Course Specification
(Bachelor)

Course Title:	Chromatographic Analysis
Course Code:	313CHEM-3
Program:	Bachelor of Science in Chemistry
Department:	Physical Sciences
College:	College of Science
Institution:	Jazan University (JU)
Version:	TP 153-2024
Last Revision Date:	5/5/2024

Table of Contents

A. General information about the course:

1. Course Identification

1. Credit hours: (3 Credit Hours)

2. Course type

A.	☐ University	☐College	☒ Department	☐Track	☐Others
B.	☒ Required		☐Elective		

3. Level/year at which this course is offered: (Level 7 / Year 4)

4. Course general Description:

Course Title	*Course Number*	*Contact Hours (CH)*		*Credit unit (CU)*	*Year*	*Level*	*Pre- requisite*
		Lec.	*Prac.*				
Chromatographic Analysis	*313 CHEM 3*	*2*	*2*	*3*	*4th*	*7th*	*212CHEM3*

Course Objectives; They are to identify the following:

[1] Develop basic understanding of chromatography principles and theories.
[2] Describe the setup and instrumentation of the main chromatographic techniques.
[3] Recognize the advantages and limitations of the main chromatographic techniques.
[4] Calculate chromatographic factors and constants.
[5] Interpret chromatographic data and results.
[6] Develop basic experimental skills of chromatographic analysis.

Syllabus: A-Theoretical content

Definitions of chromatographic analysis terms and parameters, classifications of chromatographic techniques, advantages and disadvantages of the different techniques, main theories of chromatography, calculating and interpreting chromatographic factors and parameters, setup and instrumentation of main chromatographic techniques (PC, TLC, GC and HPLC), applications of chromatographic analysis.

Syllabus: B-Practical content

Practical experiments using different chromatographic separation techniques.

5. Pre-requirements for this course (if any)**:**

212CHEM3

6. Co-requisites for this course (if any)**:**

None

7. Course Main Objective(s):

This course aims to give the student an introduction to the principles and theories of chromatography as a tool of separation for quantitative and qualitative analyses. The course will also cover the setup and instrumentation of the main chromatographic techniques and their applications.

2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100
2	E-learning		
3	Hybrid • Traditional classroom • E-learning		
4	Distance learning		

3. Contact Hours (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	30
2.	**Laboratory/Studio**	30
3.	**Field**	
4.	**Tutorial**	
5.	**Others (specify)**	
Total		60

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
1.0	Knowledge and understanding ; (Upon completion of the course, student will be able to)			
1.1	***Demonstrate a broad understanding and critical view of the principal theories, concepts and terminology of chromatographic analysis and its applications (M)***	***K(1.1)***	***lecture / discussion /Seminars /presentation***	***oral and written examinations/ laboratory reports***
1.2	***Describe the main techniques and instrumentations used in chromatographic analysis and their advantages and limitations and applications (M)***	***K(1.2)***	***lecture / discussion /Seminars /Individual presentation***	***oral and written examinations/ laboratory reports***
2.0	Skills ; (Upon completion of the course, student will be able to)			

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
2.1	***Demonstrate an ability in critical thinking, numeracy, statistical, analytical reasoning, use of graphs and charts to solve problems in chromatographic analysis. (M)***	***S(2.1)***	***lecture / discussion /Seminars /Individual presentation***	***oral and written examinations/ laboratory reports***
2.2	***Perform experiments using various chromatographic techniques; record, analyze and interpret the chromatographic data, and write reports (M)***	S(2.2)	***Lab work, group work***	***Lab report/ Lab notebook.***
2.3	***Apply the proper procedures and regulations for safe handling, use and disposal of chemicals. (M)***	S(2.3)	***Lab demonstrations / hands-on student learning activities***	***Observation of practical skills / Safety exam / Practical assignments and laboratory reports***
3.0	Values, autonomy, and responsibility; (Upon completion of the course, student will be able to)			
3.1	***Working as a group leader in cooperation with other colleagues. (M)***	V(3.1)	***lab demonstrations / whole group and small group discussions***	***group project reports / Practical assignments and laboratory reports***

