# Course Specification
## (Bachelor)

| | |
|---|---|
| Course Title: | **Fundamentals of Analytical Chemistry** |
| Course Code: | **CHM 1235** |
| Program: | **Bachelor of Science in Chemistry** |
| Department: | **Chemistry** |
| College: | **Science** |
| Institution: | **Imam Mohammed Ibn Saud Islamic University** |
| Version: | **2024 V1** |
| Last Revision Date: | 12 October 2024 |

## Table of Contents

## A. General information about the course:

### -1. Course Identification

| | | | | | |
|---|---|---|---|---|---|
| **1. Credit hours: (4)** | | | | | |
| **4 (1 Lectures, 3Lab, 2 Tutorials)** | | | | | |
| **2. Course type** | | | | | |
| **A.** | ☐University | ☐College | ☒ Department | ☐Track | ☐Others |
| **B.** | ☒ Required | | ☐Elective | | |
| **3. Level/year at which this course is offered: Level 3/ year 2** | | | | | |
| **4. Course general Description:** | | | | | |
| **This course is an introduction to the theory, principles, and practices of quantitative analytical chemistry. The course covers the fundamentals of analytical chemistry: concentration units, statistical data analysis, Chemical Equilibrium, Acids-Bases Equilibria and Fundamentals of Electrochemistry.** | | | | | |
| **5. Pre-requirements for this course** (if any)**:** | | | | | |
| **General Chemistry 2/ CHM 1102** | | | | | |
| **6. Co-requisites for this course** (if any)**:** | | | | | |
| **None** | | | | | |
| **7. Course Main Objective(s):** | | | | | |

- **To provide a basic knowledge and understanding of essential principles of analytical chemistry.**
- **To express the concentration of substances in different forms.**
- **To verify the correctness of the analytical measurements using statistical concepts.**
- **To provide a knowledge of Chemical equilibria and acid-base equilibria.**
- **To introduce the Fundamentals of Electrochemistry.**

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

| No | Mode of Instruction | Contact Hours | Percentage |
|---|---|---|---|
| 1 | Traditional classroom | **90** | **100%** |
| 2 | E-learning | **0** | **0** |
| 3 | Hybrid<br>• Traditional classroom<br>• E-learning | **0** | **0** |
| 4 | Distance learning | **0** | **0** |

## 3. Contact Hours (based on the academic semester)24

| No | Activity | Contact Hours |
|---|---|---|
| 1. | **Lectures** | **15** |
| 2. | **Laboratory/Studio** | **45** |
| 3. | **Field** | **0** |
| 4. | **Tutorial** | **30** |
| 5. | **Others (specify)** | **0** |
| **Total** | | 90 |

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

| Code | Course Learning Outcomes | Code of PLOs aligned with program | Teaching Strategies | Assessment Methods |
|---|---|---|---|---|
| **1.0** | **Knowledge and understanding** | | | |
| **1.1** | **To list the main principles of analytical chemistry.** | **K1** | ▪ Six hours are weekly, containing lectures and laboratory activities.<br>▪ A Private study including home exam. | • Short quizzes<br>• Assignment<br>• Marks<br>• Written exams |
| **1.2** | **To state formula related to statistics and the effect of different errors on the analytical results** | **K2** | • Lecturing,<br>• solving problems,<br>• group discussions,<br>• Homework<br>• assignment | • Homework Assignment marks<br>• written exams<br>• laboratory report |
| **1.3** | **To outline some of the analytical chemistry methods and types of concentration expressions.** | **K1, K3** | • Discussions,<br>• Laboratory classes | • Quizzes and MCQs,<br>• laboratory reports |
| **1.4** | **To define safety principles, list emergency responses, and outline the routes of exposure to hazards, the minimization, and controlling and** | **K4** | • Lecturing,<br>• Group discussions,<br>• Homework assignment | • Homework<br>• Assignment marks<br>• laboratory activities.<br>• Written exams |

