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



separation of complex mixture. The students will be able to understam         The students will also learn about the basic concepts of chromatograph         Chromatographic techniques:         Basic principle of chromatography, classifications of chromatograph         column, paper and thin layer chromatographic techniques; their instrand limitations         Ion exchange chromatography:         Cation exchange resin, anion exchange resin, cross-linkage, effect         separation of metal ions by anions/cations exchange columns, applichromatography.         Learning Outcomes         On the completion of the course, the students will:         1.       Explain the basic principles and classifications of chromatography.         Sexplain the principles and applications of ion exchange chromatography.         5.       Perform separations of metal ions using anion and cation exchange and applications in analytical chemistry reachromatography.         6.       Course Content       A         Week 1       Introduction to Chromatography       Co         Overview of different types of chromatography       Re       Re         Overview of different types of chromatography       Re       Re         Week 3       Principles of column Chromatography       Re         Applications and Limitations of Column       Re       Applications and Limitations of Column	BS Chemistry Semester-V							
Course Introduction           Course Introduction           This course will help the students in understanding chromatograph separation of complex mixture. The students will be able to understant The students will also learn about the basic concepts of chromatograph Chromatographic techniques:           Basic principle of chromatography, classifications of chromatograph column, paper and thin layer chromatographic techniques; their instr and limitations           Ion exchange chromatography:           Cation exchange resin, anion exchange resin, cross-linkage, effect separation of metal ions by anions/cations exchange columns, applic chromatography.           Learning Outcomes           On the completion of the course, the students will:           1.         Explain the basic principles and classifications of chromatal 2. Implement practical applications of column, paper, and thi           3.         Explain the effect of pH on amino acids and its signic chromatography.           5.         Perform separations of metal ions using anion and cation extoragraphy.           Course Content           Week 1         Introduction to Chromatography           Mereix 2         Cations of Chromatography           Week 2         Course of chromatography           Week 3         Theory of Column Chromatography           Re         Class Discussion           Week 3         Theory of Column chromatography           Instrumentatio	Programme		<b>BS</b> Chemistry	Course Code		Credit Hours	2	
This course will help the students in understanding chromatograph separation of complex mixture. The students will be able to understan. The students will also learn about the basic concepts of chromatograph Chromatographic techniques:         Basic principle of chromatography, classifications of chromatograph column, paper and thin layer chromatographic techniques; their instrand limitations         Ion exchange chromatography:         Cation exchange resin, anion exchange resin, cross-linkage, effect separation of metal ions by anions/cations exchange columns, applichromatography.         Learning Outcomes         On the completion of the course, the students will:         1.       Explain the basic principles and classifications of chromatal 2. Implement practical applications of column, paper, and thi         3.       Explain the principles and applications of ion exchange chromatography.         5.       Perform separations of metal ions using anion and cation e Course Content         Meek 1       Introduction to Chromatography         Meek 2       Calssifications of chromatography       Co         Week 3       Theory of Column Chromatography       Re         Querview of different types of chromatography       Re         Week 3       Theory of Column Chromatography       Re         Querview of column chromatography       Icc       Icc         Applications and Limitations of Column       Re       Applications and Limitations of Column	Course Ti	itle	Chromatographic Technic	ques-I C	ourse Typ	e Major (Ele	ective)	
separation of complex mixture. The students will be able to understam         The students will also learn about the basic concepts of chromatograph         Chromatographic techniques:         Basic principle of chromatography, classifications of chromatograph         column, paper and thin layer chromatographic techniques; their instrand limitations         Ion exchange chromatography:         Cation exchange resin, anion exchange resin, cross-linkage, effect         separation of metal ions by anions/cations exchange columns, applichromatography.         Learning Outcomes         On the completion of the course, the students will:         1.       Explain the basic principles and classifications of chromatography.         Separations of metal ions by anions/cations of column, paper, and thi         3.       Explain the principles and applications of ion exchange ch         4.       Understand the effect of pH on amino acids and its signic chromatography.         Separations of metal ions using anion and cation e         Course Content         4.       Introduction to Chromatography       Co         Coinsein analytical chemistry         Casifications of Chromatography         Basic principles of chromatography       Re         Overview of different types of chromatography       Re         Overview of			Course	Introduction				