C. Course Content

No	List of Topics	Contact Hours
1.	***Course introduction and organization***	1
2.	***Introduction to separation***	2
3.	***Introduction to chromatography***	2
4.	***Basic chromatographic theories, terms and equations***	5
5.	***Paper chromatography (PC)***	1
6.	***Thin-layer chromatography (TLC)***	1
7.	***High Performance Liquid chromatography (HPLC)***	7
8.	***Gas chromatography (GC)***	6
9	***Analysis of real samples***	2
10	***Other separation techniques***	1
11	***Exam, quizzes and discussions***	2

12	***Practical experiments on different chromatographic separation techniques.***	***30***
Total		60

D. Students Assessment Activities

No	Assessment Activities *		Assessment timing (in week no)	Percentage of Total Assessment Score
1	**Homework assignment**		**2-13**	**1.25**
2	**Lecture Quiz**		**2-13**	**1.25**
3	**Homework assignment**		**2-13**	**1.25**
4	**Lecture Quiz**		**2-13**	**1.25**
5	**Mid-term exam**		**9-11**	**15**
6	***LAB***	**Practical Sheet**	***15***	**5**
7		**Lab Report**	**2-13**	**9**
8		**Final Lab Exam**	**15**	**10**
9		**Safety Exam**	**14**	**3**
10		**Group evaluation rubric**	**2-13**	**3**
11	***Final Exam***		***16-17***	***50 %***
Total				***100 %***

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.).

E. Learning Resources and Facilities

1. References and Learning Resources

Essential References	1- العثمان، زيد بن عبدالله و محمود، كريم يوسف حسن. الكروماتوجرافيا: الأسس، تحضير العينات، والطرق المرتبطة. دار جامعة الملك سعود للنشر، الطبعة الأولى، 2021. 2-Skoog, Douglas, Donald West, F. L. Holler, and Stanley Crouch. *Fundamentals of analytical chemistry*. Cengage Learning, 9th Edition 2014.
Supportive References	• سلامة، أحمد خميس محمد. التحليل الكروماتوجرافي (اساسيات وطرق التحليل). جامعة المجمعة، الطبعة الأولى، 2015. • العسود، بسام إبراهيم. التحليل الآلي. دار الفكر، الطبعة الأولى، 2011. • Ahuja, Satinder. *Chromatography and separation science*. Vol. 4. Academic Press, 2003. • Miller, James M. *Chromatography: concepts and contrasts*. John Wiley & Sons, 2nd Edition, 2005. • Braithwaite, Alan, and J. F. Smith. Chromatographic methods. Springer, 5th Edition, Reprint 1999.
Electronic Materials	• http://www.chromacademy.com/ • www.chromforum.org/ • http://www.lcresources.com/ • http://www.sepscience.com

	• http://chemwiki.ucdavis.edu/Analytical_Chemistry/Instrumental_Analysis/Chromatography/ • https://chem.libretexts.org/Special:Search?qid=&fpid=230&fpth=&query=chromatography&type=wiki
Other Learning Materials	***None***

2. Required Facilities and equipment

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	*- Lecture Hall for 30 students equipped with modern teaching technology (projector, smart board, computer and internet)* *- Laboratory in accordance with the rules of safety and personal protection accessories should be available to all students*
Technology equipment (projector, smart board, software)	*- Laptop computer, smart board and internet access in the classroom and laboratory*
Other equipment (depending on the nature of the specialty)	*- Chemicals and standards used in lab experiments* *- Related analytical equipment and instruments such as GC, HPLC, UV lamp for TLC, separation columns and accessories, pH meter, analytical balance, …etc*

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Student	Likert-type Survey (CES) Indirect
Effectiveness of Students assessment	Student	Likert-type Survey (CES) Indirect
Quality of learning resources	Program coordinator	Indirect
The extent to which CLOs have been achieved	Instructor & Course coordinator	Classroom evaluation (direct & indirect)
Other		

Assessors (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	Physical Sciences Department Council
REFERENCE NO.	Psci2415
DATE	28/03/1446 Corresponding to 1 / 10 /2024

