# Course Specification
## (Bachelor)

| | |
|---|---|
| **Course Title:** | Analytical Chemistry |
| **Course Code:** | BIO-1307 |
| **Program:** | Bachelor of Science in Biology |
| **Department:** | Biology |
| **College:** | Science |
| **Institution:** | Imam Mohammad Ibn Saud Islamic University (IMSIU) |
| **Version:** | 01 |
| **Last Revision Date:** | *Pick Revision Date.* |

## Table of Contents

## Course Identification

| | |
|---|---|
| **1. Credit hours:** | **4(2 Lectures, 3 Lab, 1 Tutorial)** |
| **2. Course type** | |
| **a.** | University ☐ College ☐ Department ☑ Others ☐ |
| **b.** | Required ☑ Elective ☐ |
| **3. Level/year at which this course is offered:** | **Level 4/Year 2** |
| **4. Pre-requisites for this course** (if any)**:** | **General Chemistry 2 – CHM 102** |
| **5. Co-requisites for this course** (if any)**:** | **None** |

**6. Mode of Instruction** (mark all that apply)

| No | Mode of Instruction | Contact Hours | Percentage |
|---|---|---|---|
| 1 | Traditional classroom | 45 | 52% |
| 2 | Blended | | |
| 3 | E-learning | | |
| 4 | Correspondence | | |
| 5 | Other | 42 | 48% |

**7. Contact Hours** (based on academic semester)

| No | Activity | Contact Hours |
|---|---|---|
| 1 | Lecture | 45 |
| 2 | Laboratory/Studio | 42 |
| 3 | Tutorial | 0 |
| 4 | Others (specify) | 8.5 |
| | Total | 95.5 |

## Course Objectives and Learning Outcomes

**1. Course Description:**

This course is an introduction to the theory, principles, and practices of quantitative analytical chemistry. The course covers the fundamentals of analytical chemistry: statistical data analysis, application of chemical equilibrium to gravimetry, titrimetry and electrochemistry.

2. Course Main Objective: ***This course is intended:***

- 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 introduce the basic analytical techniques and practical aspects of volumetric analysis.
- To solve problems related to titrimetric analysis and interpret analytical results.

## 3. Course Learning Outcomes

| CLOs | | Aligned PLOs |
|---|---|---|
| 1 | **Knowledge and Understanding** | |
| 1.1 | To recognize the main principles of analytical chemistry. | K1 |
| 1.2 | To state formula related to statistics and the effect of different errors on the analytical results | K2 |
| 1.3 | To list some of the analytical chemistry methods and types of concentration expressions. | K1, K3 |
| **2** | Skills : | |
| 2.1 | To differentiate between the types of statistical errors and predict results obtained from chemical analysis statistically. | S1, S3 |
| 2.2 | To conduct accurate chemical analysis through accurate preparation of standards and reagents. | S1, S3 |
| 2.3 | To manipulate 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 |
| 2.4 | To demonstrate 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 |
| **3** | Values: | |
| 3.1 | To Build self-confidence attitudes through single and team work practical sessions, presentations, and discussions. Avoid over consumption of materials and chemicals and keep the lab instruments and equipment clean and safe. | V1, V2 |

## Course Content

| No | List of Topics | Contact Hours |
|---|---|---|
| | **Topics to be covered (Lectures and Tutorial)** | |
| 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. | **3** |
| 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 | **6** |
| 3 | **Acid/Base Titrations: Titration:** methods of end point determination, , acid – base titrations, titration of strong acid with strong base, regions of equivalence point , before , at and after equivalence point, the titration curves, finding the end point with indicators, choosing an indicator. Precipitation Titrations: Precipitation titration curve, concentrations before, at and after the equivalence point, the shape of titration curves. | **3** |
| 4 | **Complexometric Titrations:** EDTA titrations, metal chelate complexes, acid-base properties of EDTA, EDTA complexes, EDTA titration curves, regions of equivalence point , before , at and after equivalence point, titration calculations, | **6** |

