هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد NCAAA T4 2020

# Course Specifications

| | |
|---|---|
| **Course Title:** | Instrumental Chemical Analysis Training |
| **Course Code:** | CHEM 497 |
| **Program:** | Undergraduate |
| **Department:** | Chemistry Department |
| **College:** | College of Science |
| **Institution:** | King Saud University |

## Table of Contents

## A. Course Identification

| | |
|---|---|
| **1. Credit hours:** | : 2 (0+0+2) |
| **2. Course type** | |
| **a.** | University ☐ College ☐ Department ☑ Others ☐ |
| **b.** | Required ☑ Elective ☐ |
| **3. Level/year at which this course is offered:** | 7th or 8th level / 4th year |
| **4. Pre-requisites for this course** (if any)**:** | CHEM 101, 250, 351, 352 |
| **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** | | |
| 2 | **Blended** | | |
| 3 | **E-learning** | | |
| 4 | **Distance learning** | | |
| 5 | **Other** | 56 | 100 |

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

| No | Activity | Contact Hours |
|---|---|---|
| 1 | **Lecture** | 0 |
| 2 | **Laboratory/Studio** | 56 |
| 3 | **Tutorial** | 0 |
| 4 | **Others** (specify) | 0 |
| | **Total** | |

## B. Course Objectives and Learning Outcomes

**1. Course Description**

Chemical instrumentation is increasingly important in providing so much of the data necessary for industry, health science, environment protection, food production and basic research to mention just a few areas. Instrumentation fills only part of the need, as the challenges presented often require highly developed skills and judgement of chemists using these in order for the best results to be obtained. This course develops knowledge, experience and skills related to a variety of mainstream instrumental techniques in areas of spectroscopy, separation science and electrochemistry, and builds on the foundations provided in CHEM 250, CHEM 351 & CHEM 352.

**2. Course Main Objective**

The course will provide students with the knowledge and skills needed to conduct laboratory research, understand instrument design and analyze instrumental results. Over the duration of the course the student will be expected to learn the theory behind a range of instrumental techniques, instrumentation hardware and data analysis techniques. The class will cover the theory of Spectroscopic techniques, Mass Spectrometry, Ion Mobility, High Performance Liquid Chromatography, Gas Chromatography, Potentiometry and Computational Modeling.

The student will be required to develop critical reading skills, develop his/her technical writing skills and present material to the instructor and the class.

### 3. Course Learning Outcomes

| | CLOs | Aligned PLOs |
|---|---|---|
| 1 | **Knowledge and Understanding** | |
| 1.1 | Recognize principles and concepts for specific various chemical analysis techniques and instruments and their relevant applications. | K1 and K2 |
| 1.2 | Define all units of concentrations of analytes in various sample matrices. | K3 |
| 1.3 | Explain the meaning of, and how, to estimate the bias, precision, accuracy and detection limits of an analytical method. | K2 |
| 1.4 | Suggest and Implement suitable methods of sampling and analysis. | K3 |
| **2** | **Skills :** | |
| 2.1 | Ability to set, prepare, calibrate these instruments and techniques. | S1 and S2 |
| 2.2 | Capability to read the results and analyze them beside the explain them and conclude them meanings. | S3 and S4 |
| 2.3 | Students are expected to develop the essential critical thinking skills needed for the transfer of theoretical knowledge into practice and solve any problem that may occur. | S3 |
| 2.4 | Identify unknown compounds by interpretation of combined spectra. | S3 |
| 2.5 | Apply critical thinking and hypothesis-driven methods of scientific inquiry. | S4 |
| 2.6 | Analyze and interpret quantitative & qualitative results. | S3 and S4 |
| 2.7 | Differentiate between different methods of determination, their preparations and conditions. | S2 |
| 2.8 | Gain mental calculating skills and trains on it. | S1 |
| **3** | **Values:** | |
| 3.1 | Work effectively both individually and in teams in the laboratory. | V2 |
| 3.2 | An understanding of the importance of performing accurate and precise experimental measurements and the ability to keep legible and complete experimental records. | V3 |
| 3.3 | Improve and develop laboratory handling and skills following the common safety rules | V1 |

