|  |  |
| --- | --- |
| **Course Title:** | **Advanced Studies in Analytical Chemistry** |
| **Course Code:** | **CHEM 651** |
| **Program:** | **1st level of PhD program** |
| **Department:** | **Chemistry** |
| **College:** | **Science** |
| **Institution:** | **King Saud University (KSU)** |

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# A. Course Identification

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **1. Credit hours:** | | **3 (3 + 0)** | | |
| **2. Course type** | | | | |
|  | Required | | Elective | |
| **3. Level/year at which this course is offered:** | | | | **1st level in Ph.D. Program in Chemistry** |
| **4. Pre-requisites for this course** (if any)**:NA** | | | | |
| **5. Co-requisites for this course** (if any)**:NA** | | | | |
|  | | | | |

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

| **No** | **Mode of Instruction** | **Contact Hours** | **Percentage** |
| --- | --- | --- | --- |
| **1** | **Traditional classroom** |  | 80 |
| **2** | **Blended** |  | 20 |
| **3** | **E-learning** |  |  |
| **4** | **Correspondence** |  |  |
| **5** | **Other** |  |  |

**7. Actual Learning Hours** (based on academic semester)

|  |  |  |
| --- | --- | --- |
| **No** | **Activity** | **Learning Hours** |
| **Contact Hours** | | |
| **1** | **Lecture** | 33 |
| **2** | **Laboratory/Studio** | 3 |
| **3** | **Seminars** |  |
| **4** | **Others** (specify) Tutorial | 6 |
|  | **Total** | 42 |
| **Other Learning Hours\*** | | |
| **1** | **Study** |  |
| **2** | **Assignments** |  |
| **3** | **Library** |  |
| **4** | **Projects/Research Essays/Theses** |  |
| **5** | **Others** (specify) |  |
|  | **Total** |  |

**\*** The length of time that a learner takes to complete learning activities that lead to achievement of course learning outcomes, such as study time, homework assignments, projects, preparing presentations, library times

# B. Course Objectives and Learning Outcomes

|  |
| --- |
| 1. Course Description Gas chromatography and mass spectrometry |
|  |
| 2. Course Main Objective |
| * Acquisition of basic theoretical and experimental knowledge on hyphenated analytical techniques based on chromatography and mass spectrometry * Training students on interpretation of chromatographic and mass spectral data for both qualitative and quantitative determinations * Solving practical problems from various analytical fields |

## 3. Course Learning Outcomes

| **Course Learning Outcomes (CLOs)** | | **Aligned****PLOs\*** |
| --- | --- | --- |
| 1 | **Knowledge** |  |
| 1.1 | Recognize the principles and applications of gas chromatography, qualitative and quantitative | K1 |
| 1.2 | Describe the fundamental theoretical and experimental aspects of chromatographic separation techniques and mass spectrometry | K2 |
| 1.3 | Outline the retention data used for qualitative and quantitative determinations | K3 |
| 1... | Describe the mass spectra of known and unknown organic compounds | K2 |
| **2** | **Skills** |  |
| 2.1 | Use the advanced analytical instruments | S1 |
| 2.2 | Develop of experimental parameters | S2 |
| 2.3 | Interpret of chromatographic and mass spectrometric data | S3 |
| 2... | Work in team in the lab | S4 |
| **3** | **Competence** |  |
| 3.1 | Analyze practical problems | C1 |
| 3.2 | Demonstrate good practice in laboratory on advanced equipment with experienced searchers | C2 |
| 3.3 | Evaluate the main analytical parameters to calculate the retention data and spectral features | C3 |
| 3... | Use of spectral libraries and specialized software | C4 |
|  | Interpret manual and computer assisted experimental data, and comparison of the results | C2 |

\* Program Learning Outcomes

# C. Course Content

|  |  |  |
| --- | --- | --- |
| **No** | **List of Topics** | **Contact Hours** |
| 1 | Principles and instrumentation of gas and liquid chromatography. Classification of solute interactions. Packed and capillary columns. Retention and diffusion phenomena. Column efficiency and optimization | 12 |
| 2 | Basic components of the mass spectrometer. Ion source. Quadrupole, magnetic and other analysers. High vacuum systems. Interfacing GC and MS. Detectors | 3 |
| 3 | Ionization techniques in MS: electron impact, positive and negative chemical ionization, fast atom bombardment, laser desorption, electrospray ionization | 3 |
| 4 | Tandem mass spectrometry: precursor and fragment ions, neutral loss, collisional activation. MS/MS and MSn | 3 |
| 5 | Organic mass spectrometry: accurate mass measurement, calibrating the mass scale. Fragmentation of organic molecules: odd and even electron ions, homolytic and heterolytic cleavages, rearrangements. Fragmentation of the main compound classes | 3 |
| ... | Interpretation of mass spectra: evaluation of the spectrum quality. Molecular and base peaks, adduct ions, multiply charged ions, contribution of isotopes, characteristic isotopic clusters. Determination of the molecular weight and the formula | 6 |
|  | Use of mass spectral library. Computer assisted interpretation | 3 |
|  | Solving practical problems, interpretation of standard spectra, identification of unknown compounds, elucidation of fragmentation mechanism | 6 |
|  | Laboratory experiments: working on a GC and a GC-MS instrument. Sample injection, parameters setting and results interpretation. | 3 |
| **Total** | | 42 |