H. Attachments

1- Practical Work

Experiment	Chemicals, Glassware and Equipment	Remarks
Lab. Experiments' organization and manual design	Data Show.	Week 1
Safety demonstration and laboratory equipment tour	Safety and lab. Equipment in the analytical chemistry labs.	Week 2
Separating food colors using paper chromatography	Goggles; gloves and fume hoods. Chromatography paper; Capillary tube to spot samples; Beaker tall-form 500-mL; Watch glass large (to fit beaker); Scissors; Pencil; Ruler. Commercial food colors; Sodium chloride solution, NaCl, 0.1%.	Week 3
Separating Amino Acids by Thin Layer Chromatography	Goggles; gloves and fume hoods. Thin Layer Chromatography Sheet: (20 x 20 cm) covered with 0.20 mm layer of silica gel 60 (MACHEREY-NAGEL ALUGRAM® Xtra SIL G or similar); Capillary tube to spot samples; Beaker, 1000-mL (Developing Chamber); Watch glass, large (to fit beaker); Spraying bottle for the detecting reagent; Scissors to cut the TLC sheet; Pencil; Ruler. Amino Acids STANDARD solutions of: Lysine, β-Alanine, Tryptophan. Developing solvent (Mobile Phase): a mixture of Acetonitrile : water (70:30 vol/vol). Detecting reagent: Ninhydrin solution - 0.3% (w/vol) Ninhydrin in n-butyl alcohol containing 3% glacial acetic acid. Drying oven or hair dryer for hot air.	Week 4
Separation and Identification of Pain-Killing Drugs by Thin Layer Chromatography	Goggles; gloves; face masks and fume hoods. Thin Layer Chromatography Sheet: (20 x 20 cm) covered with 0.20 mm layer of silica gel 60 (MACHEREY-NAGEL ALUGRAM® Xtra SIL G or similar); Capillary tube to spot samples; Beaker, 1000-mL (Developing Chamber); Watch glass, large (to fit beaker); Scissors to cut the TLC sheet; Pencil; Ruler. STANDARD solutions for Active ingredients: Caffeine (6.5 mg/mL); Paracetamol (50 mg/mL); Acetylsalicylic acid (30 mg/mL); Painkiller tablets; Developing solvent (Mobile Phase): a mixture of Ethyl acetate / Hexane / Acetic acid (60:39:1). UV light box with lamp at short wavelength.	Week 5
Separation of dyes by Column Chromatography	Goggles; gloves; face masks and fume hoods. Chromatography column (400 x 22 mm); Beakers (2), 100-mL; Plastic droppers or Pasteur pipettes; Measuring cylinder, 50-mL; Funnel with wide stem; Pencil (for tapping); Long glass rod to position the cotton wool plug.	Week 6-7

