Republic of Yemen

Ministry of Higher Education & Scientific Research

21 September University for Medicals and Applied Sciences

Faculty of Clinical Pharmacy

Bachelor of Pharm. D.

Course Specification of

Pharmaceutical Instrumental Analysis

Course Code. (02.04.251)

2023

T4: This Template is Developed and Approved by CAQA-Yemen, 2023

Prepared by:	Reviewed by:	Head of the Department:	Vice Dean for Quality Affairs	Dean of College:
Dr. Abdulelah Thabet	Prof. Ali Alkaf	Dr. -----……	Dr. Abdulelah Thabet	Dr. Ali Alyahawi

I. General Information:

1.	**Course Title:**	Pharmaceutical Instrumental Analysis				
2.	**Course Code:**	02.04.251				
3.	**Credit Hours:**	**Credit Hours**	**Theory Contact Hours**		**Practical Contact Hours**	
			Lecture	**Tutorial/ Seminar**	**Lab**	**Clinical**
		3	2		2	--
4.	**Level/ Semester at which this Course is offered:**	4th Level / 2nd Semester				
5.	**Pre –Requisite (if any):**	Pharmaceutical Analytical Chemistry				
6.	**Co –Requisite (if any):**	**physical chemistry**				
7.	**Program (s) in which the Course is Offered:**	Bachelor of Clinical Pharmacy & Pharm D				
8.	**Language of Teaching the Course:**	English				
9.	**Location of Teaching the Course:**	Faculty of Clinical Pharmacy				
10.	**Prepared by:**	Dr. Abdulelah Thabet				
11	**Date and Number of Approval by Council:**	2023				

II. Course Description:

The course is designed to give pharmacy schools an overview of the various modern instrumental analytical techniques that deal with identification and quantitation of pharmaceutical compounds used in pharmaceutical research and industry. Basic principles, components, behind each technique (physicochemical, electrochemical, spectroscopic, and chromatographic methods) how it works, what kind of information it provides, how to interpret the data, how to use them to solve pharmaceutical problems. The associated laboratory practical component provides extensive experience in applying these techniques to the chemical analysis of different pharmaceutical samples.

III. Course Intended Learning Outcomes (CILOs) : Upon successful completion of the course, students will be able to:		Referenced PILOs	
	A. Knowledge and Understanding:	**I, P or M/A**	
a1	Recognize the importance of the instrumental analysis in different aspects of science, and the principles of pharmaceutical instrumental techniques.		A1
a2	Describe the theory behind techniques of instrumental analysis.		A1, A2
a3	Recognize the most appropriate analytical methods to analyze a given analyte and matrix,		A2
a4	Give knowledge about applications of these different analytical techniques for the estimation of medicinal agents.		A4
	B. Intellectual Skills:		
b1	Choose appropriate analytical methods for qualitative and quantitative analysis of a material of pharmaceutical relevance.		B1, B2
b2	Analyze the different types of drug substances by chromatographic and electrochemical techniques. The student can apply this to practical work in pharmacy.		B1, B2
b3	Understand the instrumentation of different modern instrumental analytical techniques and their use in pharmaceutical and biochemical analysis.		B1, B2
	C. Professional and Practical Skills:		
c1	Using chromatographic and electrochemical techniques, to isolate and gain quantitative and qualitative information about pharmaceutical compounds in samples.		C1, C2
c2	Critically analyze and translate experimental data into useful information which can form the basis for conclusions and decisions made about analyzed samples.		C1, C2
c3	Summarize results of an analytical experiment, and the conclusions drawn from these results, in a written lab report.		C1
c4	Follow rules of safety, good laboratory practice (GLP) and environmental protection		C1

	D. Transferable Skills:		
d1	Use computer and information technology efficiently to prepare and search for sources of interest related to analysis.		D3
d2	Work independently or as a team member and effectively communicate with the teaching staff and colleagues.		D1
d3	Manage the time in an analytical work effectively.		D1
I= Introduced, P=Practiced or M/A= Mastered/Advanced			

(A) Alignment of Course Intended Learning Outcomes (Knowledge and Understanding) to Teaching Strategies and Assessment Methods:

	Course Intended Learning Outcomes	Teaching Strategies	Assessment Strategies
a1	Recognize the importance of the instrumental analysis in different aspects of sciencem, and the principles of pharmaceutical instrumental techniques.	▪ Lecture ▪ Instructor – student Interactive ▪ Office hour	▪ Exam ▪ Assignment ▪ Quiz
a2	Describe the theory behind techniques of instrumental analysis.	▪ Lecture ▪ Instructor – student Interactive ▪ Office hour	▪ Exam ▪ Assignment ▪ Quiz
a3	Recognize the most appropriate analytical methods to analyze a given analyte and matrix,	▪ Lecture ▪ Instructor – student Interactive ▪ Office hour	▪ Exam ▪ Assignment ▪ Quiz
a4	Give knowledge about applications of these different analytical techniques for the estimation of medicinal agents.	▪ Lecture ▪ Instructor – student Interactive ▪ Office hour	▪ Exam ▪ Assignment ▪ Quiz

(B) Alignment of Course Intended Learning Outcomes (Intellectual Skills) to Teaching Strategies and Assessment Methods:

	Course Intended Learning Outcomes	Teaching Strategies	Assessment Strategies
b1	Choose appropriate analytical methods for qualitative and quantitative analysis of a material of pharmaceutical relevance.	▪ Lecture ▪ Instructor – student Interactive ▪ Exercises ▪ Solving Problem Methods	▪ Problem-Solving Exercises. ▪ Assignment ▪ Quiz
b2	Analyze the different types of drug substances by chromatographic and electrochemical techniques. The student	▪ Lecture ▪ Instructor – student Interactive	▪ Problem-Solving Exercises. ▪ Assignment

	can apply this to practical work in pharmacy.	▪ Exercises ▪ Solving Problem Methods	▪ Quiz
b3	Understand the instrumentation of different modern instrumental analytical techniques and their use in pharmaceutical and biochemical analysis.	▪ Lecture ▪ Instructor – student Interactive ▪ Exercises ▪ Solving Problem Methods	▪ Problem-Solving Exercises. ▪ Assignment ▪ Quiz

(C) Alignment of Course Intended Learning Outcomes (Professional and Practical Skills) to Teaching Strategies and Assessment Methods:

Course Intended Learning Outcomes		Teaching Strategies	Assessment Strategies
c1	Using chromatographic and electrochemical techniques, to isolate and gain quantitative and qualitative information about pharmaceutical compounds in samples.	▪ Lecture ▪ Instructor – student Interactive ▪ Self-Learning	▪ Exam ▪ Assignment ▪ Quiz
c2	Critically analyze and translate experimental data into useful information which can form the basis for conclusions and decisions made about analyzed samples.	▪ Lecture ▪ Instructor – student Interactive ▪ Self-Learning	▪ Exam ▪ Assignment ▪ Quiz
c3	Summarize results of an analytical experiment, and the conclusions drawn from these results, in a written lab report.	▪ Lecture ▪ Instructor – student Interactive ▪ Self-Learning	▪ Exam ▪ Assignment ▪ Quiz
c4	Follow rules of safety, good laboratory practice (GLP) and environmental protection	▪ Lecture ▪ Instructor – student Interactive ▪ Self-Learning	▪ Exam ▪ Assignment ▪ Quiz

(D) Alignment of Course Intended Learning Outcomes (Transferable Skills) to Teaching Strategies and Assessment Methods:

Course Intended Learning Outcomes		Teaching Strategies	Assessment Strategies
d1	Use computer and information technology efficiently to prepare and search for sources of interest related to analysis.	Self-Learning Seminar Exercises	Presentation Assignment Quiz
d2	Work independently or as a team member and effectively communicate with the teaching staff and colleagues.	Seminar Instructor–student Interactive Exercises	Presentation Assignment Quiz
d3	Manage the time in an analytical work		Presentation

	effectively.		Assignment Quiz

IV. Course Contents:

A. Theoretical Aspect:

Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	Contact Hours
1	**Introduction to Instrument analysis.**	a1- a4, b1, b3, d1-d2	- Definitions, Classifications, selection, and types of Instrumental Analysis - Instrumental methods of analysis- Advantages, comparison with Classical Methods of analysis.	1	2
2	**Physiochemicl & Electrochemical methods**	a1-3, b1-3,, d1-3	**Physicochemical methods** **1-Densitometry:** Definition, principles, instrumentation and pharmaceutical applications **2-Refractometry:** Definition, principles, instrumentation and pharmaceutical applications **Electrochemical methods** **1.Polarography**:_____Definition, principles, instrumentation, pharmaceutical applications **2.Conductometry:** Definition, principles, instrumentation, pharmaceutical applications **3.Voltammetry:** Definition, principles, instrumentation, pharmaceutical applications	2	4
3	**Spectroscopic methods**	a1- a4, b1, b3, d1-d2	**Introduction to Spectroscopy** - Electromagnetic Radiation and its interaction with matter, & quantum mechanical property - Absorption and Emission of Radiation - The electromagnetic spectrum	1	2

			1. **UV-Visible spectroscopy**: Introduction, Basic Principles, Absorption characteristics of some chromophores, auxochromes, bathochromic, hypochromic shift, Instrumentation, and Pharmaceutical Application) 2. **Atomic Absorption and Emission spectroscopy** (Principles, Instrumentation, & Pharmaceutical Analytical Applications) 3. **Spectrofluorimetry**: Definition, principles, instrumentation and pharmaceutical applications **4. Infra-red Spectroscopy** - Introduction - Energy levels in vibrating and rotating molecules - Characteristic vibrational frequencies - Factors affecting group frequencies. - Instrumentation - Interpretation of some spectra of pharmaceutical analyte in samples. 5. **H^1-NMR and C^{13} NMR** :- - Basic principle of NMR - NMR spectrometers - Proton NMR - C–13 NMR - Interpretation of NMR spectra of some pharmaceutical material. 6. **Mass Spectroscopy:** Definition, principles, instrumentation, pharmaceutical applications	5	10
4	**Mid Exam**	a1- a4, b1, b3, d1-d2	**8th week**	**1**	**2**
5	**Chromatographic Methods**	a1- a4, b1, b3, d1-d2	**1. Introduction to Chromatography** - History and principles - Classifications	5	10

			- Definition of terminologies - Mechanisms & Techniques. **2. Thin layer Chromatography (TLC)** - Definition, principles, - Sample application - Quantitative measurement and pharmaceutical applications 3. **Gas Chromatography** - Definition, & principles - instrumentation, - Temperature Programming - Pyrolysis and derivatization - The limitation and advantages of the technique - pharmaceutical applications 4. **High performance liquid Chromatography** - Definition, & principles - instrumentation, - Isocratic and Gradient Elution's - The limitation and advantages of the technique - pharmaceutical applications (Identification, Quantitative analysis, and Chiral separation) **5. Capillary Electrophoresis** - Definition, & principles - instrumentation, - The limitation and advantages of the technique - pharmaceutical applications		
	Final Exam	a1- a4, b1, b3, d1-d2		**1**	**2**
Number of Weeks /and Units Per Semester				**16**	**32**