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|---|---|---|
| | metal ion indicators, EDTA titrations techniques, direct, indirect , displacement and back titrations, water hardness, masking. | |
| 5 | **Oxidation/Reduction Titrations:** Basic concepts of Redox reactions, galvanic cells, salt bridges, line notations, Nernest equation for half reaction, Nernest equation for complete reaction, Redox titrations. The shape of redox titration curves, regions of equivalence point, before, at and after equivalence point, finding the end, Redox indicators. | **9** |
| 6 | **Fundamentals of chemical equilibria:** The equilibrium constant. Manipulations of equilibrium constant. Equilibrium and thermodynamics.( enthalpy, entropy and free energy.), Le chatelie principle, solubility products. Common ion effect. Separation by precipitation. Complex formation protic acids and bases, Bronosted concept, salts, conjugate acids and bases. Autoprotysis, pH, strength of acids and bases. Weak acids and bases. Polyprotic acids and bases, relation between Ka and Kb. Solving equilibrium problems with concentration tables. | **9** |
| 7 | **Effect of Electrolytes on equilibrium systems:** The effect of ionic strength on the solubility of salts. Meaning of ionic strength, Activity coefficient, pH and the activity coefficients. Systematic treatment of equilibrium. Charge and mass balance. Applications to the systematic treatment of equilibrium. Monocratic acid base equilibrium. strong acids and bases equilibrium. Weak acids and bases , equilibrium. weak acids equilibria + problems. Weak bases equilibria + problems. Buffers. Henderson – Hassel Balch Equation. Buffer action. Addition of acids and bases to buffers. How to prepare a buffer solution. poly protic acid base equilibrium, diprotic acids and bases equilibrium + calculations poly protic acid base equilibrium, triprotic systems identification of principle species in the equilibrium | **9** |
| **Topics to be covered (Laboratories)** | | |
| 1 | Safety in the Chemistry Laboratory & Laboratory Report writing | **3** |
| 2 | (1)Assuring the Quality of Weight Measurements (Calibration of the Analytical Balances). (2) Statistical Evaluation of Measurements. | **3** |
| 3 | (1) Weight Uniformity of Dosing Units (2) Statistical Evaluation of Measurements. | **3** |
| 4 | Determination of the Acidic Content of Vinegar | **3** |
| 5 | (1) Calibration of PH-meter. (2) PH Titration Curves of Weak Acid and bases). | **3** |
| 6 | (1) Preparation and Standardization of EDTA. (2)Determination of Water Hardness | **3** |
| 7 | (1) Standardization of Silver Nitrate Solution.<br>(2) Determination of Chloride Content in Table Salt and Tap Water by the Mohr Method | **3** |
| 8 | Standardization of Ferrous Ammonium Sulphate Using Standard Potassium Dichromate Solution. | **3** |
| 9 | Determination of Iron Oxide Content in Portland Cement. | **3** |
| 10 | (1) Sampling of Natural Samples, e.g., Soil of the garden, Rocks, Plant Leaves, etc. (2) Sampling of Commercial Products, eg, Cement, Flour, Toilet Soap. | **3** |
| 11 | Determination of Moisture Content in Natural and Industrial Samples. | **3** |
| 12 | Practice of Gravimetric Analysis Using Physical Separation Methods: Gravimetric Determination of Sulphate in a Commercial Unknown.( gypsum) | **3** |
| 13 | The Percent of Water of Crystallization in Hydrated Barium Chloride. | **3** |
| 14 | **Review** | **3** |
| **Total** | | **87** |

## Teaching and Assessment

### 1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

| Code | Course Learning Outcomes | Teaching Strategies | Assessment Methods |
|---|---|---|---|
| **1.0** | **Knowledge and Understanding** | | |
| 1.1 | To recognize the main principles of analytical chemistry. | lecturing | Short quizzes |
| 1.2 | To state formula related to statistics and the effect of different errors on the analytical results | Lecturing, solving problems, group discussions, Homework and assignment | Homework and assignment marks and written exams |
| 1.3 | To list some of the analytical chemistry methods and types of concentration expressions. | Discussions, Laboratory classes | Quizzes and MCQs, laboratory reports |
| **2.0** | **Skills** | | |
| 2.1 | To differentiate between the types of statistical errors and predict results obtained from chemical analysis statistically. | Lecturing, oral discussion and laboratory experiments | Short quizzes Exams, Homework assignment and laboratory reports |
| 2.2 | To conduct accurate chemical analysis through accurate preparation of standards and reagents. | Lecturing and oral discussion supported by laboratory experiments | Homework assignment, Examination and laboratory report |
| 2.3 | To manipulate 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 | • Provide student with manual and instructions.<br>• Group discussions and 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 demonstrate 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. | • Oral participation<br>• Group discussions and lab experiment and reports<br>• Encourage students to use electronic mail to submit homework and assignments. | • Oral tests and lab performance, reports and sheets Marks<br>• Assignments and homework marks |
| **3.0** | **Values** | | |
| 3.1 | To Build self-confidence attitudes through single and team work practical sessions, presentations, and discussions. Avoid over consumption of materials and chemicals and keep the lab | • Group discussion, assignments and homework<br>• Lab-reports | • Oral tests, lab performance, Lab-reports and sheets Marks |

