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| Form: Course Syllabus | Form Number | EXC-01-02-02A |
| | Issue Number and Date | 2/3/24/2022/2963 05/12/2022 |
| | Number and Date of Revision or Modification | |
| | Deans Council Approval Decision Number | 2/3/24/2023 |
| | The Date of the Deans Council Approval Decision | 23/01/2023 |
| | Number of Pages | 06 |

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|-----|--|---|
| 1. | Course Title | Advanced chromatography |
| 2. | Course Number | 0333913 |
| 3. | Credit Hours (Theory, Practical) | (3,0) |
| | Contact Hours (Theory, Practical) | Theory: three hour-lecture/week |
| 4. | Prerequisites/ Corequisites | Non |
| 5. | Program Title | Ph.D in chemistry |
| 6. | Program Code | 3 |
| 7. | School/ Center | Faculty of Graduate Studies |
| 8. | Department | Chemistry |
| 9. | Course Level | Ph.D |
| 10. | Year of Study and Semester (s) | Programs years 1 st or 2 nd semesters |
| 11. | Other Department(s) Involved in Teaching the Course | Non |
| 12. | Main Learning Language | English |
| 13. | Learning Types | x <input type="checkbox"/> Face to face learning <input type="checkbox"/> Blended <input type="checkbox"/> Fully online |
| 14. | Online Platforms(s) | <input type="checkbox"/> Moodle X <input type="checkbox"/> Microsoft Teams |
| 15. | Issuing Date | 23/01/2023 |
| 16. | Revision Date | 11-11-2024 |

17. Course Coordinator:

| | |
|---|-------------------------------------|
| Name: Prof. Dr. Sharif Arar | Contact hours: 11:00 am -12:00 noon |
| Office number: 203 old chemistry building | Phone number: 065355000 Ext. 22150 |
| Email: s.arar@ju.edu.jo | |



18. Other Instructors:

Name:

Office number:

Phone number:

Email:

Contact hours:

Name:

Office number:

Phone number:

Email:

Contact hours:

19. Course Description:

Extraction and distillation fundamentals and applications, extraction techniques with emphasis on solid phase separation techniques, Purnell equation, diffusion, kinetics, and band Broadening. Innovations in HPLC techniques, innovations in GC techniques and instrumentation, hyphenated techniques including mass-spectrometry. Multidimensional analysis, electro-separations and chiral separations.

20. Program Student Outcomes (SO's): (To be used in designing the matrix linking the intended learning outcomes of the course with the intended learning outcomes of the program)

SO1. Develop chemistry expertise, focus on theory and practice, and contribute to advancing knowledge in a specific research field.

SO2. Conduct original, high-quality research that advances knowledge in chemistry by developing complex projects using innovative methodologies.

SO3. Mentor junior researchers and students and demonstrate leadership in the scientific community through collaboration, peer review, and knowledge exchange.

SO4. Recognize the ethical implications and responsibly use chemistry solutions to tackle global challenges.

SO5. Participate in ongoing professional development to stay up to date with the latest research and innovations.



21. Course Intended Learning Outcomes (CLO's): (Upon completion of the course, the student will be able to achieve the following intended learning outcomes)

- 1. Gain advanced knowledge in different types of chromatographic systems, fundamentals of drugs solubilities and key factors for optimization method drugs chromatographic parameters**
- 2. Gain and develop in depth knowledge in extraction techniques with focusing on solid phase extraction (SFE) and automated extraction methods**
- 3. Obtain better knowledge of how to control factors leading to chromatographic separation, efficiency, selectivity, and retention based on Purnell equation**
- 4. Develop and gain enhanced knowledge in Diffusion, kinetics, and Band Broadening and how to manipulate certain chromatographic parameters to reduce band broadening**
- 5- Acquire advanced knowledge in latest techniques in HPLC , GC, and hyphenated mass spectrometry, in addition to tandem mass spectrometry to assist in conducting advance research work out research issues**
- 6- Acquire advanced knowledge in chiral separation and Electrophoresis**