B. Practical Aspect (Lab/Clinical) (if any):

No.	Tasks/ Experiments	Number of Weeks	Contact Hours	Learning Outcomes (CILOs)
1.	Introduction to spectroscopic analysis and prepare a series of standards to construct the calibration curve.	1	2	c1- c4 & d1. d2
2.	Determination of density & refractive indices of some pharmaceutical substances.	1	2	c1- c4 & d1. d2
3.	Potentiometric determination of ammonium iron (II) sulphate.	1	2	c1- c4 & d1. d2
4.	Conductimetric titration of mixture of weak acid and strong acid with weak base.	1	2	c1- c4 & d1. d2
5.	Voltametric determination of ciprofloxacin. or Pb 2+ in solution	1	2	c1- c4 & d1. d2
6.	Determination of copper via amine complex formation using standard series method.	1	2	c1- c4 & d1. d2
7.	Effect of pH upon the Absorption Curve of Sulphanilamide or Absorption Spectrum of thymol Blue	1	2	c1- c4 & d1. d2
8.	**Mid-Exam**	1	2	c1- c4 & d1. d2
9.	Simultaneous determination of caffeine and acetylsalicylic acid in tablets of Melhoral	1	2	c1- c4 & d1. d2
10.	Identification & Quantification of salicylic acid in aspirin tablets by **UV-Vis** spectrophotometry derivative	1	2	c1- c4 & d1. d2
11.	Identification drug samples of some pharmaceutical substances as indomethacin or phenobarbital using based on their functional groups or fingerprint region spectrum by **IR spectroscopy**	1	2	c1- c4 & d1. d2
12.	Practice the explanation of **^{1}H NMR and ^{13}C NMR** of some pharmaceutical substances.	1	2	c1- c4 & d1. d2
13.	Determination of active pharmaceutical ingredients using **Thin layer Chromatography (TLC).**	1	2	c1- c4 & d1. d2
14.	Separation, determination, & Quantification of mixture of pharmaceutical substances using **Gas Chromatography (GC)**	1	2	c1- c4 & d1. d2
15.	Separation, determination, & Quantification of active pharmaceutical ingredient (API) and impurities using **HPLC**	1	2	c1- c4 & d1. d2
16.	- **Final Exam**	1	2	c1- c4
Number of Weeks /and Units Per Semester		**16**	**32**	

VII. Assignments:

No.	Assignments	Week Due	Mark	Aligned CILOs (symbols)
1	**Assignments 1**	Week 2	**2.5**	All CILOs
2	**Assignments 2**	Week 11	**2.5**	All CILOs
Total			**5**	

VIII. Schedule of Assessment Tasks for Students During the Semester:

	Assessment of Theoretical Part				
No.	**Assessment method**	**Week due**	**Mark**	**Proportion of Final Assessment**	**CILOs**
1	**Class attendance and participation**	weekly	5	16.7%	All CILOs
2	**Quizzes (two)**	6th and 12th	5	8.3%	All (a, b, c)
3	Research	-	-	-	
4	**Assignments (two)**	8th and 14th	5	8.3%	All CILOs
5	**Mid-semester exam**	7th	15	16.7%	All (a, b, c)
6	**Final exam**	16th	40	50%	All (a, b, c)
	Total		**70**	**100%**	
	Assessment of Practical Part				
1	**Lab. attendance and participation**	weekly	5	12.5%	All CILOs
2	**Quizzes (two)**	6th and 12th	5	6.25%	All (a, b, c)
3	**Lab. logbook and portfolio**	Weekly	5	6.25%	All CILOs
4	**Mid-semester exam**	7th	5	25.0%	All (a, b, c)
5	**Final exam**	12th	10	50.0%	All (a, b, c)
	Total		**30**	**100%**	

IX. Learning Resources:

1- Required Textbook(s):

1- Douglas A. Skoog, F. James Holler, Stanley R. Crouch, Principles of Instrumental Analysis, 7 th Ed. Cengage Learning, 2018.
2- Pharmaceutical analysis: a textbook for pharmacy students and pharmaceutical chemists. 5th Edition, D. G. Watson. Churchill Livingstone. Edinburgh, Elsevier, 2020

2- Essential References.

	1. L.D. Field, S. Sternhell and S. Kalman, Organic structure from spectra, 2nd ed., John Wille sons, 1995. 2. Harvey, D. (2000). Modern Analytical Chemistry, McGraw-Hill Companies, United States of America. 3- Helmut Günzler and Alex William (2002). Handbook of analytical techniques, , Wiley-VCH, Weinheim, Germany. 4. Lectures Notes and Practical Manual.
3- Electronic Materials and Web Sites *etc*.	
	1. PubMed (https://pubmed.ncbi.nlm.nih.gov/) 2. https://www.sciencedirect.com/journal/talanta 3 -J. Pharm. & Biomed. Anal. 4. The Analytical Abstracts database (http://www.rsc.org/ CFAA/AASearchPage.cfm) 5. J. Assoc. of Anal. Chem 6. https://www.loc.gov/preservation/scientists/instrumentation/index.html 7. https://nmr-challenge.uochb.cas.cz/

