# Course Specification
## (Bachelor)

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|---|
| Course Title: Instrumental Methods of Analysis for non-major |
| Course Code: Chem 350 |
| Program: BSc in Chemical Engineering |
| Department: Chemistry – Service Course |
| College: Science |
| Institution: King Saud University |
| Version: TP-153 (2024) |
| Last Revision Date: 5 May 2025 |

## Table of Contents

## A. General Information About the Course:

### 1. Course Identification

| | | | | | |
|---|---|---|---|---|---|
| **1. Credit hours: (4)** | | | | | |
| 4 (2 Lecture + 2 Practical) | | | | | |
| **2. Course type** | | | | | |
| **A.** | ☐University | ☐College | ☒ Department | ☐Track | ☐Others |
| **B.** | ☒ Required | | ☐Elective | | |
| **3. Level/year at which this course is offered: (6th level / 3rd year)** | | | | | |
| **4. Course general description:** | | | | | |
| This course designed and conducted to the laboratory experiments to give the students the basic principles of the spectroscopic, chromatographic, and electro-analytical methods of analysis. The course will focus on how to detect, measure, interpret, monitor, and control various types of chemical samples using traditional and advanced instruments.<br>Practical section:<br>Selected experiments covering different spectroscopic, chromatographic, and electro-analytical methods of analysis. | | | | | |
| **5. Pre-requirements for this course** (if any)**:** | | | | | |
| CHEM 101 | | | | | |
| **6. Co-requisites for this course** (if any)**:** | | | | | |
| None | | | | | |
| **7. Course main objective(s):** | | | | | |
| The main purpose of this course is to help the students to learn and understand several concepts in spectroscopic, chromatographic, and electro-analytical methods. By the end of this course, students expected to:<br>-To provide the students with the basic knowledge and understanding of the molecular and atomic spectrometry.<br>-To learn the students with the knowledge and skills of separation methods, especially GC and HPLC techniques.<br>-To learn the students with the basic knowledge and understanding of the principles of electro-analytical techniques and the theory of the three main categories; potentiometry, coulometry, and voltammetry.<br>-Predict the proper analysis tool for specific metals or compounds.<br>-Evaluate and interpret how to treat with the spectroscopic, chromatographic, and electrochemical experimental data.<br>This course designed to give students the opportunity to perform and evaluate different spectroscopic, chromatographic, and electro-analytical experiments, to identify various standard compounds, and to deal with some traditional and modern analytical instruments. | | | | | |

## 2. Teaching Mode (mark all that apply)

| No | Mode of instruction | Contact hours | Percentage |
|---|---|---|---|
| 1 | Traditional classroom | 86 | 100 |
| 2 | E-learning | | |
| 3 | Hybrid<br>• Traditional classroom<br>• E-learning | | |
| 4 | Distance learning | | |

## 3. Contact Hours (based on the academic semester)

| No | Activity | Contact Hours |
|---|---|---|
| 1 | **Lectures** | 30 |
| 2 | **Laboratory/Studio** | 56 |
| 3 | **Field** | |
| 4 | **Tutorial** | |
| 5 | **Others (specify)** | |
| **Total** | | **86** |

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

| Code | Course learning outcomes | Code of PLOs aligned with the program | Teaching strategies | Assessment methods |
|---|---|---|---|---|
| **1.0** | **Knowledge and understanding** | | | |
| 1.1 | Recognize the basic principles of spectroscopic, chromatographic, and electro-analytical techniques | K3 | -Lecture<br>-Demonstration<br>-Discussion<br>-Homework | -Quizzes<br>-Homework assignments<br>-Midterm exam<br>-Final exam |
| 1.2 | Recall some of the spectroscopic chromatographic, and electro-analytical techniques such as fluorometry, phosphorometry, chemiluminescence, GC, HPLC, potentiometry, coulometry, and voltammetry | K1 | -Lecture<br>-Demonstration<br>-Discussion<br>-Homework | -Quizzes<br>-Homework assignments<br>-Midterm exam<br>-Final exam |

| Code | Course learning outcomes | Code of PLOs aligned with the program | Teaching strategies | Assessment methods |
|---|---|---|---|---|
| **2.0** | **Skills** | | | |
| 2.1 | Predict the proper analysis tool for certain metals or compounds | S3 | -Lecture<br>-Demonstration<br>-Discussion<br>-Homework<br>-Solving problems | -Quizzes<br>-Homework assignments<br>-Midterm exam<br>-Final exam |
| 2.2 | Explain the basic components of some spectroscopic, chromatographic, and electro-analytical technique | S2 | -Lecture<br>-Demonstration<br>-Discussion<br>-Homework<br>-Solving problems | -Quizzes<br>-Homework assignments<br>-Midterm exam<br>-Final exam |
| 2.3 | Collect, represent and interpret experimental data | S1 | -Laboratory experiments<br>-Preparing laboratory reports | -Laboratory reports<br>-Practical exams |
| **3.0** | **Values, autonomy, and responsibility** | | | |
| 3.1 | Demonstrate safe handling of laboratory chemicals, equipment, classical and modern instrumentation techniques, and glassware during experiments | V2 | -Laboratory experiments<br>-Demonstration<br>-Solving problems with group | -Midterm exam<br>-Reports and quizzes evaluation<br>-Final exam<br>-Observation<br>-Short problems |

