

## Course Syllabus

1	<b>Course title</b>	Electrochemical Methods of Analysis
2	<b>Course number</b>	0303912
3	<b>Credit hours</b>	3
	<b>Contact hours (theory, practical)</b>	(3 Theory, 0 Practical)
4	<b>Prerequisites/corequisites</b>	None
5	<b>Program title</b>	Ph.D. in Chemistry
6	<b>Program code</b>	33
7	<b>Awarding institution</b>	The Department of Chemistry
8	<b>School</b>	School of Graduate Studies
9	<b>Department</b>	Department of Chemistry
10	<b>Course level</b>	Graduate/Ph.D.
11	<b>Year of study and semester (s)</b>	First or second year
12	<b>Other department (s) involved in teaching the course</b>	None
13	<b>Main teaching language</b>	English
14	<b>Delivery method</b>	<input checked="" type="checkbox"/> Face to face learning <input type="checkbox"/> Blended <input type="checkbox"/> Fully online
15	<b>Online platforms(s)</b>	<input type="checkbox"/> Moodle <input checked="" type="checkbox"/> Microsoft Teams <input type="checkbox"/> Skype <input type="checkbox"/> Zoom <input type="checkbox"/> Others.....
16	<b>Issuing/Revision Date</b>	

### 17 Course Coordinator:

Name: Prof. Dr. Mohammed Khair Hourani	Contact hours: 11:30 - 12:30 p.m Work days
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**18 Other instructors:**

Name: none

Office number:

Phone number:

Email:

Contact hours:

Name:

Office number:

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**19 Course Description:**

Thermodynamics of electrochemical reactions, kinetics of electrochemical reactions, mass transfer, electrode processes, potentiometry, electrogravimetry, coulometry, chronoamperometry, chronocoulometry, polarography, stripping analysis, ultramicroelectrodes, hydrodynamic techniques, modified electrodes, spectroelectrochemistry

## 20 Course aims and outcomes:

- CLO 1-Defines and explains all the thermodynamic terms and concepts of electrochemical systems and explains the relevance of the electrical quantities like the current and potential to chemical systems.
- CLO-2. Defines and explains all the theoretical aspects of mass transfer and electrode kinetics.
- CLO-3. Defines the terms and explains the theory of metallic electrodes, ion selective electrodes, bulk electrolysis techniques, chronoamperometry, chronocouometry, linear sweep voltammetry, cyclic voltammetry, stripping analysis, hydrodynamic techniques.
- CLO-4. Explains the electrochemical instrumentation for the various electroanalytical techniques.
- CLO-5 Performs the calculations for the concentration and cites the applications of the various electroanalytical techniques.

## 21. Topic Outline and Schedule:

Week	Lecture	Topic	Student Learning Outcome	Learning Methods (Face to Face/Blended/ Fully Online)	Platform	Synchronous / Asynchronous Lecturing	Evaluation Methods	Resources
1	1.1	Course Introduction		Face-to-face			Quizzes, exams, homeworks ,presentations, termpapers ,	
	1.2	Fast review of electrochemical terms, electrodes and reactions		Face-to-face			Quizzes, exams, homeworks ,presentations, termpapers ,	
	1.3	Some aspects of electrode reactions		Face-to-face			Quizzes, exams, homeworks ,presentations,	

							termpapers ,	
2	2.1	Dynamic electrochemical experiments, polarizable and nonpolarizable electrodes		Face-to-face			Quizzes, exams, homeworks ,presentations, termpapers ,	
	2.2	Static Techniques (i=0)		Face-to-face			Quizzes, exams, homeworks ,presentations, termpapers ,	
	2.3	Metallic electrodes and Ion selective electrodes		Face-to-face			Quizzes, exams, homeworks ,presentations, termpapers ,	
<b>Week</b>	<b>Lecture</b>	<b>Topic</b>	<b>Student Learning Outcome</b>	Face-to-face	<b>Platform</b>	<b>Synchronous / Asynchronous Lecturing</b>	Quizzes, exams, homeworks ,presentations, termpapers ,	<b>Resources</b>
3	3.1	Advances in potentiometric instrumentation		Face-to-face			Quizzes, exams, homeworks ,presentations, termpapers ,	
	3.2	Potentiometric titrations		Face-to-face			Quizzes, exams, homeworks ,presentations, termpapers ,	

	3.3	Mass Transfer: General mass transfer theory and equation		Face-to-face			Quizzes, exams, homeworks, presentations, term papers,	
4	4.1	Mass Transfer : Diffusion		Face-to-face			Quizzes, exams, homeworks, presentations, term papers,	
	4.2	Kinetics of Electrode Processes		Face-to-face			Quizzes, exams, homeworks, presentations, term papers,	
	4.3	Kinetic models		Face-to-face			Quizzes, exams, homeworks, presentations, term papers,	
5	5.1	Implications of kinetic equations		Face-to-face			Quizzes, exams, homeworks, presentations, term papers,	
	5.2	Tafel Equation and Tafel plots		Face-to-face			Quizzes, exams, homeworks, presentations, term papers,	
	5.3	Applications of Kinetics to		Face-to-face			Quizzes, exams, homeworks	

