Department: Chemistry

College: Education

University: Salahaddin

Subject: Electrochemistry

Course Book: *Stage* 3; Second semester

Lecturer's name: Khozan A. Haji

Academic Year: 2022-2023

Course Book

1. Course name	Electrochemistry
2. Lecturer in charge	Dr.Khozan A. Haji
3. Department/ College	Chemistry/ Education
4. Contact	e-mail:khozan.haji@su.edu.krd
5. Time (in hours) per week	Theory: 4
6. Office hours	Thursday 10.5am – 12.5 pm or by appointment
7. Course code	
8. Teacher's academic profile	I graduated from the College of Education, Department of Chemistry in 1997 and got a bachelor's degree BSc in chemistry. After that. I then started to study MSc/Analytical Chemistry in 1998 at Salahaddin University. After finishing my MSc study in 2000, I worked in Collage of Education / Chemistry department, as an assistant lecturer. The teaching experience is practical in the analytical Physical, Industrial &Organic Chemistry. Finally, I received my PhD-Physical Chemistry in the same University in 2015. My academic and research program interest focus on Kinetic study; I have more than 4 published articles and going to publish some other articles.
9. Keywords	**Kinetic study, chalcones, spectrophotometry, bromination, rate of reaction.**

10. Course overview:

Electrochemistry is the branch of chemistry that deals with the relation between chemical changes and electricity. It deals with the study of electrical properties of electrolytes and also the chemical changes brought about by passage of electricity.

Electrolytes are electrovalent substances that form ions in solution which conduct an electric current. Sodium chloride, copper (II) sulphate and potassium nitrate are examples of electrolytes.

Nonelectrolytes, on the other hand, are covalent substances which furnish neutral molecules in solution. Their water-solutions do not conduct an electric current. Sugar, alcohol and glycerol are typical nonelectrolytes.

An electrolyte invariably undergoes chemical decomposition as a result of the passage of electric current through its solution.

The phenomenon of decomposition of an electrolyte by passing electric current through its solution is termed Electrolysis (lyo=breaking).

11. Course objective:

It has been fashionable to describe electrochemistry as a discipline at the interface between the branches of chemistry and many other sciences. A perusal of the table of contents will affirm that view. Electrochemistry finds applications in all branches of chemistry as well as in biology, biochemistry, and engineering electrochemistry gives us batteries and fuel cells, electroplating and electro synthesis, and a host of industrial and technological applications which are barely touched on in this book. However, I will maintain that electrochemistry is really a branch of physical chemistry. Electrochemistry grew out of the same tradition which gave physics the study of electricity and magnetism. The reputed founders of physical chemistry-

Arrhenius, Ostwald, and van't Hoff-made many of their contributions in areas which would now be regarded as electrochemistry.

12. Student's obligation

The student attendance in class two hours a week, preparation of the home works examinations and participate in the discussion in the classroom.

13. Forms of teaching

Different forms of teaching will be used to reach the objectives of the course: Direct questions, Quizzes, Discussion and conclusions. Power point presentations

14. Assessment scheme

Exams: There will be two closed book exams given throughout the semester.
Each test will be to take 90 minutes. Each exam carries out 7.5 degrees, they considered = 15%.

Final Exam: The Final Exam is Comprehensive in all course outlines. Carry out 50% degrees of the grade.

Theoretical grade = 65% Practical grade = 35%

15. Student learning outcome:

The student will learn the phase rules, chemical equilibrium, finding the equilibrium constant for different reactions, in addition to learning the colligative properties of a mixtures

16. Course Reading List and References:

1- P.Atkins, and J.DE Paula. " ATKINS Physical Chemistry "6th edition.
2- IRA N. Levine. "Physical Chemistry" 6th edition.
3- A. Bahl, B.S. Bahl, and G.D. Tuli " Essential of physical Chemistry" .
4- R.A. Alberty, and R.J. Silbey."Physical Chemistry" 2nd edition.