| Course CLOs | The learning levels to be achieved | | | | | |
|-------------|------------------------------------|---------------|----------|-----------|------------|----------|
| | Remembering | Understanding | Applying | Analysing | evaluating | Creating |
| 1 | ✓ | ✓ | | ✓ | | |
| 2 | ✓ | ✓ | | ✓ | | |
| 3 | ✓ | ✓ | | ✓ | | |
| 4 | ✓ | ✓ | | ✓ | | |
| 5 | ✓ | ✓ | | ✓ | ✓ | |
| 6 | ✓ | ✓ | | ✓ | | |
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22. The matrix linking the intended learning outcomes of the course with the intended learning outcomes of the program:

| Program SO's Course CLO's | SO (1) | SO (2) | SO (3) | SO (4) | SO (5) | SO (6) | SO (7) |
|------------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| CLO (1) | ✓ | ✓ | | | | | |
| CLO (2) | ✓ | ✓ | | | | | |
| CLO (3) | ✓ | ✓ | | | | | |
| CLO (4) | ✓ | ✓ | | | | | |
| CLO (5) | ✓ | ✓ | | ✓ | ✓ | | |
| CLO (6) | ✓ | ✓ | | | | | |

23. Topic Outline and Schedule:

| Week | Lecture | Topic | CLO/s Linked to the Topic | Learning Types Face to Face (FF) Blended (BL) Fully Online (FO) | Platform Used | Synchronous (S) Asynchronous (A) | Evaluation Methods | Learning Resources |
|------|---------|--|---------------------------|--|---------------|-------------------------------------|------------------------------------|--------------------|
| 1 | 1.1 | Chromatography overview and chromatographic latest advanced techniques | 1 | Face to face | Non | Non | Quizzes/group discussion+ mid-exam | Reference No-1,2,3 |



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|---|-----|--|---|--------------|-----|-----|------------------------------------|------------------------|
| | 1.2 | Classification of chromatographic methods and flash chromatography | 1 | Face to face | Non | Non | Quizzes/group discussion+ mid-exam | Reference No-1,2,3 |
| 2 | 2.1 | Semi-preparative and size exclusion chromatography (SCE) | 1 | Face to face | Non | Non | Quizzes/group discussion+ mid-exam | Reference No-1,2,3, 4 |
| | 2.2 | Extraction techniques | 2 | Face to face | Non | Non | Quizzes/group discussion+ mid-exam | Reference No-1,2,3, 4 |
| 3 | 3.1 | Solid phase extraction | 2 | Face to face | Non | Non | Quizzes/group discussion+ mid-exam | Reference No-1,2,3,4 |
| | 3.2 | Automated extraction methods | 2 | Face to face | Non | Non | Quizzes/group discussion+ mid-exam | Reference No-1,2,3, 4 |
| 4 | 4.1 | Extraction and distillation | 2 | Face to face | Non | Non | Quizzes/group | Reference No-1,2, 3, 4 |



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| | | | | | | | discuss ion+ mid- exam | |
| | 4.2 | Distribution coefficient and partitioning coefficients | 1,2 | Face to face | Non | Non | Quizzes/ group discussion+ mid- exam | Reference No- 1,2,3, 4 |
| 5 | 5.1 | chromatographic separation, efficiency | 3 | Face to face | Non | Non | Quizzes/ group discussion+ mid- exam | Reference No- 1,2,3, 4 |
| | 5.2 | Chromatographic selectivity, and retention | 3 | Face to face | Non | Non | Quizzes/ group discussion+ mid- exam | Reference No- 1,2,3, 4 |
| 6 | 6.1 | Diffusion, kinetics, and Band Broadening | 4 | Face to face | Non | Non | Quizzes/ group discussion+ mid- exam | Reference No- 1,2,3, 4 |
| | 6.2 | Resistance to mass transfer | 4 | Face to face | Non | Non | Quizzes/ group discussion+ mid- exam | Reference No- 1,2,3, 4 |