		electrochemical systems					,presentations, term papers	
6	6.1	Potential-Step Techniques: Theory		Face-to-face			Quizzes, exams, homeworks, presentations, term papers	
	6.2	Chrono-amperometry		Face-to-face			Quizzes, exams, homeworks, presentations, term papers	
	6.3	Chrono-coulometry		Face-to-face			Quizzes, exams, homeworks, presentations, term papers	
7	7.1	Applications of Chronoamperometry and chronocoulometry		Face-to-face			Quizzes, exams, homeworks, presentations, term papers	
	7.2	Potential Sweep Techniques: Theory		Face-to-face			Quizzes, exams, homeworks, presentations, term papers	
	7.3	Linear Sweep voltammetry		Face-to-face			Quizzes, exams, homeworks, presentations,	

							termpapers ,	
8	8.1	Cyclic voltammetry		Face-to-face			Quizzes, exams, homeworks ,presentatio ns, termpapers ,	
	8.2	Applications of cyclic voltammetry		Face-to-face			Quizzes, exams, homeworks ,presentatio ns, termpapers ,	
	8.3	Stripping Analysis		Face-to-face			Quizzes, exams, homeworks ,presentatio ns, termpapers ,	
9	9.1	Stripping Analysis		Face-to-face			Quizzes, exams, homeworks ,presentatio ns, termpapers ,	
	9.2	Ultramicroelec trodes: basics		Face-to-face			Quizzes, exams, homeworks ,presentatio ns, termpapers ,	
	9.3	Ultramicroelec trodes: theory		Face-to-face			Quizzes, exams, homeworks ,presentatio ns, termpapers ,	

10	10.1	Ultramicroelec trodes: applications		Face-to-face			Quizzes, exams, homeworks ,presentatio ns, termpapers ,	
	10.2	Bulk electrolysis techniques: basics		Face-to-face			Quizzes, exams, homeworks ,presentatio ns, termpapers ,	
	10.3	Bulk electrolysis techniques : Theory		Face-to-face			Quizzes, exams, homeworks ,presentatio ns, termpapers ,	
<b>Week</b>	<b>Lecture</b>	<b>Topic</b>	<b>Student Learning Outcome</b>	Face-to-face	<b>Platform</b>	<b>Synchronous / Asynchronous Lecturing</b>	<b>Evaluation Methods</b>	<b>Resources</b>
11		Bulk electrolysis techniques: electrometric end point detection		Face-to-face			Quizzes, exams, homeworks ,presentatio ns, termpapers ,	
	11.1	Applications of bulk electrolysis techniques		Face-to-face			Quizzes, exams, homeworks ,presentatio ns, termpapers ,	
	11.2	Electrochemic al instrumentation: an overview		Face-to-face			Quizzes, exams, homeworks ,presentatio ns, termpapers ,	



12	12.1	Electrochemical instrumentation		Face-to-face			Quizzes, exams, homeworks, presentations, term papers,	
	12.2	Operational amplifiers circuits		Face-to-face			Quizzes, exams, homeworks, presentations, term papers,	
	12.3	Potentiostats and galvanostats		Face-to-face			Quizzes, exams, homeworks, presentations, term papers,	
13	13.1	Potential control problems		Face-to-face			Quizzes, exams, homeworks, presentations, term papers,	
	13.2	Dealing with small currents		Face-to-face			Quizzes, exams, homeworks, presentations, term papers,	
	13.3	Classical polarographic analysis		Face-to-face			Quizzes, exams, homeworks, presentations, term papers,	
14	14.1	Normal pulse polarography		Face-to-face			Quizzes, exams, homeworks	

							,presentations, termpapers ,	
	14.2	Differential pulse polarography		Face-to-face			Quizzes, exams, homeworks ,presentations, termpapers ,	
	14.3	Differential pulse voltammetry		Face-to-face			Quizzes, exams, homeworks ,presentations, termpapers ,	
15	15.1	Hydrodynamic Voltammetry : basics		Face-to-face			Quizzes, exams, homeworks ,presentations, termpapers ,	
	15.2	Rotating disc electrode		Face-to-face			Quizzes, exams, homeworks ,presentations, termpapers ,	
	15.3	Rotating ring-disk electrode		Face-to-face			Quizzes, exams, homeworks ,presentations, termpapers ,	

## 22 Evaluation Methods:

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

Evaluation Activity	Mark	Topic(s)	SLOs	Period (Week)	Platform
Midterm exam	30	Electrochemical thermodynamics, Potentiometric techniques, mass transfer, kinetics of electrode processes, potential step techniques	SLO-1 – SLO-5	8 weeks	
Quizzes	10	At the end of each unit	SLO-1-SLO-5	Every couple of weeks	
Homeworks	5	After finishing each unit	SLO-1-SLO-5	Almost weekly	
Seminars	15	2 weeks before the end of the semester	SLO-1-SLO-5	1 at the semester	
Final	40	At the end of the semester	SLO-1-SLO-5		

### 23 Course Requirements

(e.g: students should have a computer, internet connection, webcam, account on a specific software/platform...etc):



1. Laptop for Power Point Presentation and Videos.
2. Data Show for Power Point Presentation.
3. Internet connection
4. Screen
5. Some laboratory equipment for demonstration

#### 24 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.

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

- E-Learning resources
- Computer resources
- Computer and a Data Show

## 25 References:

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

- **Textbook :**

Bard, A., Faulkner, L., Electrochemical Methods; Fundamentals and Applications, White, Henry, 3<sup>rd</sup> ed, Wiley New York , 2022.

