance/Lab reports
Week 16	FINAL TERM EXAMS	

## Textbooks and Reading Material

#### **Recommended Books:**

- 1. Parker, F. (2012). Applications of infrared spectroscopy in biochemistry, biology, and medicine. Springer Science & Business Media
- 2. Christian, G. D. (2020). Evolution of Analytical Sciences in the United States: A Historical Account. Annual Review of Analytical Chemistry, 13(1), 475-496.
- 3. Advances in Infrared Group Frequencies by L.J. Bellacy, Mathuen & Col. Amsterdam (1968).
- 4. Gupta, P., Das, S. S., & Singh, N. B. (2023). Spectroscopy. Jenny Stanford Publishing
- 5. Kuptsov, A. H., & Zhizhin, G. N. (1998). Handbook of Fourier transform Raman and infrared spectra of polymers. Elsevier.

#### **Teaching Learning Strategies**

- Lecturing using white/black board/Multimedia
- Written Assignments/presentations/ Task related to assigned topics
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- Quiz about last lecture
- Class Presentations Audio/visual Aids/ Tutorials
- Laboratory performance

#### Assignments: Types and Number with Calendar

Assignments, quiz, Tasks, Presentation etc.

	Assessment			
Sr. No.	Elements	Weightage	Details	
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.	
2.	Formative Assessment	25%	Continuous assessment includes classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.	
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.	

	BS Chemistry Semester-VII					
Program	BS Chemistry	Course Code	Chem-450	Cred	it Hours	2
Course Title	Atomic Spectroche		is Cour	se Type	Major Ele	ective
		Course In	ntroduction			
atomic flue theory and	In this course, the students will be able to learn about atomic emission, atomic absorption and atomic fluorescence spectroscopic techniques. The course will enable students to understand the theory and applications of atomic spectroscopy in various samples.					
spectroscop elements; application Instrument Atomic At	mission/Atomic Flores by; Source of atomizati flame as a source of s and limitations, ation, Applications, plas psorption Spectroscopy, urnace and hydride ge	on; Use of a atomization a Flame temp ma sources an Basic Princip	atomic spectra and excitation peratures. A d ICP-AES le of AAS, F	for dete ; Instrum tomic I lameless	AA spectro	determination of wolved in FES; Spectroscopy, oscopy including
		Learning	g Outcomes			
1. 2.	<ul> <li>On the completion of the course, the students will be able to: <ol> <li>Learn about atomic emission, atomic absorption and atomic fluorescence spectroscopic techniques.</li> <li>Enable students to understand the theory of atomic spectroscopy in various samples.</li> </ol> </li> <li>Enable students to understand the applications of atomic spectroscopy in variety of samples.</li> </ul>					
	Course Content Assignments/Readings					
Week 1Atomic Emission / Atomic Florescence Spectroscopy, Basic principle of atomic emission spectroscopyClass bas		Class base	d Learning/Test			
Week 2	Source of atomization; and determination of el		e spectra for de	etection	Class base	d Learning/Test
Week 3	eek 3Flame as a source of atomization and excitationClass based Learning/Test				d Learning/Test	
Week 4	Teek 4Instrumentation involved in FES; applications and limitationsClass based Learning/Test				d Learning/Test	
Week 5	Flame temperatures				Class base	d Learning/Test
Week 6	<b>k 6</b> Atomic Florescence Spectroscopy, Instrumentation Class based Learning/Test					
Week 7	ek 7       Applications, plasma sources and ICP-AES       Class based Learning/Test				d Learning/Test	
Week 8	MID TERM ASSESSM	IENT			1	
Week 9	Atomic Absorption Spe Basic Principle of AAS	1.			Class base	d Learning/Test

Week 10	Flameless AA spectroscopy   Class based Learning/					
Week 11	Flameless AA spectroscopy including graphite furnace Class based Learning/					
		C C				
Week 12	Flameless AA spectroscopy including hydride generation	Class based Learning/Test				
Week 13	Interferences	Class based Learning/Test				
Week 14	4 Instrumentation of AAS Class based Learning/Te					
Week 15	eek 15Application and limitations of AASClass based Learning/T					
Week 16 FINAL TERM ASSESSMENT						
Textbooks and Reading Material						
Recommended Books:						
1. Thomas, R. (2023). Practical Guide to ICP-MS and Other Atomic Spectroscopy						
Techniques: A Tutorial for Beginners.						
2. Sultan, K. (2022). Practical Guide to Materials Characterization: Techniques and						
Applications. John Wiley & Sons.						
rr						

- 3. Analytical Chemistry by Gary D. Christian, John Wiley and Sons (2014).
- 4. Stockwell, P. B. (1979). A total systems approach to laboratory automation. Journal of Analytical Methods in Chemistry, 1(4), 216-221.
- 5. Angino, E. (Ed.). (2012). Atomic absorption spectrometry in geology
- 6. Lai, W. F. (Ed.). (2023). Materials Science and Engineering in Food Product Development. John Wiley & Sons.