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| 7 | 7.1 | The van Deemter equation | 4 | Face to face | Non | Non | Quizzes/group discussion+ mid-exam | Reference No- 1,2,3, 4 |
| | 7.2 | Factors affecting H in packed columns (LC) and GC | 4 | Face to face | Non | Non | Quizzes/group discussion+ mid+ exams | Reference No- 1,2,3, 4 |
| 8 | 8.1 | Gas chromatography advances and instrumentation | 5 | Face to face | Non | Non | Quizzes/group discussion+ Mid+final exam | Reference No- 1,2,3, 4 |
| | 8.2 | GC injection modes, detectors, column technologies and stationary phases | 5 | Face to face | Non | Non | Quizzes/group discussion+ Mid+Final exam | Reference No- 7,,8,9,10 |
| 9 | 9.1 | Liquid chromatography advances and instrumentation | 5 | Face to face | Non | Non | Quizzes/group discussion+ Final-exam | Reference No- 7,,8,9,10 |



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| | 9.2 | HPLC column technologies and latest innovations | 5 | Face to face | Non | Quizzes /group discussion+ Final-exam | Reference No-7,,8,9,10 | Face to face |
| 10 | 10.1 | 2D- Chromatography and its major classifications | 5 | Face to face | Non | Non | Quizzes/group discussion+ Final-exam | Reference No-7,,8,9,10 |
| | 10.2 | Hyphenated mass spectrometers | 5 | Face to face | Non | Non | Quizzes/group discussion+ Final-exam | Reference No-7,,8,9,10 |
| 11 | 11.1 | Ionization sources, analyzers, detectors | 5 | Face to face | Non | Non | Quizzes/group discussion+ Final-exam | Reference No-7,,8,9,10 |
| | 11.2 | Tandem mass spectrometry | 5 | Face to face | Non | Non | Quizzes/group discussion+ Final-exam | Reference No-7,,8,9,10 |



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| 12 | 12.1 | Gel electrophoresis fundamentals | 6 | Face to face | Non | Non | Quizzes/group discussion+ Final-exam | Reference No-7,,8,9,10 |
| | 12.2 | Vertical and horizontal electrophoresis | 6 | Face to face | Non | Non | Quizzes/group discussion+ Final-exam | Reference No-7,,8,9,10 |
| 13 | 13.1 | Chiral separations | 6 | Face to face | Non | Non | Quizzes/group discussion+ Final-exam | Reference No-7,,8,9,10 |
| | 13.2 | Seminar topic | 1,2,3,4,5, and 6 | Face to face | Non | Non | Quizzes/group discussion+ Final-exam | Reference No-7,,8,9,10 |
| 14 | 14.1 | Seminar topic | 1,2,3,4,5, and 6 | Face to face | Non | Non | Quizzes/group discussion+ Final-exam | Reference No-7,,8,9,10 |
| | 14.2 | Seminar topic | 1,2,3,4,5, and 6 | Face to face | Non | Non | Quizzes/group | Reference No- |



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| | | | | | | | discuss ion+ Final- exam | 7,,8,9,1 0 |
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24. Evaluation Methods:

Opportunities to demonstrate achievement of the CLOs are provided through the following assessment methods and requirements:

| Evaluation Activity | Ma rk | Topic(s) | CLO/s Linked to the Evaluat ion activity | Period (Week) | Platform |
|---------------------------------------|----------|-------------------------------------|---|------------------|----------------------|
| Oral presentations /term paper | 20 | All related topics in the course | 1,2,3,4, 5 and 6 | 13-14 | Face to face |
| Quizzes, HomeWorks and assignments | 10 | Topics in weeks 1-10 | 1,2,3,4, and 5 | 3, 6, 11 | Face to face |
| Mid-exam | 30 | Weeks 1-8 | 1,2,3,4, and 5 | 11 | In the department |
| Final-exam | 40 | Weeks 1-13 | 1,2,3,4, 5 and 6 | 16 | In the department |
| | | | | | |

25. Course Requirements:

Students should have a computer, internet connection, Microsoft teams



26. Course Policies:

A- Attendance policies:

Attending the course is mandatory. Failure to sit an exam will result in a mark of zero, unless a valid reason (with supporting documentation) for the absence is presented.

B- Absences from exams and handing in assignments on time:

Proof of illness requires a signed medical certificate. Notify me as soon as possible if you are going to miss an exam. If any course component is missed for a valid reason, that portion of the exam grade will/may be shifted to the final examination.