Kissinger, P., Heiman, W.(Eds) Laboratory Techniques in Electroanalytical Chemistry, CRC, New York, 1996.

- Lecture notes
- Handouts

### B- Recommended books, materials, and media:

1. Bockris, J. O.M. and Khan, S. U. M , Surface Electrochemistry, Plenum press, New York, 1993.

2. Brett, C. M. A and Brett, A. M. O, Electrochemistry: Principles, Methods, and Applications, Oxford University Press, Oxford, 1993.


3. Chrestensen, P. A., and Hament, A. , *Techniques and Mechanisms in Electrochemistry*, Blackie Academic and Professional, Glasgow, 1994.
4. Crow, D. R., *Principles and Applications of Electrochemistry*, 3<sup>rd</sup> Edition, Chapman and Hall, London, 1988.
5. Gileadi, E. *Electrode Kinetics for Chemists, Chemical Engineering and Materials Scientists*, VCH, New York, 1993.
6. Kissinger, P. T. and Heinman, W. R, Eds. *Laboratory Techniques in Electroanalytical chemistry*, 2<sup>ed</sup> Edition, Dekker, New York, 1996.
7. Koryata, J. Dvorak, J. and Kavan, L. *Principles of Electrochemistry*, Second Edition, Wiley, New York, 1993.
8. Oldham, K. B. and Myland, J. C., *Fundamentals of Electrochemical Science*, Academic Press, San Diego, 1994.
9. Reieger, P. H., *Electrochemistry*, 2<sup>ed</sup> Edition, Chapman and Hall, New York, 1994.
10. Sawyer, D. T. , Sobwowski, A., and Roberts, J.L., Jr, *Electrochemistry for Chemists*, 2<sup>ed</sup> Edition, Wiley-Interscience, New York, 1995.
11. Wang, J. , *Analytical Electrochemistry*, VCH, New York, 1994.
12. Compton, R. G., and Hamnet, M. A., eds. *New Techniques for the study of Electrodes and their Reactions*, Volume 29, Elsevier, Amsterdam, 1989.
13. Goodisman, J., *Electrochemistry : Theoretical Foundations*, Wiley, New York, 1987.
14. Gutierrez, C. and Melendez, C. eds., *Spectroscopic and Diffraction Techniques in Electrochemistry*, kluwer, Boston, 1988.
15. Lipkowski, J., and Ross, P. N., eds. *Structure of Electrified Interfaces*, VCH, New York, 1993.

16. Rubenstein, I., ed., *Physical Electrochemistry*, Dekker, New York, 1995.
17. Varma, R. , and Selman, J. R., eds. *Techniques for Characterization of Electrodes and Electrochemical Processes*, Wiley, New York, 1991.
18. Vijih, A. K., *Electrochemistry of Metals and Semiconductors*, Dekker, New York, 1973.
19. Bard, A. J., Parsons, R. and Jordan, J., eds., *Standard Potentials in Aqueous solution*, Dekker, New York, 1985.
20. Bockris, J. O'M., ed., *Comprehensive Treatise of Electrochemistry*, Plenum Press, New York, 1980 (All volumes).
21. Gerischer, H. ed., *Advances in Electrochemistry and Electrochemical Engineering*, Wiley-Interscience, New York, 1961 (All volumes).
22. Bond, A, M., *Modern Polarographic Methods in Analytical Chemistry*, Dekker, New York, 1980.
23. Durst, R. A., ed., *Ion-Selective Electrodes*, National bureau of Standards, Special Publication 314, Washington, 1969.
24. Freezer, H., ed., *Ion-Selective Electrodes in Analytical Chemistry*, Plenum Press, New York, 1980.
25. Koryata, J. , *Ions, Electrodes, and Membranes*, New York, 1982.
26. Koryata, J., and Stulik, K., *Ion-Selective Electrodes*, Cambridge University Press, London, 1983.
27. Morrison, S. R. , *Electrochemistry at Semiconductor and Metal Oxide Electrodes*, Plenum Press, New York, 1980.
28. Pletcher, D. *Industrial Electrochemistry*, Chapman and Hall, London, 1982.
29. Serjeant, E. P., *Potentiometry and Potentiometric Titrations*. Wiley, New York, 1984.



## 26 Additional information:

None

Name of Course Coordinator: Prof. Dr. Mohammed Khair Hourani	Signature: 
Date: November 12, 2023	
Head of Curriculum Committee/Department: -----	Signature: -----
Head of Department: -----	Signature: -----
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Head of Curriculum Committee/Faculty: -----	Signature: -----
-	
Dean: -----	Signature: -----