17. The Topics:	Lecturer's name
1st week Electrolysis and Electrical Conductance 2nd week CONDUCTANCE IN SOLUTIONS OF ELECTROLYTES 3rd week Equivalent conductance and molar conductance 4th week Kohlrausch's Law	Dr.Khozan A. Haji 2 hours

5th week Applications of conductance Measurement 6th week Conductometric titration 7th week Electrochemical cells 8th week Electrode potential and standard electrode potential 9th week Cell potential or emf 10th week THERMODYNAMICS OF A CELL 11th week Nernst equation 12th week Types of Electrodes 13th week Batteries 14th week Fuel cells 15th week Concentration cells and liquid-junction potential	

19. Examinations:

Examples:

1st example

Q1: Fill the following blanks: **(15M)**

1- The phenomenon of decomposition of an electrolyte by passing electric current through its solution is termed ---------.

2- Substances that allow the passage of current through them are called

-------- and the phenomenon is called ----------.

3- The factors that affect metallic conductance are -----,-----,-----, and-----.

4- In case of strong electrolytes, increase in temperature increases the ----- of the ions. This results in increased --------. In case of weak electrolytes, increase in temperature increases the --------.

5- The variation in molar conductivity with concentration for strong electrolytes is given by an empirical relation proposed by -------- based on a number of experimental observations.

6- The reciprocal of resistivity (specific resistance) is called ------- and is represented by -------.

7- Conductivity of a solution is defined as the ------- of a solution of 1cm length and its area of cross-section of -----.

Q2: Explain the conductometric titration of a strong acid against a weak base. (Let the explanation be on the graph). **(10M)**

Q3: The specific conductivity of a saturated solution of Ag_2S at 25°C is $1.62 \times 10^{-6} S/cm$ and that of water is $1.6 \times 10^{-6} S/cm$.

The molar conductivity at infinite dilution is $200\ S.cm^2/mol$. What is the K_{sp} of Ag_2S in water at 25°C? **(15M)**

Q4: The molar conductivities at infinite dilution for Na_2SO_4, K_2SO_4, KCl, HCl and $HCOONa$ at 300K are 260. 308, 150, 426, and 105 $S.cm^2.mol^{-1}$ respectively. Hence find Λ_m^o for formic acid. **(10M)**

2nd example

Q1// Calculate Λ_m^o for $SrCl_2$ at 25°C, from the following data: (10M)

Concentration/(mol/l)	0.25	1
$\Lambda_m/(\Omega^{-1}.cm^2.mol^{-1})$	260	250

Q2// A) Specific conductance of 0.02 M KCl is $0.2768\ S.m^{-1}$ and it has a resistance of $82.4\ ohm$ at 25°C. What is specific conductance of 0.01 M K_2SO_4 solution at the same temperature if it has resistance of $300\ ohm$? (5M)

B) From the following data calculate the molar conductance Λ_o for ammonium hydroxide:

$$\Lambda_o\ for\ Ba(OH)_2 = 228.3\ \Omega^{-1}.cm^2.mol^{-1}$$

$$\Lambda_o\ for\ BaCl_2 = 120.3\ \Omega^{-1}.cm^2.mol^{-1}$$

$$\Lambda_o\ for\ NH_4Cl = 129.8\ \Omega^{-1}.cm^2.mol^{-1}$$ **(5M)**

Q3// A) The molar conductivity of 0.025M of $HCOOH_{(aq)}$ is $4.61\ mS.m^2.mol^{-1}$. Determine the pK_a of the acid. If the Limiting ionic conductivity of H^+ and $HCOO^-$ in water is (34.98 and 5.6) $mS.m^2.mol^{-1}$ respectively. (5M)

B) Write anode, cathode and overall reaction for lead storage batteries. (5M)

Q4// Calculate E_{cell} of the following cell: (10M)

$$Pt|\ Fe^{2+}(0.1M), Fe^{3+}(0.2M)\ ||\ Ag^+(1M)\ |\ Ag$$

Given $E^o_{Fe^{3+},Fe^{2+}/Pt} = 0.77\ V$, $E^o_{Ag^+/Ag} = 0.8V$.

Q5// A) Make complete cell diagrams of the following cell reaction:

$$Cd^{2+}_{(aq)} + Zn_{(s)} \longrightarrow Zn^{2+}_{(aq)} + Cd_{(s)}$$ **(5M)**

B) Write cell reactions of the following cell:

$$Pt \mid Fe^{2+}, Fe^{3+} || MnO_4^-, Mn^{2+}, H^+ \mid Pt$$ **(5M)**

20. Extra notes:

21. Peer review