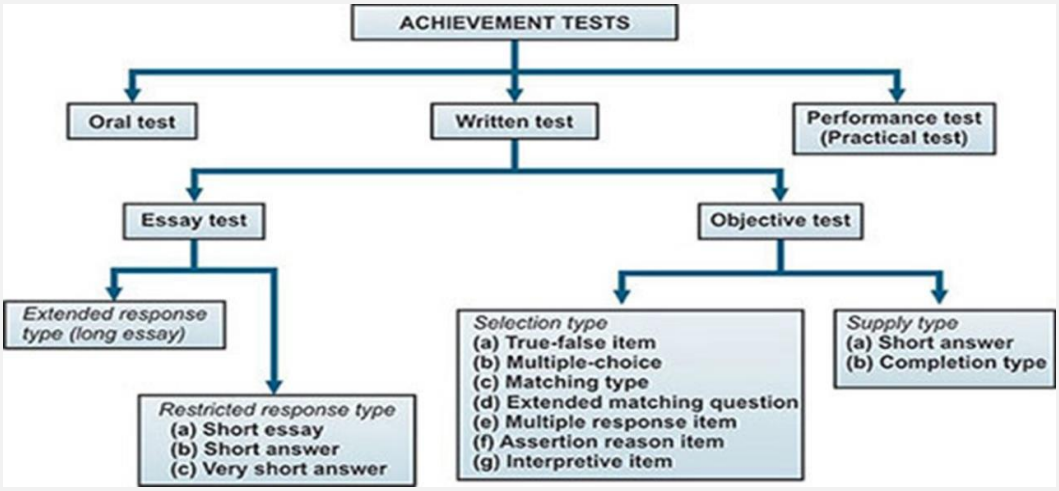
	Dyes Mixture: Mixture of Methyl Orange and Methylene Blue solutions (1:1). Single-compound solutions are prepared in 95% ethanol; Mobile Phase (Elution solvents): FIRST elution solvent: 95% (v/v) Ethanol/Water. SECOND elution solvent: Acetonitrile-Water-Acetic Acid (80:15:5 v/v).	
Determination of Caffeine and Benzoic Acid in Soft Drinks by HPLC with UV detector	Goggles; gloves; and fume hoods. HPLC with UV Detector; Ultrasonic bath. Volumetric flasks (2x10 mL); Reagent bottles (1x60 mL); Glass pipette (1x1 mL); Beakers (1x50 mL, 2x25 mL); Syringe Filter (0.2 µm); Plastic syringe (1x2 mL); HPLC glass vial (1x1.5mL). Soft drink sample; Phosphate buffer solution at pH=3 (50 mL); HPLC mobile phase components (Methanol and Phosphate buffer).	Week 8-10
Qualitative Separation of Alcohols by Gas Chromatography	Goggles; gloves; and fume hoods. GC with Thermal Conductivity Detector (TCD). Small Vials for the solvents; 10 uL micro syringe. Single-Standard of Alcohols (Methanol, Ethanol, 2-Propanol and 1-Butanol); Mixture of all the four alcohols to examine the separation conditions; Unknown mixture of the above alcohols.	Week 11-12
Field trip to a chromatography lab	A bus accommodating the total number of students in addition to 3 instructors.	Week 13
Experiments review and discussions.	Data show and glassware for demonstration.	Week 14
Practical and sheet exams	Depends on the experiments assigned for the exam.	Week 15

2- Blue Print

Course Name	Chromatographic Analysis
Course Code	313 CHEM-3

PLOs	K1	K2	S1	S2	S3	S4	V1	V2
CLOs	1.1	1.2	2.1	2.2	2.3		3.1	
Marks	**18**	**22**	**30**	**24**	**3**		**3**	

Learning Domain	PLOs	CLOs	Assessment Type	Assessment Tool	No of Questions	Marks of the Assessment	Weight of the Assessment
Knowledge & understanding	K1	1.1 (18M)	H.W.	Essay Q	5	1	1.25
			Mid term	Objective Q	8	4	4
			Final Exam	Objective Q	1	13	13
	K2	1.2 (22M)	Quiz	Essay Q	5	1	1.25
			Mid term	Essay Q	5	5	5
			Final Exam	Essay Q	4	16	16
Skills	S1	2.1 (30M)	H.W	Solving Problems & chart analysis	1	1	1.25
			Quiz	Solving Problems & chart analysis	5	2	1.25
			Mid term	Solving Problems & chart analysis	3	6	6
			Final Exam	Solving Problems & chart analysis	3	21	21
	S2	2.2 (24M)	Practical Sheet	Objective Q	10	5	5
			Lab Report	Lab Report Rubric	6	9	9
			Final Lab Exam	Lab Exam	1	10	10
	S3	2.3 (3M)	***Safety EXAM***	Objective Q	6	3	3
Value	V1	3.1 (3M)	Group work	Group evaluation rubric	-	3	3
					TOTAL		100


ACHIEVEMENT TESTS
Oral test
Written test
Performance test (Practical test)
Essay test
Objective test
Extended response type (long essay)
Restricted response type
(a) Short essay
(b) Short answer
(c) Very short answer
Selection type
(a) True-false item
(b) Multiple-choice
(c) Matching type
(d) Extended matching question
(e) Multiple response item
(f) Assertion reason item
(g) Interpretive item
Supply type
(a) Short answer
(b) Completion type