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X. Course Policies: (Based on the Uniform Students' By law (2007)

1	**Class Attendance:** Class Attendance is mandatory. A student is considered absent and shall be banned from taking the final exam if his/her absence exceeds 25% of total classes.
2	**Tardiness:** A student will be considered late if he/she is not in class after 10 minutes of the start time of class.
3	**Exam Attendance/Punctuality:** No student shall be allowed to the exam hall after 30 minutes of the start time, and shall not leave the hall before half of the exam time has passed.
4	**Assignments & Projects:** Assignments and projects must be submitted on time. Students who delay their assignments or projects shall lose the mark allocated for the same.
5	**Cheating:** Cheating is an act of fraud that results in the cancelation of the student's exam or assignment. If it takes place in a final exam, the penalties stipulated for in the Uniform Students' Bylaw (2007) shall apply.
6	**Forgery and Impersonation:** Forgery/Impersonation is an act of fraud that results in the cancelation of the student's exam, assignment or project. If it takes place in a final exam, the penalties stipulated for in the Uniform Students' Bylaw (2007) shall apply**.**
7	**Other policies:** The University official regulations in force will be strictly observed and students shall comply with all rules and regulations of the examination set by the Department, Faculty and University Administration.

Faculty of Medical Sciences

Department of Pharmacy

Program of Bachelor of Pharmacy

Course Plan (Syllabus) of

Pharmaceutical Instrumental Analysis

Course Code. 02.04.251

I. Information about Faculty Member Responsible for the Course:							
Name of Faculty Member:	Dr. Abdulelah Thabet	**Office Hours**					
Location& Telephone No.:							
E-mail:		SAT	SUN	MON	TUE	WED	THU

2022- 2023

II. Course Identification and General Information:

11.	**Course Title:**	Pharmaceutical Instrumental Analysis				
12.	**Course Code:**	02.04.251				
13.	**Credit Hours:**	**Credit Hours**	**Theory Contact Hours**		**Practical Contact Hours**	
			Lecture	**Tutorial/ Seminar**	**Lab**	**Clinical**
		3	2		2	--
14.	**Level/ Semester at which this Course is offered:**	4th Level / 2nd Semester				
15.	**Pre –Requisite (if any):**	Pharmaceutical Analytical Chemistry				
16.	**Co –Requisite (if any):**	**physical chemistry**				
17.	**Program (s) in which the Course is Offered:**	Bachelor of Clinical Pharmacy & Pharm D				
18.	**Language of Teaching the Course:**	English				
19.	**Location of Teaching the Course:**	Faculty of Clinical Pharmacy				
20.	**Prepared by:**	Dr. Abdulelah Thabet				
11	**Date and Number of Approval by Council:**	2023				

III. Course Description:

The course is designed to give pharmacy schools an overview of the various modern instrumental analytical techniques that deal with identification and quantitation of pharmaceutical compounds used in pharmaceutical research and industry. Basic principles, components, behind each technique (physicochemical, electrochemical, spectroscopic, and chromatographic methods) how it works, what kind of information it provides, how to interpret the data, how to use them to solve pharmaceutical problems. The associated laboratory practical component provides extensive experience in applying these techniques to the chemical analysis of different pharmaceutical samples.

IV. Course Intended Learning Outcomes (CILOs) :

Upon successful completion of the Course, student will be able to:

	A. Knowledge and Understanding:	**I, P or M/A**	
a1	Recognize the importance of the instrumental analysis in different aspects of science, and the principles of pharmaceutical instrumental techniques.		A1
a2	Describe the theory behind techniques of instrumental analysis.		A1, A2
a3	Recognize the most appropriate analytical methods to analyze a given analyte and matrix,		A2
a4	Give knowledge about applications of these different analytical techniques for the estimation of medicinal agents.		A4
	B. Intellectual Skills:		
b1	Choose appropriate analytical methods for qualitative and quantitative analysis of a material of pharmaceutical relevance.		B1, B2
b2	Analyze the different types of drug substances by chromatographic and electrochemical techniques. The student can apply this to practical work in pharmacy.		B1, B2
b3	Understand the instrumentation of different modern instrumental analytical techniques and their use in pharmaceutical and biochemical analysis.		B1, B2
	C. Professional and Practical Skills:		
c1	Using chromatographic and electrochemical techniques, to isolate and gain quantitative and qualitative information about pharmaceutical compounds in samples.		C1, C2
c2	Critically analyze and translate experimental data into useful information which can form the basis for conclusions and decisions made about analyzed samples.		C1, C2
c3	Summarize results of an analytical experiment, and the conclusions drawn from these results, in a written lab report.		C1
c4	Follow rules of safety, good laboratory practice (GLP) and environmental protection		C1

D. Transferable Skills:			
d1	Use computer and information technology efficiently to prepare and search for sources of interest related to analysis.		D3
d2	Work independently or as a team member and effectively communicate with the teaching staff and colleagues.		D1
d3	Manage the time in an analytical work effectively.		D1
I= Introduced, P=Practiced or M/A= Mastered/Advanced			

V. Course Contents:

A. Theoretical Aspect:

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Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	Contact Hours
1	**Introduction to Instrument analysis.**	a1- a4, b1, b3, d1-d2	- Definitions, Classifications, selection, and types of Instrumental Analysis - Instrumental methods of analysis- Advantages, comparison with Classical Methods of analysis.	1	2
2	**Physiochemicl & Electrochemical methods**	a1-3, b1-3,, d1-3	**Physicochemical methods** **1-Densitometry:** Definition, principles, instrumentation and pharmaceutical applications **2-Refractometry:** Definition, principles, instrumentation and pharmaceutical applications **Electrochemical methods** **1.Polarography:** Definition, principles, instrumentation, pharmaceutical applications **2.Conductometry:** Definition, principles, instrumentation, pharmaceutical applications **3.Voltammetry:** Definition, principles, instrumentation, pharmaceutical applications	2	4

3	**Spectroscopic methods**	a1- a4, b1, b3, d1-d2	**Introduction to Spectroscopy** - Electromagnetic Radiation and its interaction with matter, & quantum mechanical property - Absorption and Emission of Radiation - The electromagnetic spectrum	1	2
			7. **UV-Visible spectroscopy**: Introduction, Basic Principles, Absorption characteristics of some chromophores, auxochromes, bathochromic, hypochromic shift, Instrumentation, and Pharmaceutical Application) 8. **Atomic Absorption and Emission spectroscopy** (Principles, Instrumentation, & Pharmaceutical Analytical Applications) 9. **Spectrofluorimetry**: Definition, principles, instrumentation and pharmaceutical applications **10. Infra-red Spectroscopy** - Introduction - Energy levels in vibrating and rotating molecules - Characteristic vibrational frequencies - Factors affecting group frequencies. - Instrumentation - Interpretation of some spectra of pharmaceutical analyte in samples. 11. **H^1-NMR and C^{13} NMR** :- - Basic principle of NMR - NMR spectrometers - Proton NMR - C–13 NMR - Interpretation of NMR spectra of some pharmaceutical material. 12. **Mass Spectroscopy:** Definition, principles,	5	10

			instrumentation, pharmaceutical applications		
4	**Mid Exam**	a1- a4, b1, b3, d1-d2	**8th week**	**1**	**2**
5	**Chromatographic Methods**	a1- a4, b1, b3, d1-d2	**6. Introduction to Chromatography** - History and principles - Classifications - Definition of terminologies - Mechanisms & Techniques. **7. Thin layer Chromatography (TLC)** - Definition, principles, - Sample application - Quantitative measurement and pharmaceutical applications 8. **Gas Chromatography** - Definition, & principles - instrumentation, - Temperature Programming - Pyrolysis and derivatization - The limitation and advantages of the technique - pharmaceutical applications 9. **High performance liquid Chromatography** - Definition, & principles - instrumentation, - Isocratic and Gradient Elution's - The limitation and advantages of the technique - pharmaceutical applications (Identification, Quantitative analysis, and Chiral separation) **10. Capillary Electrophoresis** - Definition, & principles - instrumentation, - The limitation and advantages of the technique - pharmaceutical applications	5	10
	Final Exam	a1- a4, b1, b3, d1-d2		**1**	**2**
Number of Weeks /and Units Per Semester				**16**	**32**