### **Teaching Learning Strategies**

- Lecturing using white/black board/Multimedia
- Written Assignments/presentations/ Task related to assigned topics
- Class activities and Discussion
- Quiz about last lecture
- Class Presentations Audio/visual Aids/ Tutorials

## Assignments: Types and Number with Calendar

Assignments, quiz, Tasks, Presentation etc.

	Assessment				
Sr. No.	Elements	Weightage	Details		
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.		
2.	Formative Assessment	25%	Continuous assessment includes classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.		
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.		

BS Chemistry Semester-VII						
Program	Code		Chem-451	51 Credit Hour		
Course Ti	tle Atomic Spectrocher (Lab)	<b>Course Type</b>	Major (Electiv	ve)		
		Course Introdu	ction			
concentrati determinati obtain the Flame Emi Determinati Determinati Find out th Determinati Estimation Indirect det Atomic Ab	e is organized so that st ons, understand the hands on of various elements i valuable information. ssion / Spectrophotometry ion of Sodium in tap wate ion of Potassium in tap wate ion of Potassium in tap wate ion of Li by flame photom of purity of various comp termination of various comp sorption/ Spectrophotome	on use of atomic n the given sam : r by using Flame ater by using Flam by flame photon hetry. ounds on the base pounds by flame try:	Photometer. Photometer. ne Photometer. netry. e of flame emission photometric techr	aniques for the pr atomic spectrosco Spectrophotome iques.	actical opy to	
	of standard calibration gr ion of Cd, Cu, Fe, Pb and					
		Learning Outco	omes			
2. 3.	<ul> <li>On the completion of the course, the students will be able to: <ol> <li>Prepare the solutions of various concentrations.</li> <li>Understand the hands-on use of atomic spectroscopic techniques for the practical determination of various elements in the given samples.</li> <li>Use the atomic spectroscopy to obtain the valuable information.</li> <li>Estimate the concentration of metals in unknown samples.</li> </ol> </li> </ul>					
	Course Cont	ent	As	signments/Readi	ngs	
Week 1	Week 1Flame Emission / Spectrophotometry: Determination of Sodium in tap water by using Flame Photometer.			pased Performanc ts	e/Lab	
Week 2	Week 2Determination of Potassium in tap water by using Flame Photometer.Lab based Performance/L reports				e/Lab	
Week 3	Find out the calcium in chalk sample by flame Lab based Performance/Lab reports				e/Lab	
Week 4	Week 4Determination of Li by flame photometry.Lab based Performance/Lab reports					
Week 5	Estimation of purity of various compounds on the base of flame emission Spectrophotometry.Lab based Performance/Lab reports			e/Lab		
Week 6	Estimation of purity of various compounds on the base of flame emission Spectrophotometry.Lab based Performance/Lab reports				e/Lab	
Week 7	Indirect determination of various compounds by flame photometric techniques.Lab based Performance/Lab reports			e/Lab		
Week 8						

Week 9	k 9Atomic Absorption/ Spectrophotometry: Preparation of standard calibration graphs of Cd, Cu, Fe, Pb and Zn by AAS.Lab based Performetry: reports				
Week 10Preparation of standard calibration graphs of Cd, Cu, Fe, Pb and Zn by AAS.		Lab based Performance/Lab reports			
Week 11	Determination of Cd, Cu, Fe, Pb and Zn in soil samples by AAS technique.	Lab based Performance/Lab reports			
Week 12	Determination of Cd, Cu, Fe, Pb and Zn in soil samples by AAS technique.	Lab based Performance/Lab reports			
Week 13	Determination of Cd, Cu, Fe, Pb and Zn in soil samples by AAS technique.	Lab based Performance/Lab reports			
Week 14	Week 14Determination of Cd, Cu, Fe, Pb and Zn in soil samples by AAS technique.Lab based Performan reports				
Week 15	Determination of Cd, Cu, Fe, Pb and Zn in soil samples by AAS technique.	Lab based Performance/Lab reports			
Week 16	FINAL TERM EXAMS				
	Textbooks and Reading Materia	ıl			
Recomme	nded Books:				
	omas, R. (2023). Practical Guide to ICP-MS and Other	r Atomic Spectroscopy			
	chniques: A Tutorial for Beginners.				
	tan, K. (2022). Practical Guide to Materials Character	ization: Techniques and			
<ul><li>Applications. John Wiley &amp; Sons.</li><li>3. Stockwell, P. B. (1979). A total systems approach to laboratory automation. Journal of</li></ul>					
	alytical Methods in Chemistry, 1(4), 216-221.	fatory automation. Journal of			
	gino, E. (Ed.). (2012). Atomic absorption spectrometry	v in geology			
	, W. F. (Ed.). (2023). Materials Science and Engineeri				
	velopment. John Wiley & Sons	0			
Teaching Learning Strategies					
•	Lecturing using white/black board/Multimedia				
Written Assignments/presentations/ Task related to assigned topics					
Class activities and Discussion					
• Quiz about last lecture					
Class Presentations Audio/visual Aids/ Tutorials					
Laboratory performance					
Assignments: Types and Number with Calendar					
Assignments, quiz, Tasks, Presentation etc.					