# 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** | | |
| 1.1 | Recognize the principles and applications of gas chromatography, qualitative and quantitative | Presentation and tutorials | Short and main exams |
| 1.2 | Describe the fundamental theoretical and experimental aspects of chromatographic separation techniques and mass spectrometry | Presentation and tutorials | Short and main exams |
| … | Outline the retention data used for qualitative and quantitative determinations | Presentation and tutorials | Short and main exams |
|  | Describe the mass spectra of known and unknown organic compounds | Presentation and tutorials | Short and main exams |
| **2.0** | **Skills** | | |
| 2.1 | Use the advanced analytical instruments | Solving model problems and interpretation of experimental results | Short and main exams |
| 2.2 | Develop of experimental parameters | Literature survey | Short and main exams |
| … | Interpret of chromatographic and mass spectrometric data | Comparison of theoretical principles with experimental applications | Short exams |
|  | Work in team in the lab | Solving problems with group and group discussion | Short and main exams |
| **3.0** | **Competence** | | |
| 3.1 | Analyze practical problems | Case studies | Short and main exams |
| 3.2 | Demonstrate good practice in laboratory on advanced equipment with experienced searchers | Laboratory experiments | Short and main exams |
| … | Evaluate the main analytical parameters to calculate the retention data and spectral features | Laboratory experiments, training the students | Short and main exams |
|  | Use of spectral libraries and specialized software | Training the students | Short and main exams |
|  | Interpret manual and computer assisted experimental data, and comparison of the results | Training the students | Short and main exams |

## 2. Assessment Tasks for Students

| **#** | **Assessment task\*** | **Week Due** | **Percentage of Total Assessment Score** |
| --- | --- | --- | --- |
| **1** | **Major exam 1** | **Week 8** | **20%** |
| **2** | **Major exam 2** | **Week 12** | **20%** |
| **3** | **Final exam** | **Week 15** | **60%** |
| **4** |  |  |  |
| **5** |  |  |  |
| **6** |  |  |  |
| **7** |  |  |  |
| **8** |  |  |  |

**\*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:** |
| * Office hours (10 hours per week for all students) * Assistance of students in lab sessions * Solving model problems in class |

# F. Learning Resources and Facilities

## 1. Learning Resources

|  |  |
| --- | --- |
| **Required Textbooks** | *- Current Practice of Gas Chromatography Mass Spectrometry, W.M.A. Niessen, Marcel Dekker Inc., 2001*  *- GC/MS A Practical User’s Guide, M.C. McMaster, Wiley-Interscience, 2008* |
| **Essential Reference Materials** | * Journal of Chromatography * Journal of Mass Spectrometry * Analytical Chemistry |
| **Electronic Materials** | * Sciencedirect.com * Scopus.com * Scifinder.cas.org |
| **Other Learning Materials** | * Handouts and power-point presentations * Simulation videos |

## 2. Educational and research Facilities and Equipment Required

| **Item** | **Resources** |
| --- | --- |
| **Accommodation**  (Classrooms, laboratories, demonstration rooms/labs, etc.) | * Classroom with 10 seats * Smart board and projector |
| **Technology Resources**  (AV, data show, Smart Board, software, etc.) | Computer for each student (spectral libraries, simulation, data processing…) |
| **Other Resources**  (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list) |  |

# G. Course Quality Evaluation

| **Evaluation**  **Areas/Issues** | **Evaluators** | **Evaluation Methods** |
| --- | --- | --- |
| **1- Course evaluation by students every semester.** | * Students   Peer to peer evaluation from another colleague | Semester questionnaires |
| **2- Peer to peer evaluation from another colleague.** | * Peer consultation on teaching * Specialty council meetings * Department council meetings | - Discussion with another faculty group. |
| **3. Processes for Improvement of Teaching** | * Workshops presented by experts on new teaching methodologies * Consultation with colleagues of Chemistry Department | - I took many workshops presented with experts on teaching methodologies.  Monitoring of available materials relevant to the course on the internet. |
| 4. Processes for Verifying Standards of Student Achievement (e.g. check marking by an independent member teaching staff of a sample of student work, periodic exchange and remarking of tests or a sample of assignments with staff at another institution) | * Grading some questions by other colleagues from the analytical group * Consultation of colleagues from other universities | - check marking by an independent member teaching staff of a sample of student work, periodic exchange and remarking of tests or a sample of assignments with staff at another institution.  - Using learning management system (LMS) to evaluate the % of matching in student papers. |
| 5. Describe the planning arrangements for periodically reviewing course effectiveness and planning for improvement. | * Evaluation at the Department Council meetings and Faculty Council meetings * Assessment by the Head of Chemistry Department | - Periodical revision of course material and making appropriate changes and updates. |
|  |  |  |
|  |  |  |

**Evaluation Areas/Issues** (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** | **2019** |