Course Plan for Bachelor Program - Study Plan Development and Updating Procedures/ Pharmacy Department	QF02/0408-4.0E

Study Plan No.	**2021/2022**		**University Specialization**		**Bachelor of Pharmacy**	
Course No.	**0201360**		**Course Name**		**Instrumental Analysis**	
Credit Hours	**3**		**Prerequisite *Co-requisite**		**Analytical Chemistry + Pharmaceutical Organic Chemistry (2)**	
Course Type	☐ Mandatory University Requirement	☐ University Elective Requirement	☐ Faculty Mandatory Requirement	☐ Support course family requirements	☑ **Mandatory Requirement**	☐ Elective Requirement
Teaching Style	☐ Full Online Learning		☐ Blended Learning		☑ **Traditional Learning**	
Teaching Model	☐ 1 Synchronous: 1 Asynchronous		☐ 1 Face to Face: 1 Asynchronous		☑ **2 Traditional**	

Faculty Member and Study Divisions Information *(to be filled in each semester by the subject instructor)*

Name	Academic rank	Office No.	Phone No.	E-mail	
Office Hours (Days/Time)	**Sunday, Tuesday, Thursday**		**Monday, Wednesday**		
Division number	**Time**	**Place**	**Number of Students**	**Teaching Style**	**Approved Model**
				Traditional Learning	**2 Traditional**

Brief Description

This course is designed to provide students with knowledge about the most important instrumental techniques used in pharmaceutical analysis. It describes the principles and applications of the most commonly used spectroscopic techniques such as UV-Vis, MES, AAS, AES, IR, NMR and Mass spectroscopies. In addition to separation techniques such as chromatography and capillary electrophoresis, and electrochemical techniques.

Learning Resources

Course Book Information (Title, author, date of issue, publisher ... etc)	Pharmaceutical Analysis: A Textbook for Pharmacy Students and Pharmaceutical Chemists, 5th edition, David Watson, Elsevier/ Churchill Livingstone, 2020. (Available at Al-Zaytoonah University of Jordan library)			
Supportive Learning Resources (Books, databases, periodicals, software, applications, others)	1. Principles of instrumental analysis, 7th edition, Douglas Skoog, James Holler, and Stanley Crouch, Cengage learning, 2018. 2. Spectrometric Identification of Organic Compounds, 8th edition, Robert Silverstein, Francis Webster, David Kiemle, and David Bryce, Wiley, 2014. 3. Fundamentals of Analytical Chemistry, 9th edition, Donald West, F. James Holler, Douglas A. Skoog & Stanley R. Crouch. Brooks/Cole – Thomson Learning, 2014.			
Supporting Websites				
The Physical Environment for Teaching	☑ **Classroom**	☐ Labs	☑ **Virtual Educational Platform**	☐ Others
Necessary Equipment and Software	Moodle			
Supporting People with				

Special Needs	
For Technical Support	E-Learning & Open Educational Resources Center. Email: elearning@zuj.edu.jo; Phone: +962 6 429 1511 ext. 425/362.

Course learning outcomes *(K= Knowledge, S= Skills, C= Competencies)*

No.	Course Learning Outcomes	The Associated Program Learning Output Code
Knowledge **The student should be able to:**		
K1	Identify categories and classifications of instrumental methods used in pharmaceutical analysis.	**MK2**
K2	Recognize the electrochemical instrumentation employed in analysis of pharmaceuticals.	**MK2**
K3	Outline the theory, principles, and applications of specific types of spectroscopy (UV-Vis, luminescence, atomic, IR, mass and NMR) used in pharmaceutical analysis.	**MK2**
K4	Describe classes and applications of separation techniques (HPLC, GC, and CE) utilized in pharmaceutical analysis.	**MK2**
Skills **The student should be able to:**		
S1	Predict the approaches addressed by instrumental analysis.	**MS4**
S2	Perform qualitative and quantitative analysis by interpretation of UV, luminescence, IR, NMR, and Mass spectra.	**MS4**
S3	Select the appropriate method of analysis for identification and structural elucidation of organic compounds.	**MS4**
S4	Determine the proper separation technique for analysis of various samples and dosage forms.	**MS4**
Competencies **The student should be able to:**		
C1	Demonstrate critical thinking skills required for methods development and validation applied in pharmaceutical analysis procedures.	**MC3**

Mechanisms for Direct Evaluation of Learning Outcomes

Type of Assessment / Learning Style	Fully Electronic Learning	Blended Learning	Traditional Learning (Theory Learning)	Traditional Learning (Practical Learning)
Midterm Exam	30%	30%	**30%**	0%
Participation / Practical Applications	0%	0%	**20%**	50%
Asynchronous Interactive Activities	20%	20%	**0%**	0%
Final Exam	50%	50%	**50%**	50%