Learning Outcomes         On the completion of the course, the students will:         1.       Explain the basic principles and classifications of chromat         2.       Implement practical applications of column, paper, and thi         3.       Explain the principles and applications of ion exchange ch         4.       Understand the effect of pH on amino acids and its signic chromatography.         5.       Perform separations of metal ions using anion and cation et course Content         Metek 1         Introduction to Chromatography         Classifications of Chromatography       Co         Week 1       Introduction to Chromatography       Re         Overview of different types of chromatography       Comparison between various chromatography       Re         Week 3       Theory of Column Chromatography       Re         Week 4       Theory of Column chromatography       Re         Instrumentation and setup       quadratic       Applications and Limitations of Column	This course will help the students in understanding chromatographic techniques, involving separation of complex mixture. The students will be able to understand ion exchange methods. The students will also learn about the basic concepts of chromatography. Chromatographic techniques: Basic principle of chromatography, classifications of chromatographic techniques, theory of column, paper and thin layer chromatographic techniques; their instrumentation, applications and limitations Ion exchange chromatography: Cation exchange resin, anion exchange resin, cross-linkage, effect of pH on amino acids,							
On the completion of the course, the students will:       1. Explain the basic principles and classifications of chromat         2. Implement practical applications of column, paper, and thi       3. Explain the principles and applications of ion exchange ch         4. Understand the effect of pH on amino acids and its signic chromatography.       5. Perform separations of metal ions using anion and cation e         Course Content         Meek 1         Introduction to Chromatography         Re         Overview of different types of chromatography         Comparison between various chromatography         Re discussion         Week 3         Theory of Column Chromatography         Re         Output for column chromatography         Re         Output for column chromatography         Re         Overview of different types of chromatography         Comparison between various chromatography         Class Discussion         Theory of Column Chromatography         Instrumentation and setup         Applications and Limitations of Column         Chromatography         Re      <	chromatog	raphy						
Course ContentAWeek 1Introduction to Chromatography Basic principles of chromatography Importance and applications in analytical chemistryCoWeek 2Classifications of Chromatographic Techniques Overview of different types of chromatography Comparison between various chromatographic techniquesRe lec queWeek 3Theory of Column Chromatography Instrumentation and setupRe que queAmount Applications and Limitations of Column ChromatographyRe lec queClass DiscussionRe lec que Re lec queClass DiscussionRe lec que Re lec que Re 	<ol> <li>Explain the basic principles and classifications of chromatography.</li> <li>Implement practical applications of column, paper, and thin layer chromatography.</li> <li>Explain the principles and applications of ion exchange chromatography.</li> <li>Understand the effect of pH on amino acids and its significance in ion exchange chromatography.</li> </ol>							
Week 1Introduction to Chromatography Basic principles of chromatography Importance and applications in analytical chemistryCo rec reaWeek 2Classifications of Chromatographic Techniques Overview of different types of chromatography Comparison between various chromatographic techniquesRe lec queWeek 3Theory of Column Chromatography Instrumentation and setupRe lec queApplications and Limitations of Column ChromatographyRe lec				0		ssignments/Read		
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Week 3Theory of Column Chromatography Principles of column chromatography Instrumentation and setupRe lec que queApplications and Limitations of Column ChromatographyRe	Week 2	Week 2Classifications of Chromatographic Techniques Overview of different types of chromatography Comparison between various chromatographicRead and understand lecture and make possi question for discussion				ossible		
Week 3       Principles of column chromatography       lec         Instrumentation and setup       que         Applications and Limitations of Column       Re		Class Discussion						
Chromatography	Week 3	Principles of column chromatography lecture and make possible				ossible		
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	Theory of Paper Chromatography	Read and understand the
Week 5	Principles of paper chromatography	lecture and make possible
	Instrumentation and setup	question for discussion
	Class discussion	1
	Applications and Limitations of Paper	Read and understand the
Week 6	Chromatography	lecture and make possible
WEEK U	Practical applications of paper chromatography	question for discussion
	Limitations and troubleshooting	
	Theory of Thin Layer Chromatography (TLC)	
	Principles of TLC	Read and understand the
