Department of Chemistry

College of Science

University of Salahaddin

Subject: Electro-Chemistry

Course Book – *third stage*

Lecturer's name: **AsistproffDr.RounakMerzaShariffJaff**

Academic Year: 2022-2023

Assistant(for Practical): Asst.Prof.Dr.Heman A.Smail, ***lawen esmail and rezan jalal.***

Course Book

1. Course name	**Electro-Chemistry**
2. Lecturer in charge	**AsistproffDr.RounakMerzaShariffJaff**
3. Department/ College	**Chemistry/ Science**
4. Contact	**rounak.shariff@su.edu.krd**
5. Time (in hours) per week	**theory: 3**
6. Office hours	**10 hours per week to the student during the week**
7. Course code	**6h**
8. Teacher's academic profile	**I received my Bachelors B.SC of Science in Chemistry from Salahaddin University, Erbil-Iraq in 1988. From 1983-1988, I worked as a lab instructor at the Department of Chemistry; and also received Master of Science in Analytical Chemistry from Salahaddin University, Erbil-Iraq in 1994. Finally I received PH. D. of Science in PhysicalChemistry from Salahaddin University, Erbil-Iraq in 2008.Finally I upgraded to assist proffers in 2015.**
9. Keywords	**Physical Chemistry, Electro Chemistry, Reaction Kinetics, Conductance, Thermodynamics.**

10. Course overview:

This course includes a detailed overview of physical aspect for the equation that are impotent theory for conductance. Description the kinetic theory for gas, and solution and its application for reaction rate. Study of electricity and how it relates to chemical reactions, How chemical cell converts chemical energy into electrical energy. A chemical reaction takes place inside the battery and causes electric current to flow.Definition and types of electrolyte, conductivity types, Conductance behavior as a function of concentration for strong and weak electrolytes. Applications of conductivity to find some of variables.The concentrations of species at any time after the start of the reaction, The form of the rate law also provides insight into the series of elementary steps by which a reaction takes place, The key task in this connection is the construction of a rate law from a proposed mechanism and its comparison with experiment. Simple elementary steps have simple rate laws, and these rate laws can be combined together by invoking one or more approximations, These approximations include the concept of the rate determining stage of a reaction, the steady-state concentration of a reaction intermediate, and the existence of a pre-equilibrium. The introduces the principles of chemical kinetics, the study of reaction rates, by showing how the rates of reactions may be measured and interpreted. The develop this material in more detail and apply it to

more complicated or more specialized cases. The rate of a chemical reaction might depend on variables under our control, such as the pressure, the temperature, and the presence of a catalyst, and we may be able to optimize the rate by the appropriate choice of conditions. The study of reaction rates also leads to an understanding of the mechanisms of reactions, their analysis into a sequence of elementary steps.

11. Course objective:

Learning the student:

- **Prepare the chemical solution.**
- **Using the instruments and equipment.**
- **Plot the graph depending on specific laws.**
- **Compare and discuss practical and theoretical value.**
- **Writing report for each experiment.**

12. Student's obligation

the attendance & completion of all tests
exams
assignments
Reports
Seminar&etc….

13. Forms of teaching

Power point text andwhite board.

14. Assessment scheme

- **Quizzes: About 12 quizzes will be given throughout the semester. They will be given at the beginning of the class period and last 10 minutes.**
- **Report: writing report for each experiment.**
- **Oral examinations in the laboratory each week.**
- **Written Exams: There will be three closed book exams given throughout the semester. Each test will be scheduled for 90 minutes.**
- **Final Exam: The Final Exam is Comprehensive in all course outlines.**

15. Student learning outcome:

This course includes a detailed overview of the relationship between chemical change and electrical work and most impotent theory and the equation that used in .Electrochemical cell

16. Course Reading List and References:

Physical chemistry, 4th Edition by N. Ira. Levin.
Physical Chemistry, 6th Edition. By: ATKINS.
Physical Chemistry, 2ed Edition. By: Gilbert W. Castellan.
The Chemistry of molecular nature and change, 1st Edition. By: Martin Siberbeg.

17. The Topics:	Lecturer's name

Introduction in Electrochemistry: 1.1. Introduction 1.2. Course outline 1.3. Classification of electro-conductivity. 1.3.1. Ohms law. 1.3.2. Some important definition. 1.3.3. Examples. 2nd Week: Classification of electrolytes: 2.1. Introduction. 2.2. Law that used for conductance. 2.3. Examples how to use the equations: 2.3.1. Whetestone bridge: 2.3.1.1. Types of conductance cell. 2.3.1.2. Conductance water. 2.3.1.3. Demal solution. 2.3.2. Degree of dissociation: 2.3.2.1. Method that used for determining the ionic mobility. 2.3.2.2. Moving boundary. 2.3.2.3. Hydrogen mobility. 2.3.3. Examples. 3rd Week: Conductance titration: 3.1. Introduction. 3.2. Strong acid vise strong base. 3.3. Strong acid vise weak base. 3.4. Weak acid vise weak base 3.5. Displacement titration. 3.6. Examples. 4th Week: Theory of electrolytic conductance: 4.1. Deby –Hukel theory. 4.1.1. Asymmetric effect. 4.1.2. Electrophortic effect. 4.2. In complete dissociation. 4.3. Ionic Thickness. 4.3.1. Some examples. 4.4. Significance of the degree of the dissociation. 4.5. Ionization.	AsistproffDr.RounakMerzaShariffJaffex:(3hrs) ex: 14/10/2016

