Chemistry Department

College of education

University of Salahaddin- Erbil

Course Book– 4th stage

Subject: Instrumental Analysis / Theoretical Molecular spectrometry

Lecturer's name: Dr. SEERWAN F.SHAWKET

Academic Year: 2022/2023

1. Course name	**Instrumental Analysis**
2. Lecturer in charge	**Dr. SEERWAN F. SHAWKET**
3. Department/ College	**Chemistry/ education**
4. Contact	**e-mail: sirwan.shawket@su.edu.krd**
5. Time (in hours) per week	**Theory: 2hs**
6. subject time	**Sunday.: G1 08:30 - 10:30** **G2 10.30 - 12.30**
7. Course code	
8. Teacher's academic profile	➢ **Dr. SEERWAN F. SHAWKET** ▪ Lecturer in Analytical Chemistry ➢ **Research interests:** ▪ Flow Injection Analysis ▪ Spectrophotometry ▪ Environmental analysis ▪ Atomic absorption spectrometry ➢ **Teaching interests:** ▪ Analytical Chemistry ▪ Chemical pollution ▪ Instrumental analysis ➢ **Education** ▪ B.Sc. in Chemistry, College of Science, Salahaddin University-Erbil, Iraq, 1982 ▪ M.Sc. in biochemistry, " College of Science, Salahaddin University-Erbil, Iraq, 1992 ▪ Ph.D. in Analytical Chemistry, College of Science, Baghdad University, Iraq, 2002.
9. Keywords	**Instrument , Analysis , Chemistry**

10. Course overview:

- This course presents a survey of instrumental methods of chemical analysis. We will focus on understanding the fundamental principles underlying instrumental methods and their realization in modern instrumentation for chemical analysis. We will focus on the following broad methodological areas: optical spectroscopy and Electrochemistry, .We focus on principles and concepts of implementation should provide greater insight both into how current instruments work as well as the basis for your understanding how they will work a decade from now. Lastly, we will pay attention to the chemical systems to which these methods are applicable and how best to obtain the chemical information desired using the most appropriate instrumental methods. The most important topics in this course are:
- Instruments for Optical Spectrometry,
- Luminescence's methods,

11. Course objective:

Instrumental analysis course will explain the theory of operation, instrumental design, methodology, and applications of instrumental techniques of spectroscopic methods including UV/VIS and Luminescence's methods,

At the end of the course, learner will be able to:

- Recognize the theory of operation, instrumental design and application of various instrumental methods.
- Understand and apply the various spectroscopic methods.
- Apply various electroanalytical methods.
- The main objective of this course is to introduce students to the modern instrumental methods of quantitative and qualitative analysis and to learn about the fundamental principals of operation of these methods, concentration will be drawn basically to spectroscopic and electroanalytical methods , their strengths and limitations and their application in Analysis will be discussed.

12. Student's obligation

It is important to realize that it is not possible to learn all that you need to know about Instrumental Analysis from just the text, lectures, supplemental readings, or problem sets. Rather, attention must be paid to all of these areas as the material covered in each is designed to be complementary. I think that you will find that the problems in the problem sets will be easier to solve if you've attended the lectures and done the assigned readings.

I encourage you to come to lecture having already read the assigned material as I would prefer to spend as much of our class time discussing the material, answering your questions about the material and asking you questions about the material. Obviously, our time in class will only be meaningful if you've already read the assigned readings for that particular unit.

Your attendance in class is, of course, expected - if there is a class that you know you will not be

able to attend, please let me know ahead of time so that we can make sure you don't miss anything.

Problem sets will not be collected and are not "due" at any particular time -- it is in your best interests, however, to work the problem sets contemporaneously with the lecture material. Detailed solutions to the problems sets will be made available online at the course website. Problems just like or very similar to those on the problem sets have a habit of finding their way onto exams, so it would be prudent of you to ensure that you can work the relevant problem set problems before you take one of the exams.

13. Forms of teaching

Classes will primarily consist of lecture with some in-class discussion, tutorials, problem solving, debates, and some demonstrations. Questions at any time during class are highly encouraged. Lectures will be accompanied with power point presentations of the head titles and notes.

The textbook is a good, general place to start your study of most of the topics that we will cover (and a good book to keep on your bookshelf for future reference), although we will often cover topics differently or at greater depth than is found within this book. Many additional, useful sources are on reserve. You are encouraged to read as many sources as possible because learning from several different viewpoints will deepen your knowledge and more closely simulate how you will learn new material in the future.

Experience has shown that the students who attend class, read more references, and complete more problems do much better! To be successful you will have to spend a significant amount of time on this course outside of the class time.

14. Assessment scheme

This course is divided into two portions: lecture and laboratory.

The lecture portion constitutes 65% of the overall final grade, while the laboratory portion constitutes 35%.

Lecture Grade

The Lecture grade for this course is based on, two one-hour exams (15 pts), and a comprehensive final exam (50 pts).

Quizzes: A quiz will be given in the beginning of the lectures. Any topic previously covered in the course is fair game for a quiz question.