Week 7	Instrumentation and setup	lecture and make possible
	Practical applications of TLC	question for discussion
	Limitations and troubleshooting	
Week 8	Mid-term assessment	
	Introduction to Ion Exchange Chromatography	Read and understand the
Week 9	Basic principles of ion exchange chromatography	lecture and make possible
-	Importance and applications in analytical chemistry	question for discussion
	Principles of Chromatography	Read and understand the
Week 10	Basic principles of separation techniques	lecture and make possible
WEEK IU	Understanding retention, selectivity, and resolution	question for discussion
	Class discussion	
	Cation Exchange Resin	Read and understand the
Week 11	Properties and functions of cation exchange resins	lecture and make possible
	Practical applications	question for discussion
	Anion Exchange Resin	Read and understand the
Week 12	Properties and functions of anion exchange resins	lecture and make possible
	Practical applications	question for discussion
	Quiz	
Week 13	Cross-Linkage in Ion Exchange Resins	Read and understand the
	Understanding cross-linkage and its significance	lecture and make possible
	Practical applications	question for discussion
Week 14	Effect of pH on Amino Acids	Read and understand the
	How pH affects amino acids in ion exchange	lecture and make possible
	chromatography	question for discussion
	Practical examples and experiments	1
Week 15	Separation of Metal Ions by Anion/Cation Exchange Columns	Read and understand the
	Techniques for separating metal ions	lecture and make possible
	Practical applications and examples	question for discussion
Weels 16	Final assessment	
Week 16		

## **Textbooks and Reading Material**

- 1. Chromatography by R.K Sharma, Gogel publishing home meerret
- 2. Introduction to chromatography by Nasir-ud-din, Published by author
- 3. Modern analytical chemistry by David Harvey, Roohani-art press, Islamabad
- 4. Principle and Practice of analytical chemistry by Fillfield, Blackwell Science Ltd
- 5. Fundamentals of Chromatography by H.G. Cassidy, Inter Science Publisher, London, N.Y.
- 6. Fundamentals of Analytical Chemistry by Doughlas Skoog and Donals M. W. West, Holt Reinchart and Inc, London.
- 7. Analytical Chemistry by G. D. Christian

## **Teaching Learning Strategies**

- 1. Lecturing using white/black board/Multimedia
- 2. Written Assignments
- 3. Class activities and discussion
- 4. Quiz about last lecture
- 5. Presentations

## 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 V								
Program	ProgrammeBS ChemistryCourse CodeChem- 347Credit Hour		edit Hour	1					
Course	Title	Basic Chromatographic Techniques (Lab-I)		С	ourse Titl	e	Major (Ele	ective)	
		Course	Introduction	n					
chromato separatio	ography ns.	ourse covers basic analytical v. It also finds its applications k components by paper chron	s in various fi		-	-	•	-	
Separation Separation Determinn Separation Separation	on of va on of lea ation o on of m on of ca	ves using thin layer chromato arious amino acids by thin lay af pigments using column ch of the capacity of an ion exch etal ions using cation exchan dmium and zinc using an ani- ions using anion exchange c	ver chromato romatograph ange resin ge chromatog on exchange	grap y grap col	bhy				
Recovery chromato Separatio Separatio	of the graphy on of dy on of m	separated bromophenol blue	, congo red a 1y circular pape	ind j er ch	iromatogra	phy	g TLC/colu	mn	
		Learnii	ng Outcomes	5					
1.	<ul> <li>On the completion of the course, the students will:</li> <li>1. Analyze and interpret the results of paper, TLC, and column chromatography experiments.</li> <li>2. Separate metal ions and anions using ion exchange chromatography.</li> <li>3. Analyze and interpret the results of ion exchange chromatography experiments.</li> </ul>								
		Course Content		•	As	sign	nents/Read	lings	
Week 1	Week 1         Overview of chromatography principles				reco	Collect the material from recommended books and perform experiments			
Week 2	Separation of ink components by paper Collect the ma			nded book	and and				
Week 3	Collect the material free				l from and				
Week 4	Week 4Separation of various amino acids by thin layer chromatographyCollect the material from recommended books a perform experiments				as and				
Week 5	Week 5Separation of leaf pigments using column chromatographyCollect the material from recommended books and perform experiments				as and				
Week 6	Week 6         Separation of dyes by column chromatography				reco	mme	he materia nded book xperiments	and and	

Week 7red and phenol red using TLC/Column chromatographyrecommended books and perform experimentsWeek 8Mid-term assessmentCollect the material from recommended books and perform experimentsWeek 9Introduction to ion exchange chromatographyCollect the material from recommended books and perform experimentsWeek 10Determination of the capacity of an ion exchange resin the separation of metal ions using cation exchange chromatographyCollect the material from recommended books and perform experimentsWeek 11Separation of metal ions using cation exchange chromatographyCollect the material from recommended books and perform experimentsWeekSeparation of cadmium and zinc using an anionCollect the material from recommended books and perform experiments		Recovery of the separated Bromophenol blue, congo	Collect the material from				
