



Course Specification

— (Postgraduate)

Course Title: Advanced Studies in Instrumental Analysis

Course Code: CHEM 651

Program: Doctor of Philosophy in Chemistry (PhD)

Department: Chemistry

College: Science

Institution: King Saud University

Version: TP-153-2023

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A. General information about the course:

1. Course Identification:

1. Credit hours: (3+0)

3 Credit hours

2. Course type

A. University College Department Track

B. Required Elective

3. Level/year at which this course is offered: (2nd Level / 1st year)

4. Course general description:

This course designed to give the students the principles and advanced application of the gas chromatography, high-performance liquid chromatography, and mass spectrometry.

5. Pre-requirements for this course (if any):

NA

6. Post-requirements for this course (if any):

NA

7. Course Main Objective(s):

- 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.

2. Teaching Mode: (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	45	100%
2	E-learning		
3	Hybrid <ul style="list-style-type: none"> • Traditional classroom • E-learning 		
4	Distance learning		





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

No	Activity	Contact Hours
1.	Lectures	30
2.	Laboratory/Studio	6
3.	Field	
4.	Tutorial	9
5.	Others (specify).....	
	Total	45

B. Course learning outcomes (CLOs), teaching strategies & assessment methods:

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
1.0	Knowledge and understanding			
1.1	Describe the fundamental theoretical and experimental aspects of chromatographic separation techniques and mass spectrometry.	K2	Lectures	Quizzes Exams
1.2	Outline the retention and efficiency data used for qualitative and quantitative determinations.	K3	Lectures Tutorials	Quizzes Exams
2.0	Skills			
2.1	Use advanced analytical instruments and develop experimental parameters.	S1	Lectures Solving problem Critical thinking Data analysis	Quizzes Exams
2.2	Describe the mass spectra of known and unknown organic compounds.	S2	Lectures tutorials	Quizzes Exams
2.3	Interpret chromatographic and mass spectrometric data and use spectral libraries and specialized software to interpret manual and computer-assisted experimental data and comparison of the results.	S3	Lectures Laboratory Tutorials Case studies	Presentation Quizzes
3.0	Values, autonomy, and responsibility			
3.1	To deal with ethical issues and regulations in chromatography and mass spectrometry contexts.	V2	Lectures Laboratory Tutorial Demonstration Case studies	Presentation Quizzes Student assignment
3.2	To communicate related ideas, principles, and information by oral, written, and presentation.	V3	Lectures Laboratory	Presentation Quizzes





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	8
2.	Basic components of the mass spectrometer. Ion source. Quadrupole, magnetic and other analyzers. High vacuum systems. Interfacing GC and MS. Detectors	4
3.	Ionization techniques in MS: electron impact, positive and negative chemical ionization, fast atom bombardment, laser desorption, electrospray ionization	4
4.	Tandem mass spectrometry: precursor and fragment ions, neutral loss, collisional activation. MS/MS and MS ⁿ	4
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	5
6.	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
7.	Use of mass spectral library. Computer assisted interpretation	4
8.	Solving practical problems, interpretation of standard spectra, identification of unknown compounds, elucidation of fragmentation mechanism	6
9.	Laboratory experiments: working on a GC and a GC-MS instrument. Sample injection, parameters setting and results interpretation	4
Total		45

D. Students Assessment Activities:

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	Course activities (quizzes, project, presentations, homework)	Weekly	30
2.	Midterm exam	6-8	30
3.	Final exam	15-16	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 and Practice of Modern Chromatographic Methods, 2nd ed., Kevin Robards, Danielle Ryan, Elsevier Academic Press, 2021.
Supportive References	-All lecture notes will be available on the web site of the course teacher. -Principles of Instrumental Analysis, 7th ed., Douglas Skoog, James Holler, Stanley Crouch, Cengage Learning, 2018.





	<ul style="list-style-type: none"> -Chemical Analysis: Modern Instrumentation Methods and Techniques, 3rd ed., Francis Rouessac, Annick Rouessac, John Towey, Wiley, 2022. -Ewing's Analytical Instrumentation Handbook, Nelu Grinberg, Sonia Rodriguez, 4th ed., CRC Press, 2019.
Electronic Materials	<ul style="list-style-type: none"> • Lecture notes • Any related books available in the library • Related journals and databases such as -Journal of Chromatography A -Journal of Separation Science -Journal of Mass Spectrometry -Analytical Chemistry -CHROMacademy -Sciencedirect.com -Web of Science -Scopus.com -Scifinder.cas.org
Other Learning Materials	<ul style="list-style-type: none"> -Any software used in statistical calculations -Handouts and power-point presentations -Simulation videos

2. Educational and Research Facilities and Equipment Required:

Items	Resources
Facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	<ul style="list-style-type: none"> -Classroom with suitable number of seats -Smart board and projector
Technology equipment (Projector, smart board, software)	<ul style="list-style-type: none"> -A computer room available for all students. -Spectral libraries, simulation, data processing...
Other equipment (Depending on the nature of the specialty)	<ul style="list-style-type: none"> Related analytical chemistry instruments

F. Assessment of Course Quality:

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	<ul style="list-style-type: none"> -Peer consultation on teaching -Specialty council meetings -Department council meetings 	Discussion with another faculty group
Effectiveness of students assessment	Students, Peer to peer evaluation from another colleague	Double checked the results
Quality of learning resources	Faculty and students	Semester questionnaires
The extent to which CLOs have been achieved	-Evaluation at the Department Council meetings and Faculty Council meetings	Periodical revision of course material and making appropriate changes and updates



Assessment Areas/Issues	Assessor	Assessment Methods
	-Assessment by the Head of Chemistry Department	
Other		

Assessor (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify))

Assessment Methods (Direct, Indirect)

G. Specification Approval Data:

COUNCIL /COMMITTEE	
REFERENCE NO.	
DATE	