## C. Course Content

| No | List of Topics | Contact Hours |
|---|---|---|
| 1 | Glass Electrode (pH Meter as an example) | 4 |
| 2 | Potentiometry | 4 |
| 3 | Ultra Violet Spectroscopy (UV) | 4 |
| 4 | Visible Spectroscopy | 4 |
| 5 | Flame Atomic Absorption/Emission Spectroscopy (FAAS & FAES) | 4 |
| 6 | Inductively Coupled Plasma – Optical Emission Spectroscopy (ICP-OES) | 4 |
| 7 | Inductively Coupled Plasma - Mass Spectroscopy (ICP-MS) | 4 |
| 8 | Reactive Ion Etching (RIE) -Theoretically and Virtually Only- | 4 |
| 9 | Fourier Transform Infra-Red (FTIR & IR) | 4 |
| 10 | Gas Chromatography (GC/GLC) | 4 |
| 11 | High Performance Liquid Chromatography (HPLC) | 4 |
| 12 | Ion Exchange Chromatography (IC) | 4 |
| 13 | Nuclear Magnetic Resonance (NMR) | 4 |
| 14 | Water Deionizer & Hydraulic Pellet Press (As supporting instruments) | 4 |
| **Total** | | 56 |

## D. 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 | Recognize principles and concepts for specific various chemical analysis techniques and instruments and their relevant applications. | In laboratory where current topics are interrelated the past and future topics. Basic principles, instrumental design and applications of each technique are explained And discussed with students. | - Homework assignments.<br>- Written Laboratory reports taking into consideration: presentation of results, data acquisition and analysis and the precision and accuracy of results.<br>-Laboratory performance (following the procedure, handling chemicals and equipment). |
| 1.2 | Define all units of concentrations of analytes in various sample matrices. | | |
| 1.3 | Explain the meaning of, and how, to estimate the bias, precision, accuracy and detection limits of an analytical method. | | |
| 1.4 | Suggest and Implement suitable methods of sampling and analysis. | | |
| **2.0** | **Skills** | | |
| 2.1 | Ability to set, prepare, calibrate these instruments and techniques. | - Homework assignments on problem solving.<br>- Case studies (literature applications on the various methods). | - Major and final exams.<br>- Lab written reports.<br>-Performance in discussions during the lab sessions. |
| 2.2 | Capability to read the results and analyze them beside the explain them and conclude them meanings. | | |
| 2.3 | Students are expected to develop the essential critical thinking skills needed for the transfer of theoretical knowledge into practice and solve any problem that may occur. | | |
| 2.4 | Identify unknown compounds by interpretation of combined spectra. | | |
| 2.5 | Apply critical thinking and hypothesis-driven methods of scientific inquiry. | | |
| 2.6 | Analyze and interpret quantitative & qualitative results. | | |
| 2.7 | Differentiate between different methods of determination, their preparations and conditions. | | |
| 2.8 | Gain mental calculating skills and trains on it. | | |
| **3.0** | **Values** | | |
| 3.1 | Work effectively both individually and<br>in teams in the laboratory. | - Working independently and in groups towards some case studies.<br>- Collect literature reports, summarize, | - Individual performance within a group.<br>- Written presentations.<br>- Individual performance during the lab sessions. |
| 3.2 | Work effectively in groups and exercise<br>leadership when appropriate. | | |
| 3.3 | Familiarity with current developments in Chemistry. | | |

| Code | Course Learning Outcomes | Teaching Strategies | Assessment Methods |
|---|---|---|---|
| 3.5 | Apply the Kingdom's rules and regulations for safety and chemical waste. | analyze and interpret the main findings.<br><br>- Manage resources, time and other members of the group. | |
| 3.6 | Employ interpersonal skills within team. | | |
| 3.7 | Learn how to collect and classify the material for the course. | - Homework assignments.<br>- Lab reports.<br>- Usage of computer and chemistry software packages for data acquisition and analysis in the lab reports. | - Performance in the problem solving assigned in the homework.<br>- Evaluating the proficiency in communication, experimental design and the statistical treatment of the results. |
| 3.8 | Communicate effectively in oral and written form. | | |
| 3.9 | Students are expected to get more comfortable employing their computer skills in navigating the internet for chemical technology information and specialized knowledge in instrumental analysis. | | |
| 3.10 | An understanding of the importance of performing accurate and precise experimental measurements and the ability to keep legible and complete experimental records. | | |
| | | | |