With the production of the capacity of an ion exchange chromatography       perform experiments         Week 9       Introduction to ion exchange chromatography       Collect the material from recommended books and perform experiments         Week 10       Determination of the capacity of an ion exchange resin       Collect the material from recommended books and perform experiments         Week 11       Separation of metal ions using cation exchange resin       Collect the material from recommended books and perform experiments         Week 12       Separation of cadmium and zinc using an anion exchange collect the material from recommended books and perform experiments         Week 13       Separation of anions using anion exchange chromatography       Collect the material from recommended books and perform experiments         Week 13       Separation of mixture of ink components by circular paper chromatography       Collect the material from recommended books and perform experiments         Week 14       Separation of mixture of amino acids by circular paper chromatography       Collect the material from recommended books and perform experiments         Week 15       Final assessment       Collect the material from recommended books and perform experiments         Week 16       Final assessment       Collect the material from recommended books and perform experiments         Vogel's text book of quantitative inorganic analysis by J. Bassett. The English language book Society and Longman       Collect the material from recommended books and perform experi							
Week 8       Mid-term assessment         Week 9       Introduction to ion exchange chromatography       Collect the material from recommended books and perform experiments         Week 10       Determination of the capacity of an ion exchange resin       Collect the material from recommended books and perform experiments         Week 10       Separation of metal ions using cation exchange chromatography       Collect the material from recommended books and perform experiments         Week 11       Separation of cadmium and zinc using an anion exchange column       Collect the material from recommended books and perform experiments         Week 12       Separation of anions using anion exchange chromatography       Collect the material from recommended books and perform experiments         Week 13       Separation of anions using anion exchange chromatography       Collect the material from recommended books and perform experiments         Week 14       Separation of mixture of ink components by circular paper chromatography       Collect the material from recommended books and perform experiments         Week 16       Final assessment 11       Collect the material from recommended books and perform experiments         Week 16       Final assessment 11       Collect the material from recommended books and perform experiments         15       Textbooks and Reading Material       Collect the material from recommended books and perform experiments         16       Textbooks and Reading Material	WEEK /						
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Week 10       Determination of the capacity of an ion exchange resin       Collect the material from recommended books and perform experiments         Week 11       Separation of metal ions using cation exchange chromatography       Collect the material from recommended books and perform experiments         Week 12       Separation of cadmium and zinc using an anion exchange column       Collect the material from recommended books and perform experiments         Week 13       Separation of anions using anion exchange chromatography       Collect the material from recommended books and perform experiments         Week 13       Separation of mixture of ink components by circular paper chromatography       Collect the material from recommended books and perform experiments         Week 14       Separation of mixture of amino acids by circular paper chromatography       Collect the material from recommended books and perform experiments         Week 15       Final assessment       Collect the material from recommended books and perform experiments         Week 16       Final assessment       Collect the material from recommended books and perform experiments         14       Nogel's text book of quantitative inorganic analysis by J. Bassett. The English language book Society and Longman       Collect the material from recommended books and perform experiments         14       Vogel's text book of quantitative inorganic analysis by J. Bassett. The English language book Society and Longman       Collect the material from recommended books         14			Collect the material from				
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Determination of the capacity of an ion exchange resin     recommended books and perform experiments       Week     Separation of metal ions using cation exchange chromatography     Collect the material from recommended books and perform experiments       Week     Separation of cadmium and zinc using an anion exchange column     Collect the material from recommended books and perform experiments       Week     Separation of anions using anion exchange chromatography     Collect the material from recommended books and perform experiments       Week     Separation of anions using anion exchange chromatography     Collect the material from recommended books and perform experiments       Week     Separation of mixture of ink components by circular paper chromatography     Collect the material from recommended books and perform experiments       Week     Separation of mixture of amino acids by circular paper chromatography     Collect the material from recommended books and perform experiments       Week     Separation of mixture of amino acids by circular paper chromatography     Collect the material from recommended books and perform experiments       Week     Separation of mixture of amino acids by circular paper chromatography     Collect the material from recommended books and perform experiments       15     Final assessment     Collect the material from recommended books and perform experiments       16     Textbooks and Reading Material     Number with Calenderial       1     Vogel's text book of quantitative inorganic analysis by J. Bassett. The English langu	Week						