Exams: Two one hour midterm exams will be given during the year at normal class times as indicated on the attached class schedule and one comprehensive final at the end of the course. Exams will comprise material and problems similar to those discussed during class lecture, textbook example problems and problems assigned at the end of each chapter of the text. In class examinations will generally concentrate on new material covered since the last exam. The final examination will be comprehensive and cover material from the entire course.

15. Student learning outcome:

By the end of the course students will be able to:

1. Acquire a detailed understanding of the principles of operation of modern analytical instrumentation.
2. Demonstrate critical thinking, quantitative reasoning, and scientific knowledge related to the wide variety of choices that must be made when using instrumental methods to solve analytical problems.
3. Acquire more advanced laboratory skills associated with the collection, handling, and evaluation of analytical data. The students will also demonstrate competence in writing scientific reports.
4. Interpret data and to use the appropriate statistical methods in their evaluation.

16. Course Reading List and References:

- **Principles of Instrumental Analysis , Skoog, 6th ed.; Thompson: Belmont, CA, 2007.**
- **Analytical chemistry Gary Christian**
- **Fundamentals of analytical chemistry , Skoog & West**
- **Quantitative chemical analysis : D.C. Harris**.
- **Undergraduate instrumental analysis : Robinson & Frame**

17. The Topics:	**Dr. SEERWAN**
Instrumental analysis definition, advantage and limitations,	1st week
Introduction of Spectrometric methods, Properties of Electromagnetic Radiation, Radiation Absorption, electronic excitation	2nd week
Beer's Law, Limits to Beer's Law, solving problems	3rd week
Deviation from Beer law	4th week
Quantitative Analysis (Beer's Law), Spectrometric analysis using standard curve,	5th week
Simultaneous Analysis of two compounds, Photometric Titrations, Standard Addition Method	6th week
Stoichiometry of complex ions, Continuous Variation Method, Mole-ratio method, Slope- ratio method.	7th week
Fluorescence	8th week
Phosphorescence	9th week
Chemiluminescence	10th week
Nephelometry Technics	11th week
Turbidimetry Technics'	12th week
Flow Injection Analysis ,Theory and Practice, Instrumentation	13th week

19. Examinations:

Q1/ Choose the <u>best answer</u> for each question: [10 marks]

1- A sample absorbs too strongly at a particular wavelength. You could decrease the absorbance at that wavelength by each of the following:
a- quantitatively diluting the solution. **b-** using a cell with a shorter path length.
c- decreasing the molar absorptivity. **d-** (a & b), **e-** (all of them) , **f-** (a & c) .

2- When producing an absorption spectrum, which of the following variables must be held constant?
a- path length, **b-** concentration, **c-** wavelength, **d-** (a & b) , **e-** (a & b) , **f-** (a & c)

3- The working versification of the fluorescence formula is
(a) $I_f = 2.303\ K\ \varepsilon\ b\ C\ I_o$, **(b)** $I_o = 2.303\ K\ \varepsilon\ bC\ I_f$, **(c)** $I_f = 2.303\ K\ \varepsilon\ bC$, $I_f = \varepsilon bC$

4- Molar absorptivity is designated as ε with unit ?
(a) $L.mol^{-1}.cm^{-1}$, **(b)** $L.mol.cm^{-1}$, **(c)** $L^{-1}.mol.cm$, **(d)** $mol/\ L.cm^{-1}$

5- A continuous variation method is used to find?
a- the concentration of analyte , **b-** the stoichiometric of complexes , **c-** absorption spectrum

Q2/ a- Draw the **Jablonski diagram** with indication of all the followings: [5marks]

V = 9 level of S_0 has similar energy to the **V = 0** level of S_1 , **V = 8** level of S_1 has similar energy to the **V = 0** level of S_2 , **Absorption , Vibrational relaxation, Internal conversion, Intersystem Crossing , Quenching , Fluorescence , and Phosphorescence .**

Q4/ Calculate the concentration of chloride ion in water sample, which was determined by quenching of the fluorescence intensity of quinine**,** from the following data. [6 marks]

$[Cl^{-1}]$ mol/L	0.00	0.01	0.02	0.04	0.06	0.08	Sample
Fluorescence intensity	100	30.05	18.0	11.0	6.7	5.4	25.0

Q5/ Fill the blanks with suitable words. [10marks]

1. Transmittance is given as $T = P/P_o$, P_o is the power incident on the sample and P represent……

2. In UV spectroscopy the cell is made by …… .

3. When absorbance is plotted against concentration. This plot is known as…….

4. The energy of light is related to the wavenumber by the following relation……..

5. A functional group which exhibits absorption of electromagnetic radiations in the visible or ultraviolet region is called …….

6. Deviation of Beers law divided to ……. , …….. and …….

7. The detectors are devices that convert ……..into……..

8. Fluorescence's compound usually…… compound and the quantum yield increase with number of……

9. ……methods used when the substance of interest is **not fluorescent** but may be converted into a fluorescent by reaction with a suitable (nonfluorescent) reagent.

10. According to Beer's Law, if the concentration is doubled the absorbance is ……..