Course Specification

(Postgraduate Programs)

Course Title:	**Spectroscopic Methods for Determining Organic Compounds Structures**
Course Code:	**CHM 6123**
Program:	**Master of science in chemistry**
Department:	**Chemistry**
College:	**Science**
Institution:	: Imam Mohammad Ibn Saud Islamic University
Version:	*Course Specification Version Number*
Last Revision Date:	*Pick Revision Date.*

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A. General information about the course:

1. Course Identification:

1. Credit hours: (.....)				
3 (3 Lectures, 0 Lab, 0 Tutorials)				
2. Course type				
A.	☐University	☐College	☐Department	☐Track
B.	☐ Required		☒ Elective	
3. Level/year at which this course is offered: (Level 2/ Year 1)				
4. Course General Description:				
This course was designed to lead students to a gain a good insight into the various spectroscopic characterization techniques for organic compounds structure determination. These spectroscopic techniques include infrared (IR), nuclear magnetic resonance (NMR) and mass spectroscopy (MS). The focus on theories and applications of the previously mentioned techniques combined with tutorials provides students with the required platform for solving problems related to structure elucidation of the organic compounds.				
5. Pre-requirements for this course (if any):				
Advanced Organic Chemistry – CHM 6121				
6. Pre-requirements for this course (if any):				
None				

7. Course Main Objective(s):

- **Use spectroscopic equipment such as IR, NMR (1H and 13C) in all techniques used, MS. Spectrometers.**
- **• Identify organic compounds by analysis and interpretation of spectral data.**
- **• Analyze and interpret One- Dimensional NMR (1H and 13C), and Two-Dimensional NMR spectra and relevant techniques used.**
- **• Investigate and determine the structure of typical organic chemical compounds using mass spectroscopy supported by NMR (1H and 13C), and IR.**
- **• Perform the most commonly mass spectroscopy analysis and fragmentation process in Electron Ionization Mass Spectrometry, and to interpret and the result.**

2. Teaching Mode: (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	45	100%
2	E-learning		
3	Hybrid		

No	Mode of Instruction	Contact Hours	Percentage
	• Traditional classroom • E-learning		
4	Distance learning		

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

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

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

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	To recall Spectroscopic Elucidation of Organic Molecules.	K1. *Org.*; K2. *Org.*; K3. *Org.*	▪ Five hours/week lectures. ▪ Self-study Home-exam.	▪ Regular Exams ▪ Assignments ▪ Short Quizzes ▪ Oral Discussion Participation.
1.2	To describe the full characterization of spectroscopic data of organic compounds.	K2. *Org.*; K3. *Org*; K4. *Org.*	▪ Five hours/week lectures. ▪ Think, and justify the chemical structures spectroscopically, using available references (SDL) online. Open discussion.	▪ Oral Discussion marks ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.3	To outline reasonable appropriate arguments and interpretation for	K2. *Org.*; K4. *Org.*	▪Five hours/week lectures.	▪ Midterm. ▪ Assignments. ▪ Group Discussions.

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
	identifying and elucidating organic compounds.		Group Discussion using available references (SDL)	▪ Literatures Survey ▪ Mini-seminar. Participation.
1.4	To state Specific Techniques and experimental tools for Spectroscopic Elucidation of Complex Organic Molecules.	K3. *Org*; K4. *Org*.	▪Five hours/week lectures. Group Discussion using available references (SDL)	▪ Assignments ▪ Open Discussions. ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
2.0	**Skills**			
2.1	To justify the appropriate techniques and experiments in NMR for identifying a complex organic structure.	S2. *Org*.; S3. *Org*.	▪ Lectures and Oral Discussions. ▪ Brainstorming. Self-study	▪ Questions in Lectures. ▪ Participation ▪ Oral Discussion Short Quizzes and Exams.
2.2	To summarize elucidation of chemical structures to organize thinking, evaluate and identify the chemical structures correctly.	S2. *Org*.; S3. *Org*.	▪ Lectures ▪ Group Discussions. ▪ Brainstorming. Self-study	▪ Questions in Lectures. ▪ Short Quizzes and Exams. Participation
2.3	To demonstrate Oral Communication for spectroscopic elucidation of organic molecules and its applications, accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others.	S1. *Org*.; S2. *Org*.; S4. *Org*.	▪ Group Discussion and Assignments ▪ Introduce several examples of organic molecules to elucidate and justify spectroscopically, which will require reading, writing, and oral presentation. Encourage students to use electronic mail to submit Home Exams and Assignments.	▪ Oral Discussion, Quizzes, and Exams. ▪ Giving marks for Oral Discussion in Lectures. Marks given for Assignments
2.4	To justify the appropriate techniques	S2. *Org*.; S3. *Org*.	▪ Lectures and Oral Discussions.	▪ Questions in Lectures.

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
	and experiments in NMR for identifying a complex organic structure.		▪ Brainstorming. Self-study	▪ Participation ▪ Oral Discussion Short Quizzes and Exams.
3.0	**Values, autonomy, and responsibility**			
3.1	To perform a scientific presentation, research, and work independently and integrate with a collaborated group, Using IT to acquire, analyze, and communicate information.	V1. *Org*.	▪ Brainstorming. ▪ Exercises ▪ Group Discussion. Team work.	▪ Oral Discussion. ▪ Group Discussion ▪ Assignments
3.2	To appraise effectively the collaboration and inter-professionalism in class discussions or team works, as well as independently.	V1. *Org*.; V2. *Org*.	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. Group Presentation of mini-projects	▪ Participation ▪ Homework's Mini-project(s).
...				