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Week II       Separation of metal ions using cation exchange chromatography       recommended books and perform experiments         Week I2       Separation of cadmium and zinc using an anion exchange column       Collect the material from recommended books and perform experiments         Week I3       Separation of anions using anion exchange chromatography       Collect the material from recommended books and perform experiments         Week I4       Separation of mixture of ink components by circular paper chromatography       Collect the material from recommended books and perform experiments         Week I5       Separation of mixture of amino acids by circular paper chromatography       Collect the material from recommended books and perform experiments         Week I6       Final assessment       Collect the material from recommended books and perform experiments         Week I6       Final assessment       Collect the material from recommended books and perform experiments         I.       Vogel's text book of quantitative inorganic analysis by J. Bassett. The English language book Society and Longman       Collect the material from recommended books and perform experiments         2.       Introduction to chromatography by Dr. Friedrich Cramer, London Macmilian and Co. Ltd       Thin-layer chromatography by Marini, Elservier publisher         I       Lecturing using white/black board/Multimedia       Written Assignments       Class activities and discussion         3.       Class activities and discussion       Qu							
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Week       Separation of cadmium and zinc using an anion       recommended books and         12       exchange column       Collect the material from         13       chromatography       Collect the material from         14       Separation of mixture of ink components by circular paper chromatography       Collect the material from recommended books and perform experiments         Week       Separation of mixture of amino acids by circular paper chromatography       Collect the material from recommended books and perform experiments         Week       Separation of mixture of amino acids by circular paper chromatography       Collect the material from recommended books and perform experiments         Week       Separation of mixture of amino acids by circular paper chromatography       Collect the material from recommended books and perform experiments         Week       Final assessment       Collect the material from recommended books and perform experiments         15       Final assessment       Collect the material from recommended books and perform experiments         16       Textbooks and Reading Material       Collect the material from recommended books and perform experiments         16       Textbooks and Reading Material       Collect the material from recommended books and perform experiments         17       Paper chromatography by Dr. Friedrich Cramer, London Macmilian and Co. Ltd       Thin-layer chromatography by Marini, Elservier publisher			*				
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13       chromatography       recommended books and perform experiments         Week 14       Separation of mixture of ink components by circular paper chromatography       Collect the material from recommended books and perform experiments         Week 15       Separation of mixture of amino acids by circular paper chromatography       Collect the material from recommended books and perform experiments         Week 16       Separation of mixture of amino acids by circular paper chromatography       Collect the material from recommended books and perform experiments         Week 16       Final assessment       Collect the material from recommended books and perform experiments         Week 16       Final assessment       Collect the material from recommended books and perform experiments         10       Vogel's text book of quantitative inorganic analysis by J. Bassett. The English language book Society and Longman       Introduction to chromatography by Nasir-ud-din, Published by author         11       Vogel's text book of quantitative inorganic analysis by J. Bassett. The English language book Society and Longman       Introduction to chromatography by Nasir-ud-din, Published by author         12       Paper chromatography by Marini, Elservier publisher       Endetter         13       Lecturing using white/black board/Multimedia       Viriten Assignments         14       Class activities and discussion       Quiz about last lecture       Foresentations         15       Presentations </th <th><b>XX</b>/ <b>I</b>-</th> <th rowspan="2"></th> <th></th>	<b>XX</b> / <b>I</b> -						
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	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.			