	Assessment				
Sr. No.	Elements	Weightage	Details		
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.		
2.	Formative Assessment	25%	Continuous assessment includes classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.		
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.		

	BS Chemistry Semester-VII					
Program	n BS Chemistry Course Code Chem-452 C		Credit	Hours	3	
Course Tit	le Hyphenated Chroma	atographic Te	chniques C	ourse Typ	e Major	(Elective)
		Course Intro	duction			
students w techniques. various elec will be stud Gas Liquid Formation, Gas Chrom Interfacing Infrared Sp High Perfo Elution and System, Sa Spectromet	This course deals with the advanced chromatographic techniques like HPLC and GC. The students will learn about the instrumentation, applications and the sensitivities etc of these techniques. Furthermore, basic principle and applications of Potentiometry along with the various electrodes will be studied. The role of thermal methods in the analysis of various samples will be studied. Gas Liquid Chromatography / Gas Solid Chromatography: Gas Chromatographs, Derivative Formation, Gas Chromatographic Columns, Liquid Phases and Column Selection, Detectors for Gas Chromatography, Optimization of Experimental Condition, Gas-Solid Chromatography, Interfacing Gas Chromatography with Mass Spectrometry, Interfacing Gas Chromatography with Infrared Spectrometry, High Performance Liquid Chromatography: Optimization of Column Performance, Gradient Elution and Related Procedures, Derivation, HPLC Instrumentation, Mobile-Phase Delivery System, Sample Introduction, Separation Columns, Detectors, Interfacing HPLC with Mass Spectrometry, Instrumentation, detectors, sensitivity, precisian, sample types and qualitative and					
quantitative	e analysis.	Learning Ou	tcomes			
1. 2. 3.	<ul> <li>On the completion of the course, the students will be able to: <ol> <li>Learn about the instrumentation, applications and the sensitivities etc. of HPLC and GC techniques.</li> <li>Understand the basic principle and applications of Potentiometry along with the various electrodes.</li> <li>Comprehend the role of thermal methods in the analysis of various samples.</li> <li>Interpret the graph of HPLC, GC, Potentiometric and TGA results.</li> </ol> </li> </ul>					
	Course C	ontent		Ass	signments/	Readings
Week 1			Cl Le	ass based arning/Tes		
Week 2	Week 2         Derivative Formation, Gas Chromatographic Columns         Class based           Learning/Test					
Week 3	Veek 3         Liquid Phases and Column Selection, Detectors for Gas Chromatography				ss based rning/Test	
Week 4	Optimization of Experimental Condition Class based Learning/Test					
Week 5						
Week 6	Interfacing Gas Chromate	ography with N	Aass Spectron		ss based rning/Test	:

Week 7	Interfacing Gas Chromatography with Infrared Spectrometry	Class based Learning/Test			
Week 8	MID TERM ASSESSMENT				
Week 9	High Performance Liquid Chromatography, Optimization of Column PerformanceClass based Learning/Test				
Week 10	Gradient Elution and Related Procedures, Derivation, HPLC Instrumentation	Class based Learning/Test			
Week 11	Mobile-Phase Delivery System, Sample Introduction	Class based Learning/Test			
Week 12	Separation Columns, Detectors	Class based Learning/Test			
Week 13	Interfacing HPLC with Mass Spectrometry, InstrumentationClass based Learning/Test				
Week 14	Detectors, Sensitivity, and Precision Class based Learning/Test				
Week 15	Class based				
Week 16	Week 16 FINAL TERM ASSESSMENT				
Textbooks and Reading Material					
<ol> <li>Fulekar, M. H., &amp; Pathak, B. (2017). Environmental nanotechnology.</li> <li>Grob, R. L., &amp; Barry, E. F. (Eds.). (2016). Modern practice of gas chromatography. John Wiley &amp; Sons.</li> <li>Smith, C. G. (2020). Handbook of Chromatography: Volume II: Polymers. CRC Press.</li> <li>Snyder, L. R., Kirkland, J. J., &amp; Dolan, J. W. (2011). <i>Introduction to modern liquid</i> <i>chromatography</i>. John Wiley &amp; Sons.</li> </ol>					
Teaching Learning Strategies					
• • •	<ul> <li>Written Assignments/presentations/ Task related to assigned topics</li> </ul>				
Assignments: Types and Number with Calendar					
	Assignments, quiz, Tasks, Presentation etc.				

	Assessment				
Sr. No.	Elements	Weightage	Details		
2.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.		
2.	Formative Assessment	25%	Continuous assessment includes classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.		
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.		