C- Health and safety procedures:

Special Needs Students: Feel free to inform your instructor of your special needs in order for you to have a productive learning experience.

D- Honesty policy regarding cheating, plagiarism, misbehavior:

When writing a report or paper on a given topic, you must read up the necessary information on the topic, and then present it in your own words and writing. If you want to use an exact sequence of text or an idea or data from someone else's work, that is considered a quote, then that work must be cited (you must give a proper credit to the author) specifically as a reference. Therefore, if you are caught cheating on any component of Chem.741 you will be assigned a grade of zero for the course. We shall also place a letter describing the offense in your student file.

If you see someone cheating during an exam or writing a paper or report, inform us/the proctors in the following ways: 1) Write a short message on your exam paper or report indicating what is happening. 2) Raise your hand and the proctor or myself will come over – then let us know and point out your note; we will take it from there.

It is important to point out that there is a difference between plagiarism and working out answers to a lab report or an assignment with a friend. If your writing is based on your own words and your understanding of the material, then that is acceptable. If, however, you simply write your friend's thought or answer, i.e. the same thing (cut and paste), then you have committed plagiarism. Simply, plagiarism is cheating; if you are unclear about any part of this issue or have any question, please speak up and let me know.

E- Grading Scheme and policy:

- Assignments are due at the beginning of the class, unless otherwise specified.
- Assignments, and suggested problems are intended as partial preparation for exams. Failure to put forth effort is perilous.
- Assignments are due on the dates noted. Assignments will be done individually; each student must hand in their own answers. It is acceptable, however, for students to help each other in



collaborating to solve problems and figuring out answers. We will be assuming that, you will be taking the responsibility to make sure you personally understand the solution to any problem arising from such collaboration. You also must indicate on each assignment with whom you collaborated.

- The final exam for this course is cumulative covering all material presented in the class, the exam will test your comprehension and your ability to problem solve.

F- Available university services that support achievement in the course:

- E-Learning resources and Microsoft teams
- Computer Lab

27. References:

A- Required book (s), assigned reading and audio-visuals:

- Handouts
- Lecture Notes (soft copies)
- Videos (Recorded Lectures) if needed

B- Recommended books, materials, and media:

- 1- Douglas A. Skoog, Donald M. West, F. James Holler and Stanley R. Crouch. Fundamentals of Analytical Chemistry, 9th edition, Cengage Learning 2014. **Chapters 31, 32, 33 and 34 (undergraduate level).**
- 2- Skoog, D.; Holler, and West, Principles of Instrumental Analysis, 7th edition, 2016
- 3- Jurger. H. Gross. Mass spectrometry, Springer, 2004.
- 4- Raymond P.W. Scot, principles and practice of chromatography, Kindle edition, 2003.
- 5- Serban Moldoveanu and Victor David. Modern sample preparation for chromatography, Elsevier, 2015
- 6- Raymond P.W. Scot, Preparative chromatography, Kindle edition, 2003
- 7- Raymond P.W. Scot, gas chromatography, Kindle edition, 2003
- 8- Raymond P.W. Scot, liquid chromatography, Kindle edition, 2003
- 9- Veronica R. Meyer. Practical high performance liquid chromatography. Wiley and Sons, 2004.
- 10- Reiner Westermeier, Electrophoresis in practice, Wiley-VCH Verlag GmbH & Co. KGaA

**28. Additional information:**

NA

Name of the Instructor or the Course Coordinator:

Prof. Dr. Sharif Arar

Signature:



Date: 11-11-2024

The Head of Graduate Studies Committee/
Department Chemistry**Dr. Murad AlDamen, Prof.****Signature:**

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Date:

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The Head of Department of Chemistry

Dr. Murad AlDamen, Prof.**Signature:**

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Date:

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Vice Dean for Graduate Studies and Scientific
Research / School of Science**Dr. Kamal Sweidan, Prof.****Signature:**

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Date:

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The Dean of School of Science

Dr. Mahmoud I. Jaghoub, Prof.**Signature:**

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Date:

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