## C. Course Content

| No | List of topics | Contact hours |
|---|---|---|
| **1** | Introduction to qualitative and quantitative analysis | 1 |
| **2** | Introduction to instrumental methods of analysis | 1 |
| **3** | An introduction to spectrometric methods | 1 |
| **4** | Wave properties of electromagnetic radiation | 2 |
| **5** | Basic principles of atomic and molecular spectrometry | 4 |
| **6** | Spectrometric instrumentation | 2 |
| **7** | Atomic absorption, emission, and fluorescence spectrometry | 3 |
| **8** | Molecular photoluminescence spectroscopy | 1 |
| **9** | Introduction for separation methods | 1 |
| **10** | Basics of chromatography; definition, principle, types, and applications | 2 |
| **11** | Chromatographic properties and evaluation | 2 |

| | | |
|---|---|---|
| **12** | Principles of gas chromatography (GC) and high-performance liquid chromatography (HPLC) | 4 |
| **13** | Basic principles of electro-analytical techniques | 3 |
| **14** | Fundamentals of voltammetry and potentiometry | 2 |
| **15** | Brief introduction to coulometry and conductimetry | 1 |
| **Total** | | **30** |

| No | List of topics (practical section) | Contact hours |
|---|---|---|
| **1** | Spectrophotometric determination of manganese | 4 |
| **2** | Spectrophotometric determination of permanganate and dichromate mixture | 4 |
| **3** | Spectrophotometric determination of total iron ($Fe^{2+}$, $Fe^{3+}$) using 1,10-phenanthroline and determine the molar absorptivity | 4 |
| **4** | -Spectrophotometric study of complexometric compounds<br>-Determination of preservatives (benzoic acid) in soft drinks by molecular absorption of UV spectroscopy | 4 |
| **5** | Determination Na and K in drinking water using flame atomic emission | 4 |
| **6** | Optimize determination of Ca in milk using flame atomic absorption | 4 |
| **7** | First practical exam | 4 |
| **8** | Determination of phosphoric acid using pH titration | 4 |
| **9** | Potentiometric titrations of oxidation-reduction reactions between ($Fe^{2+}$ and $Ce^{4+}$) | 4 |
| **10** | Polarographic study of metals | 4 |
| **11** | -Amperometric titration of lead with dichromate using dropping mercury electrode<br>-Conductimetric titrations | 4 |
| **12** | Gas chromatography experiment; separation and identification of some aromatic compounds in real samples | 4 |
| **13** | High-performance liquid chromatography experiment; evaluation of the performance of separation columns | 4 |
| **14** | Second practical exam | 4 |
| **Total** | | **56** |

## D. Students Assessment Activities

| No | Assessment activities * | Assessment timing (in week no) | Percentage of total assessment score |
|---|---|---|---|
| **1** | Midterm exam | 6-8 | 20 |
| **2** | Activities (assignment, discussion, quizzes, homework's, project, and presentation) | Weekly | 10 |
| **3** | Laboratory (reports) | Weekly | 10 |
| **4** | Laboratory (quizzes & practical exams) | 7 & 14 | 20 |
| **5** | Final exam | 16-17 | 40 |

*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** | Principles of Instrumental Analysis, 7th ed., Douglas Skoog, James Holler, Stanley Crouch, Cengage Learning, 2018. |
| **Supportive References** | -Chemical Analysis: Modern Instrumentation Methods and Techniques, 3rd ed., Francis Rouessac, Annick Rouessac, John Towey, Wiley, 2022.<br>-Principles and Practice of Modern Chromatographic Methods, 2nd ed., Kevin Robards, Danielle Ryan, Elsevier Academic Press, 2021.<br>-Analytical Electrochemistry, 4th ed., Joseph Wang, Wiley, 2023.<br>-Analytical Instrumentation Handbook, 4th ed., Nelu Grinberg, Sonia Rodriguez, Ewing's CRC Press, 2019.<br>-Analytical Chemistry, Instrumental Analysis, 5th ed., Ibrahim Al-Zamil, Al-Khrigi Publisher, 2015. |
| **Electronic Materials** | -All lecture notes will be available on the web site of the course teacher. |
| **Other Learning Materials** | -Web of Science, Elsevier Academic Press.<br>-Encyclopedia of chemistry, spectroscopy, chromatography, electrochemistry, and instrumental methods of analysis. |

### 2. Required Facilities and Equipment

| Items | Resources |
|---|---|
| **Facilities**<br>(Classrooms, laboratories, exhibition rooms, simulation rooms, etc.) | -Lecture hall for about 30 students equipped with modern teaching technology (projector, smart board, computer and internet).<br>-Laboratory should be supplied with the related chemicals, glassware, and the required instruments.<br>-Laboratory in accordance with the rules of safety and body protection accessories should be available to all students. |
| **Technology equipment**<br>(projector, smart board, software) | Class rooms and laboratories are equipped with desktop computers, data show, smart board, Microsoft Excel, and high-speed internet access. |
| **Other equipment**<br>(depending on the nature of the specialty) | -Laboratory contain chemicals, glassware, and related equipment.<br>-The presence of related analytical equipment and instruments such as UV/Vis spectrophotometer, FT-IR, AAS, ICP, GC, HPLC, pH and conductivity meters, analytical balances, …etc.<br>-All related accessories such as separation columns, hollow cathode lamps, selective electrodes, …etc. |

## F. Assessment of Course Quality

| Assessment areas/issues | Assessor | Assessment methods |
|---|---|---|
| Effectiveness of teaching | Student and post graduate student | Direct surveys |
| Effectiveness of students assessment | Faculty and department | Direct |
| Quality of learning resources | Faculty and program leader | Indirect |
| The extent to which CLOs have been achieved | Faculty and program leader | Direct |
| Other | | |

Assessors (Students, Faculty, Program Leaders, Peer Reviewers, Others; specify).
Assessment Methods (Direct, Indirect).

## G. Specification Approval

| | |
|---|---|
| **COUNCIL /COMMITTEE** | |
| **REFERENCE NO.** | |
| **DATE** | |