Note 1: *Asynchronous interactive activities are activities, tasks, projects, assignments, research, studies, projects, and work within student groups ... etc, which the student carries out on his own, through the virtual platform without a direct encounter with the subject teacher.*

Note 2: *According to the Regulations of granting Master's degree at Al-Zaytoonah University of Jordan, 40% of final evaluation goes for the final exam, and 60% for the semester work (examinations, reports, research or any scientific activity assigned to the student).*

Schedule of Simultaneous / Face-to-Face Encounters and their Topics

Week	Subject	Learning Style*	Reference **
1	**Introduction**: Review of the concept of pharmaceutical analysis and analytical methods, and types of Error in experimental data.	Lecture	Textbook: Ch. 1, pp. (1-24)
2	**Electrochemistry** including Potentiometry, Conductometry, and Polarimetry.	Lecture	Textbook: Ch. 3, pp. (60-71)
3	**Spectroscopy**: Basic concepts of light (spectrum and electromagnetic radiation) and interaction with matter, theory of excitation and structural requirements for light absorption. Basic design of spectroscopy.	Lecture	Textbook: Ch. 4, pp. (90-113)
4	**UV-Vis spectroscopy**: Quantitative applications of Beer's Lambert law and its use in analysis. And important considerations in using UV/ Vis. Spectroscopy e.g. potential deviations from linearity and how to diagnose and resolve the problem. In addition to effect of solvents and pH on spectra.	Lecture	Textbook: Ch. 4, pp. (90-113)
5	**UV-Vis spectroscopy**: Potential effects of different instrumental factors like stray light and chemical factors like the nature of the sample being measured. And quantitative and qualitative application and assays.	Lecture	Textbook: Ch. 4, pp. (90-113)
6	**Luminescence Spectroscopy**: Fluorescence and phosphorescence origin, and uses in spectroscopy. And effect of structure, temperature and solvent in analysis. And basic design of a spectrofluorometer and its applications.	Lecture	Textbook: Ch. 7, pp. (152-161)
7	**Atomic Emission and Atomic**	Lecture	Textbook: Ch. 6, pp. (138-150)

	Absorption Spectroscopy: Basic theory of atomic excitation. And the analytical applications. Then instrumentation, advantages and disadvantages of each technique.		
8	**Infra-Red Spectroscopy (IR)**: Origin of IR band, modes of vibrations. And, uses of IR for identification and elucidation of compounds. Then basic designs of the instrument. And practical handling of the sample.	Lecture	Textbook: Ch. 5, pp. (115-135)
9	**NMR Spectroscopy**: The origin of resonance, spin- spin coupling. And the concept of chemical shift. Then description of ^{1}H NMR. **Midterm Exam**	Lecture	Textbook: Ch. 8, pp. (165-200)
10	**NMR Spectroscopy**: ^{13}C NMR, and two dimensional NMR spectra. Then applications and examples.	Lecture	Textbook: Ch. 8, pp. (165-200)
11	**Mass Spectroscopy**: Mass spectrometer principle, mass spectrum, fragmentation. And application with examples.	Lecture	Textbook: Ch. 9, pp. (204-248)
12	**Combined structure problems**: UV, IR, Mass and ^{1}H and ^{13}C NMR	Lecture	Provided examples and exercises
13	**Chromatographic Techniques**: Theory of chromatography. And basic concept of chromatogram. Then parameters of chromatography. e.g. retention time, peak width, resolution etc.	Lecture	Textbook: Ch. 10, pp. (252-262)
14	**Chromatographic Techniques**: Instrumentation of HPLC, modes of HPLC: normal phase and reversed phase. And factors affecting retention on either mode. Then Gas chromatography Instrumentation, classes and modes. Analytical applications of HPLC. Analytical applications of GC.	Lecture	Textbook: Ch. 10 and 11, pp. (301-355) and (265-299)
15	Capillary electrophoresis: Theory of electrophoresis and instrumentation, EOF and migration times. And description of electropherogram.		Textbook: Ch. 14, pp. (376-396)
16	**Final Exam**		

** Learning styles: Lecture, flipped learning, learning through projects, learning through problem solving, participatory learning ... etc.*
*** Reference: Pages in a book, database, recorded lecture, content on the e-learning platform, video, website ... etc.*

Schedule of Asynchronous Interactive Activities *(in the case of e-learning and blended learning)*

Week	Task / Activity	Reference	Expected Results
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