C. Course Content:

No	List of Topics	Contact Hours
1.	***Recall Spectroscopic Elucidation of Simple Organic Molecules:*** Infrared Spectroscopy Proton Nuclear Magnetic Resonance, 13C nuclear Magnetic Resonance, Simple Examples.	4
2.	***Further Topics in One- Dimensional NMR Magnetic:*** Shielding, Relaxation Effects of Relaxation and NOE on Peak Intensities, Common Impurities in NMR spectra, Other Useful Nuclei, Factors that Determine Chemical Shifts, Interpretation and Use of Proton and Carbon Coupling Constants, Using Coupling Constants to Make Configuration Assignments, The Nuclear Overhauser Effect.	8
3.	***Multiple-Pulse and Multidimensional NMR Techniques:*** A Glimpse of Multiple-Pulse NMR Methods, Elements of Multiple- Pulse NMR, Two-Dimensional NMR Techniques, Using Two-Dimensional NMR in Assigning Spectra, Strategic for Using 2D NMR in structure Determination, Use of NOESY and ROESY to Determine Relative Stereochemistry and Conformations, Configurational Analysis Based on Coupling Constants, Homonuclear correlated spectroscopy	8

	(COSY); Proton detected heteronuclear multiquantum coherence (HMQC), Heteronuclear Multi-Bond Connectivity (HMBC).	
4.	***Carbon-13 Nuclear Magnetic Resonance Spectroscopy:*** Experimental Aspects of Carbon-13 Nuclear Magnetic Resonance Spectroscopy, Gated Decoupling, Assignment Techniques, Multiplicity Selection with the Heteronuclear Spin Echo Experiment Heteronuclear Two-Dimensional $^{1}H,^{13}C$ Chemical Shift Correlation, The $^{13}C,^{13}C$ INADEQUATE Experiment, Heteronuclear *J*, δ Spectroscopy, Carbon-13 Chemical Shifts Carbon-13 Spin–Spin Coupling Constants, Carbon-13 Coupling Constants and Chemical Structure, $^{13}C,^{13}C$ Coupling Constants, ^{13}C, ^{1}H Coupling Constants, ^{13}C,X Coupling Constants.	**12**
5.	***Mass Spectroscopy:*** A Glimpse of Mass Spectrometry, Isotopes, Atomic Composition, Molecular Formulas, and Ionic Mass; Low and High Resolution and Measurments.	**3**
6.	***Mass Spectrometry Analysis of Small and Large Molecules:*** A Glimpse of Molecular Ions Revisited, Small-Molecule Mass Spectral Analysis, Large-Molecule Mass Spectral Analysis.	**4**
7.	***Fragmentation Processes in Electron Ionization Mass Spectrometry:*** Interpreting a low Resolution Electron Ionization Mass Spectrum, Fragmentation Process, Identification of Functionality from Fragmentation Process, Schematic Approach for Interpretation of an EIMS.	**6**
8.		
Total		**45**

D. Students Assessment Activities:

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	**Class Activities (Open Discussion, Mini-reports, Oral Presentation, solving questions)**	**weekly**	**30 %**
2.	**Midterm Exam**	**9 th week**	**30 %**
3.	**Final Exam**	**Around 17th week**	**40 %**
...	**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	***Spectroscopic Techniques in Organic Chemistry***, Williams, D. H. Fleming, I. , 6th , McGraw-Hill, Londen, 2007. ISBN-13: 978-0077118129.

	Basic One- and Two-dimensional NMR Spectroscopy, Friebolin, H. Wiley-VCH, Weinheim, 2010. ISBN-10: 3-527-31233-1, ISBN-13: 978-3-527-31233-7. ***NMR Spectroscopy: Basic Principles, Concepts, and Applications in Chemistry***, Günther, H, 2nd Edition, John Wiley & Sons, 2013. ISBN: 978-0-471-95201-5
Supportive References	**NONE**
Electronic Materials	• Journal of Organic Chemistry, ACS • Organic Letters, ACS • Tetrahedron • Tetrahedron Letters • Organic and Biomolecules Chemistry, RSC European Journal Of Organic Chemistry
Other Learning Materials	• Blackboard Multimedia associated with the text book and the relevant websites.

2. Educational and Research Facilities and Equipment Required:

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	**Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.**
Technology equipment (Projector, smart board, software)	**The rooms are equipped with data show, Smart Board, WI-FI access.**
Other equipment (Depending on the nature of the specialty)	**None**

F. Assessment of Course Quality:

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Students	**Direct:** Questionnaire.
	Course Responsible	**Direct:** Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Peer Reviewer	**Direct:** Questionnaire. **Indirect:** External assessor report.
Effectiveness of students' assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Quality of learning resources	Students	**Indirect:** Second examiner checklist-Course report.
	Faculty (Academic Advisory-GCC)	**Direct:** course Entrance/Exit.

Assessment Areas/Issues	Assessor	Assessment Methods
		Indirect: Observations - Accreditation review.
	Program Leaders	**Direct:** Course e-Portfolio.
	Course Responsible	**Indirect:** Course evaluation survey- Observations- Syllabus review- Accreditation review.
The extent to which CLOs have been achieved	Students	**Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Program Leaders	**Indirect:** Exams.
Other		

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

Assessment Methods (Direct, Indirect)

G. Specification Approval Data:

COUNCIL /COMMITTEE	**Council of Chemistry Department**
REFERENCE NO.	**10 (No. 2/10)**
DATE	**21/04/1444- 15/11/2022**