B. Case Studies and Practical Aspect:

No.	Tasks/ Experiments	Number of Weeks	Contact Hours
17.	Introduction to spectroscopic analysis and prepare a series of standards to construct the calibration curve.	1	2
18.	Determination of density & refractive indices of some pharmaceutical substances.	1	2
19.	Potentiometric determination of ammonium iron (II) sulphate.	1	2
20.	Conductimetric titration of mixture of weak acid and strong acid with weak base.	1	2
21.	Voltametric determination of ciprofloxacin. or Pb 2+ in solution	1	2
22.	Determination of copper via amine complex formation using standard series method.	1	2
23.	Effect of pH upon the Absorption Curve of Sulphanilamide or Absorption Spectrum of thymol Blue	1	2
24.	**Mid-Exam**	1	2
25.	Simultaneous determination of caffeine and acetylsalicylic acid in tablets of Melhoral	1	2
26.	Identification & Quantification of salicylic acid in aspirin tablets by **UV-Vis** spectrophotometry derivative	1	2
27.	Identification drug samples of some pharmaceutical substances as indomethacin or phenobarbital using based on their functional groups or fingerprint region spectrum by **IR spectroscopy**	1	2
28.	Practice the explanation of **^{1}H NMR and ^{13}C NMR** of some pharmaceutical substances.	1	2
29.	Determination of active pharmaceutical ingredients using **Thin layer Chromatography (TLC).**	1	2
30.	Separation, determination, & Quantification of mixture of pharmaceutical substances using **Gas Chromatography (GC)**	1	2
31.	Separation, determination, & Quantification of active pharmaceutical ingredient (API) and impurities using **HPLC**	1	2
32.	- **Final Exam**	1	2
Number of Weeks /and Units Per Semester		**16**	**32**

No.	Tasks/ Experiments	Number of Weeks	Contact Hours
	Introduction to spectroscopic analysis and prepare a series of standards to construct the calibration curve.	1	2
	Determination of density & refractive indices of some pharmaceutical substances.	1	2

No.	Tasks/ Experiments	Number of Weeks	Contact Hours	
	- Potentiometric determination of ammonium iron (II) sulphate.	1	2	
	- Conductimetric titration of mixture of weak acid and strong acid with weak base.	1	2	
	Voltametric determination of ciprofloxacin. or Pb 2+ in solution	1	2	
	Determination of copper via amine complex formation using standard series method.	1	2	
	Effect of pH upon the Absorption Curve of Sulphanilamide or Absorption Spectrum of thymol Blue	1	2	
	Mid-Exam	1	2	
	Simultaneous determination of caffeine and acetylsalicylic acid in tablets of Melhoral	1	2	
	Identification & Quantification of salicylic acid in aspirin tablets by UV-Vis spectrophotometry derivative	1	2	
	Identification drug samples of some pharmaceutical substances as indomethacin or phenobarbital using based on their functional groups or fingerprint region spectrum by **IR spectroscopy**	1	2	
	Practice the explanation of ^{1H} NMR and ^{13C} NMR of some pharmaceutical substances.	1	2	
	Determination of active pharmaceutical ingredients using Thin layer Chromatography (TLC)**.**	1	2	
	Separation, determination, & Quantification of mixture of pharmaceutical substances using Gas Chromatography (GC)	1	2	
	- **Separation, determination**, & Quantification of active pharmaceutical ingredient (API) and impurities using **HPLC**	1	2	
		Final Exam	1	**2**
Number of Weeks /and Units Per Semester		**16**	32	

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VI. Teaching Strategies of the Course:

- Lecture
- Instructor – student Interactive
- Exercises
- Presentation
- Office hours
- Seminar
- Assignment
- Self-Learning