| Code | Course Learning Outcomes | Code of PLOs aligned with program | Teaching Strategies | Assessment Methods |
|---|---|---|---|---|
| | **laboratory management.** | | | |
| **2.0** | **Skills** | | | |
| **2.1** | **To summarize the types of statistical errors and predict results obtained from chemical analysis statistically.** | **S1, S3** | • Lecturing,<br>• Oral discussion<br>• Laboratory experiments | • Short quizzes<br>• Exams,<br>• Homework assignment<br>• Laboratory reports |
| **2.2** | **To develop accurate chemical analysis through accurate preparation of standards and reagents.** | **S1, S3** | • Lecturing<br>• Oral discussion<br>• Laboratory experiments | • Homework assignments,<br>• Examination<br>• Laboratory report |
| **2.3** | **To demonstrate the experimental set-up, operate different laboratory instruments during laboratory classes and evaluate statistical data to justify analytical measurements. To demonstrate ability to use mail and Network to communicating with others** | **S4, S3** | • Provide students with manuals and instructions.<br>• Group discussions<br>• Virtual labs.<br>• Use network and computer's software<br>• Use blackboard to submit homework | • Laboratory performance evaluation<br>• Laboratory reports and sheet<br>• Oral tests and assignments marks<br>• Assignments and homework |
| **2.4** | **To show oral communication skills by presenting seminars before his class mates and teaching staff, to write reports about real pollution cases in his community and operate electronic mail and Network skills in communicating with others.** | **S2, S3** | • Oral participation<br>• Group discussions and lab experiment and reports<br>• Encourage students to use electronic mail to submit homework and assignments. | • Oral tests<br>• Lab performance, reports<br>• Sheets Marks<br>• Assignments and homework marks |
| **3.0** | **Values, autonomy, and responsibility** | | | |

| Code | Course Learning Outcomes | Code of PLOs aligned with program | Teaching Strategies | Assessment Methods |
|---|---|---|---|---|
| 3.1 | To demonstrate self-confidence attitudes through single and teamwork practical sessions, presentations, and discussions. Avoid over consumption of materials and chemicals and keep the lab instruments and equipment clean and safe. | V1, V2 | • Group discussion, assignments and homework<br>• Lab-reports<br>• Virtual labs and demonstrations | • Oral tests<br>• Lab performance, Reports<br>• Sheets Marks<br>• Assignments and homework marks |
| 3.2 | To Appraise collaborative work skill | V2 | • Group discussion,<br>• Assignments homework<br>• Lab-reports<br>• Virtual labs and demonstrations | • Oral tests,<br>• ab performance, Lab-reports<br>• Sheets Marks |

## C. Course Content

| No | List of Topics | Contact Hours |
|---|---|---|
| 1. | **Review the basic calculations of analytical chemistry (chemical concentrations and stoichiometry relationship):** Relationship between Analytical Chemistry and other branches of science, General steps in chemical analysis, Measurements, Fundamental SI units, Derived SI units, other units, Conversion to SI units, Prefixes, Chemical concentrations, Molarity, Molality, Percentage composition, ppm and ppb, Preparing Solutions, Dilution, Stoichiometry Calculations. | 9 |
| 2. | **Statistics and data analysis in analytical chemistry:** Experimental Errors, Significant Figures, Significant Figures in arithmetic, Addition and Subtraction, Multiplication and Division. Graphs, logarithms and antilogarithms, Types of Errors, Systematic and Random Errors, Precision and Accuracy, Absolute and Relative Uncertainty, Propagation of Uncertainty from random errors | 9 |
| 3 | **Chemical equilibria:** The equilibrium constant, A System at Equilibrium, Manipulations of equilibrium constant, Homogeneous & Heterogeneous Equilibria, Le chatelie principle, solubility products. Common ion effect. Complex formation protic acids and bases. | 9 |
| 4 | **Acids-Bases Equilibria:** Electrolytes and Nonelectrolytes, Acids & Bases, Bronosted concept, salts, conjugate acids and bases. Autoprotolysis, pH: A Measure of Acidity, strength of acids and bases. Weak acids and bases, Polyprotic acids and bases, relation between Ka and Kb, Buffer Solution, Solving equilibrium problems. | 12 |
| 5 | **Fundamentals of Electrochemistry:** Redox Reactions, oxidizing agent, reducing agent, Rules for Assigning Oxidation Number. Electrochemical Cells: galvanic cell, Electrodes, salt bridge, electrode potential, standard electrode potential, The Nernst Equation, Free Energy and Cell Potential. | 6 |
| Total | | 45 |

| No | List of Experiments | Contact hours |
|---|---|---|
| 1 | Sampling Techniques of Different Materials. | 3 |
| 2 | Preparing Chemical Solutions by Physical Methods (w/v%, g/L, ppm) Making a standard solution using solid reagents. | 3 |
| 3 | Preparation and standardization of solutions by Chemical method [ Molarity, Normality and molality]. | 3 |
| 4 | Dilution of Solutions by different methods.<br>Quality Control and Assurance of Weight Measurements. | 3 |
| 5 | (A) Statistical Evaluation of Measurements (Panadol Tablets).<br>(B) Quality Control Chart | 6 |
| 6 | Chemical equilibrium: The Iron-Thiocyanate Equilibrium | 3 |
| 7 | Solubility Product Constant and Common-Ion Effect. | 3 |

| | | |
|---|---|---|
| 8 | Preparation of Buffers:<br>[Preparation of buffer pH= 9.5, Preparation of buffer pH= 5], buffer capacity and range. | 3 |
| 9 | Strong acid-strong base titration (HCl vs NaOH) | 3 |
| 10 | Weak acid-strong base titration (acetic acid vs NaOH) | 3 |
| 11 | Titration of polyprotic acid ($H_3PO_4$ vs NaOH) | 3 |
| 12 | Analysis of mixture ((acetic acid + HCl) vs NaOH) | 3 |
| 13 | Electrochemistry – Galvanic Cell and pH-metirc titration (HCl vs NaOH) | 3 |
| 14 | Galvanic Cell and pH-metirc titration (acetic acid vs NaOH) | 3 |
| **Total** | | **45** |