| Code | Course Learning Outcomes | Teaching Strategies | Assessment Methods |
|---|---|---|---|
| | instruments and equipment clean and safe. | • Virtual labs and demonstrations | • Assignments and homework marks |

**2. Assessment Tasks for Students**

| # | Assessment task* | Week Due | 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 Exam 2 | Around 11th -12thweek | 10 % |
| 5 | Final Exam | Around 15th– 16thweek | 40 % |
| 6 | Total | | 100% |

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

## Student Academic Counseling and Support

**Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :**

- **There are two office hours per week reserved by each staff member, planned on his timetable, to help the students to solve their problems.**
- **Each department has an academic advisor who will act as a mentor, providing academic and career advice and general counselling.**

## Learning Resources and Facilities

**1. Learning Resources**

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|---|---|
| **Required Textbooks** | • ***Quantitative Chemical Analysis***, Daniel C. Harris, 8th edition,2010, W. H. Freeman & Co., New York, ISBN: 9781429218153. |
| **Essential References Materials** | • ***Modern Analytical Chemistry***, David Harvey, , 1st Ed., 2000, McGraw-Hill, ISBN: 0–07–237547–7<br>• ***Chemical Analysis: Modern Instrumentation Methods and Techniques,*** Francis Rouessac, Annick Rouessac, , 2nd Ed, 2007, John Wiley & Sons, ISBN: 0470859040, 9780470859049.<br>• ***Principles of Instrumental Analysis***", D. A. Skoog, F. J. Holler, S.R. Crouch,; 6th edition (2006) , Brooks Cole, ISBN: 0495012017 , 978-0495012016. |
| **Electronic Materials** | • **Blackboard**<br>• **http://highered.mcgrawhill.com/classware/ala.do?isbn=0073048518&alaid=ala_1136810&protected=true&showSelfStudyTree=true**<br>• **http://www.chem1.com/acad/webtext/virtualtextbook.html**<br>• **http://www.shodor.org/UNChem/index.html** |

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|---|---|
| **Other Learning Materials** | **Internal server: www. Elesevier.com** |

## 2. Facilities Required

| Item | Resources |
|---|---|
| **Accommodation** (Classrooms, laboratories, demonstration rooms/labs, etc.) | **Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.** |
| **Technology Resources** (AV, data show, Smart Board, software, etc.) | **The rooms are equipped with data show, Smart Board, WI-FI access.** |
| **Other Resources** (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list) | **None** |

## Course Quality Evaluation

| Evaluation Areas/Issues | Evaluators | Evaluation 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 assessment | Program Leaders | **Direct:** Course e-Portfolio.<br>**Indirect:** Course report. |
| Extent of achievement of course learning outcomes | Course Responsible | **Direct:** Exams - Course e-Portfolio.<br>**Indirect:** Second examiner checklist-Course report. |
| | Program Leaders | **Indirect:** Exams. |
| Quality of learning resources | Students | **Indirect:** Second examiner checklist-Course report. |
| | Faculty ( Academic Advisory) | **Direct:** course Entrance/Exit.<br>**Indirect:** Observations - Accreditation review. |
| | Program Leaders | **Direct:** Course e-Portfolio.<br>**Indirect:** Course evaluation survey- Observations- Syllabus review- Accreditation review. |
| Lab Performance | Students | **Direct:** Lab reports, Final Lab exam, Course e-Portfolio. |
| | Course Responsible | |

**Evaluation areas** (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)
**Evaluators** (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)
**Assessment Methods** (Direct, Indirect)

## Specification Approval Data

| | |
|---|---|
| **Council / Committee** | |
| **Reference No.** | |
| **Date** | **November, 2020** |