VII. Assessment Methods of the Course:

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- Assignments
- Quiz
- Exam
- Oral Presentation

VIII. Assignments:

No.	Assignments	Week Due	Mark
1	**Assignments 1**	Week 2	**2.5**
2	**Assignments 2**	Week 11	**2.5**
Total			**5**

IX. Schedule of Assessment Tasks for Students During the Semester:

	Assessment of Theoretical Part				
No.	**Assessment method**	**Week due**	**Mark**	**Proportion of Final Assessment**	**CILOs**
1	**Class attendance and participation**	weekly	5	16.7%	All CILOs
2	**Quizzes (two)**	6th and 12th	5	8.3%	All (a, b, c)
3	Research	-	-	-	
4	**Assignments (two)**	8th and 14th	5	8.3%	All CILOs
5	**Mid-semester exam**	7th	15	16.7%	All (a, b, c)
6	**Final exam**	16th	40	50%	All (a, b, c)
	Total		**70**	**100%**	
	Assessment of Practical Part				
1	**Lab. attendance and participation**	weekly	5	12.5%	All CILOs
2	**Quizzes (two)**	6th and 12th	5	6.25%	All (a, b, c)
3	**Lab. logbook and portfolio**	Weekly	5	6.25%	All CILOs

4	**Mid-semester exam**	7th	5	25.0%	All (a, b, c)
5	**Final exam**	12th	10	50.0%	All (a, b, c)
	Total		**30**	**100%**	

X. Learning Resources:

1- Required Textbook(s):

1- Douglas A. Skoog, F. James Holler, Stanley R. Crouch, Principles of Instrumental Analysis, 7 th Ed. Cengage Learning, 2018.
2- Pharmaceutical analysis: a textbook for pharmacy students and pharmaceutical chemists. 5th Edition, D. G. Watson. Churchill Livingstone. Edinburgh, Elsevier, 2020

2- Essential References.

1. L.D. Field, S. Sternhell and S. Kalman, Organic structure from spectra, 2nd ed., John Willey and sons, 1995
2. Harvey, D. (2000). Modern Analytical Chemistry, McGraw-Hill Companies, United States of America.
4- Helmut Günzler and Alex William (2002). Handbook of analytical techniques, , Wiley-VCH, Weinheim, Germany.
3. Lectures Notes and Practical Manual.

3- Electronic Materials and Web Sites *etc*.

1. PubMed (https://pubmed.ncbi.nlm.nih.gov/)
2. https://www.sciencedirect.com/journal/talanta
3 -J. Pharm. & Biomed. Anal.
4. The Analytical Abstracts database (http://www.rsc.org/ CFAA/AASearchPage.cfm)
5. J. Assoc. of Anal. Chem
6. https://www.loc.gov/preservation/scientists/instrumentation/index.html
7. https://nmr-challenge.uochb.cas.cz/

XI. Course Policies: (Based on the Uniform Students' Bylaw (2007)

1	**Class Attendance:** Class Attendance is mandatory. A student is considered absent and shall be banned from taking the final exam if his/her absence exceeds 25% of total classes.
2	**Tardiness:** A student will be considered late if he/she is not in class after 10 minutes of the start time of class.
3	**Exam Attendance/Punctuality:** No student shall be allowed to the exam hall after 30 minutes of the start time, and shall not leave the hall before half of the exam time has passed.
4	**Assignments & Projects:** Assignments and projects must be submitted on time. Students who delay their assignments or

	projects shall lose the mark allocated for the same.
5	**Cheating:** Cheating is an act of fraud that results in the cancelation of the student's exam or assignment. If it takes place in a final exam, the penalties stipulated for in the Uniform Students' Bylaw (2007) shall apply.
6	**Forgery and Impersonation:** Forgery/Impersonation is an act of fraud that results in the cancelation of the student's exam, assignment or project. If it takes place in a final exam, the penalties stipulated for in the Uniform Students' Bylaw (2007) shall apply**.**
7	**Other policies:** The University official regulations in force will be strictly observed and students shall comply with all rules and regulations of the examination set by the Department, Faculty and University Administration.