## D. Students Assessment Activities

| No | Assessment Activities * | Assessment timing (in week no) | Percentage of Total Assessment Score |
|---|---|---|---|
| 1. | Quizzes, Attendance, Participation, Homework | All the semester | 10 % |
| 2. | Laboratory | All the semester | 30 % |
| 3. | Midterm Exam 1 | Around 6th 7th week | 10 % |
| 4. | Midterm Exam2 | Around 11th 12th week | 10% |
| 5. | Final Exam | Around 16th-17th week | 40 % |
| 6. | 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 | Gary D. Christian, Purnendu K. (Sandy) Dasgupta, Kevin A. Schug. ***Analytical Chemistry***, 7th Edition. ISBN: 978-0-470-88757-8. |
| Supportive References | • Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch. ***Fundamentals of analytical chemistry***, 9th Edition. ISBN-13: 978-0-495-55828-6.<br>• Daniel C. Harris. ***Quantitative Chemical Analysis,*** 8th edition,2010, W. H. Freeman & Co., New York, ISBN: 9781429218153. |
| Electronic Materials | |
| Other Learning Materials | **Internal server: www. Elesevier.com** |

## 2. Required Facilities and equipment

| Items | Resources |
|---|---|
| **facilities**<br>(Classrooms, laboratories, exhibition rooms, simulation rooms, etc.) | • **Each classroom is equipped with PC and retro projector with a maximum of 25 students.**<br>• **Each Laboratory should be equipped with maximum 25 seats**<br>• **In each laboratory, a list of safety and precautions are provided.**<br>• **In each lab has proper ventilation, and well equipped with instruments.**<br>• **In each lab, containers for solid waste, liquid waste, and crushed glasses.**<br>• **Each lab has a small pharmacy for first aid in case of an accident**<br>• **In each lab, the rules, conditions, and safety mechanism as well list of Risk, Safety precautions according to Merck Catalogue are hanging in the labs.** |
| **Technology equipment**<br>(projector, smart board, software) | **The rooms are equipped with data show, Smart Board, WI-FI access.** |
| **Other equipment**<br>(depending on the nature of the specialty) | • **Appropriate Glassware for carrying the requested experiments (burrete, pipets, conical flasks, beakers, measuring cylinders)**<br>• **Appropriate fine chemicals and solvents (Iron-Thiocyanate, potassium permanganate, sodium hydroxide, hydrochloric acid, sulphuric acid, phosohoric acid, calcium oxide, potassium carbonate)**<br>• **Analytical balance (3 digits), Drying oven, Galvanic Cell, pH meter.**<br>• **Filter papers , clamps, stands** |

## F. Assessment of Course Quality

| Assessment Areas/Issues | Assessor | Assessment Methods |
|---|---|---|
| Effectiveness of teaching | **Students** | **Direct:** Questionnaire. |
| | **Course Responsible** | **Direct:** Course e-Portfolio.<br>**Indirect:** Second examiner checklist-Course report. |
| | **Peer Reviewer** | **Direct:** Questionnaire.<br>**Indirect:** External assessor report. |
| Effectiveness of Students assessment | **Program Leaders** | **Direct:** Course e-Portfolio.<br>**Indirect:** Course report. |

| Assessment Areas/Issues | Assessor | Assessment Methods |
|---|---|---|
| Quality of learning resources | **Students** | **Indirect:** Second examiner checklist-Course report. **Direct:** course Entrance/Exit. |
| | **Faculty ( Academic Advisory)** | **Indirect:** Observations - Accreditation review. **Direct:** Course e-Portfolio. |
| | **Program Leaders** | **Indirect:** Course evaluation survey- Observations- Syllabus review- Accreditation review. |
| The extent to which CLOs have been achieved | **Course Responsible** | **Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report. |
| | **Program Leaders** | **Indirect:** Exams. |
| Lab Performance | **Students** | **Direct:** Lab reports, Final Lab exam, Course e-Portfolio. |
| | **Course Responsible** | |

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

**Assessment Methods** (Direct, Indirect)

## G. Specification Approval

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|---|---|
| **COUNCIL /COMMITTEE** | **COUNCIL OF DEPARTMENT OF CHEMISTRY** |
| **REFERENCE NO.** | **7 (NO. 2/3)** |
| **DATE** | **29/3/1446 - 2/10/2024** |