## 2. Assessment Tasks for Students

| # | Assessment task* | Week Due | Percentage of Total Assessment Score |
|---|---|---|---|
| **1** | Assignments | Weekly | 5% |
| **2** | Handling in laboratory and written reports | Continuous | 35% |
| **3** | Attendance | Weekly | 10% |
| **4** | Attitude and Cooperation | Continuous | 10% |
| **5** | Midterm Theoretical Exam | 7th week | 10% |
| **6** | Midterm Practical Exam | 7th week | 10% |
| **7** | Final Theoretical Exam | 15th week | 10% |
| **8** | Final Practical Exam | 15th week | 10% |

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

# E. Student Academic Counseling and Support

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

1. Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice. (include amount of time teaching staff are expected to be available each week):

- Ten Office hours are allocated to the students for general and specific educational activities.

- The e-mail of the course instructor is given to the students.

- The Personal mobile of the course instructor is given to the students.

- Academic advisors are available for all students within the program from the beginning of their learning experience till their graduation.

## F. Learning Resources and Facilities

### 1.Learning Resources

| | |
|---|---|
| **Required Textbooks** | - Ibrahim Al-Zamil, "Analytical Chemistry, Instrumental Analysis" 5th Ed., Al-Khrigi Publisher, 2015.<br>- G.D. Christian, P.K. Dasgupta, K.A. Schug, "Analytical Chemistry", 7th Ed., John Wiley & Sons, 2013.<br>- D.A. Skoog, F.J. Holler, S.R. Crouch, "Principles of Instrumental Analysis", 6th Ed., Brooks Cole, 2006.<br>- Adel Mujawwah, Turki Alkhulaiwi "Experiments in Analytical Chemistry" 1st Ed., KSU Publisher 2010.<br>- Sawyer, Heineman, Beebe, "Chemistry Experiments for Instrumental Methods" 1st Ed., John Wiley & Sons, LTD. 1984.<br>- Francis Rouessac & Annick Rouessac, "Chemical Analysis, Modern Instrumental Methods and Techinques". 3rd Ed., John Wiley & Sons, LTD. 1998. |
| **Essential References Materials** | - Vogel (inorganic qualitative analysis).<br>- The MERCK Index.<br>- Journal of the American Chemical Society<br>- Analytical Chemistry Research<br>- International Journal of Instrumental Analysis (IJIA).<br>- Students Interactive Notes on my official site. |
| **Electronic Materials** | - http://chemcollective.org/vlab_download<br>- http://thix.co/chemist/<br>- https://www.chemweb.com/ |
| **Other Learning Materials** | Some of useful helping materials regarding this course can be found on my Official site below: http://fac.ksu.edu.sa/talkhulaiwi/course/194022 |

### 2. Facilities Required

| Item | Resources |
|---|---|
| **Accommodation**<br>(Classrooms, laboratories, demonstration rooms/labs, etc.) | - Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.):<br>- Instrumental Analysis Laboratory equipped with instruments and tools for experiments following safety rules. |
| **Technology Resources**<br>(AV, data show, Smart Board, software, etc.) | - Computers, internet connection, projectors and smart board in separate connecting room. |

| Item | Resources |
|---|---|
| | - Some Specialized software for chemistry eg. Purchasing Institutional License for software like Chem Office ultra, ACD labs…. etc. |
| **Other Resources**<br>(Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list) | - Laboratory safety tools.<br>- Chemicals.<br>- Glassware.<br>- Instruments for: Distillation, Melting Point, UV, IR and NMR and Mass spectrometry…etc. |

## G. Course Quality Evaluation

| Evaluation Areas/Issues | Evaluators | Evaluation Methods |
|---|---|---|
| Student questionnaire for achievement of course ILOs. | Peer reviewing of teaching. | |
| Electronic course evaluation available on the University website, each student has to fill before getting his final result. | Verbal communication during the lectures. | |
| Continuous feedback through questions-answering. | Personal interview with the students. | |
| Focus group discussion with small groups of students concerning exams and assignments. | Evaluation by program coordinator. | |
| | A staff questionnaire feedback about course. | |
| | Departmental meeting discussions | |
| | The exchange of experiences with faculty members' specialists. | |

**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)

## H. Specification Approval Data

| | |
|---|---|
| **Council / Committee** | |
| **Reference No.** | |
| **Date** | |