4.6. Ionic Association. 4.7. Weak electrolyte. 4.8. Determination of hydrolysis constant. 4.9. Examples. 5th Week: Migration of Ions; 5.1. Introduction. 5.2. Transport number (t±). 5.2.1. Hytroff method. 5.2.2. Moving boundary method. 5.3. Activity and activity coefficient. 5.3.1. Activity effect on conductance. 5.3.2. Activity effect on ionic strength. 5.3.3. Activity effect on solubility. 5.3.4. Examples. 6th Week: Determination of Hydrogen concentration: 6.1. Bronsted –Lawry acid. 6.1.1. Strong acid. 6.1.2. Weak acid. 6.2. Buffer solution. 6.2.1. Solution of weak acid and its salt. 6.2.1. Solution of weak base and its salt. 6.2.1. Solution of weak acid and weak base. 6.3. Hydrolysis and Neutralization. 6.3.1. Salt of strong acid and strong base. 6.3.2. Salt of strong acid and strong base. 6.3.3. Salt of strong acid and weak base. 6.3.4. Salt of weak acid and weak base. 6.3.5. Examples.	

Course Syllabus for Electro- Chemistry II- Electricity The course will be covered as follows: • Introduction in Electrochemical cell. • Westen cell and the classification of the reversible cell. • Relative reactive ties of metals. • Polarization and over voltage. • Thermodynamic phenomena of the cell. • Corrosion of the metals • Butler Volumer equation. Course Description: This course includes a detailed overview of the relationship between chemical change and electrical work and most impotent theory and the equation that used in Electrochemical cell. Course program	

7th -8th Week: Introduction Electrochemical cell: 1.1. Introduction in voltaic cell. 1.2. Balance of the oxd-red equation. 1.3. Origin of potentiometer. 1.3.1. Weston cell and classification of reversible cell. 1.3.2. Salt bridge and the notation of Electrochemical cell. 1.3.3. Relative strength of metals. 1.3.4. E.M.F calculation of and the Electrochemical cell. 1.4. Examples. 9thWeek: Standard cell potential and electrical work: 2.1. Introduction. 2.2. Determination of ΔoG, ΔoH, ΔoS, Ecell,and K of the Electrochemical cell. 2.3. Nernist equation. 2.4. Examples. 10th -11th-12th Week: Concentration cell : 3.1. Introduction. 3.2. Transference number. 3.3. Reference electrode. 3.3.1. Standard calomel electrode. 3.3.2. Silver-silver chloride electrode. 3.4. Indicator electrode. 3.4.1. pH electrode. 3.4.2. combine pH electrode. 3.4.3. Ion – selective electrode. 3.5. Concentration cell with liquid junction. 3.9. Concentration cell without liquid junction. 3.10. Examples. 13th-14th Week: Classification of Batteries: 14.1. Primary type. 14.1.1. Alkaline Batteries. 1 4.1.2. Mercury and silver Batteries. 14.2. Secondary Batteries.	

14.3. Rechargeable. 14.3.1. Lead –acid battery. 14.3.2. Nickel –Cadmiume battery. 14.4. Fuel cells. 14.5. Examples. 15th Week: Processes at electrodes: 15.1. Introduction. 15.2. Helmholtz model. 15.3. Gouy – Chpman model. 15.4. Stren model. 16th Week: The electrode potential at the interphase. 16.1. First order. 16.2. Activation Gibbs energy. 16.3. Tafelplote. 16.4. Butler Volumerequation . 1 6.5. Examples. 17th Week: Most important methods that used : 17.1. Voltametry. 17.1.1. Introduction. 17.1.2. Linear –Sweep Voltametry. 17.1.3. Different pulsVoltametry 1 7.1.4. Cyclic Voltametry. 1 7.3. Polarization. 17.2.1. Concentration Polarization. 17.2.2. Current Polarization. 1 7.4. Examples. 18th Week: Types of over potential: 18.1. Introduction. 18.1.1. Activation over potential. 18.1.2. Diffusion over potential. 18.1.3. Resistance over potential 18.2. Examples.	

19th Week: Corrosion: 1 9.1. Introduction. 19.1.2. protecting material against corrosion. 20th Week: Electro kinetic effect: 20.1. Introduction. 20.1.2. Electro osmosis phenomena. 20.1.3. Streaming potential. 20.2. Electrophoresis phenomena.	
18. Practical Topics (If there is any)	
Experiment -1-Determination of cell constant. **Experiment -2-Dissociation constant of weak acid from conductivity measurement.** **Experiment -3-Determination of equivalent conductance of strong electrolytes.** **Experiment -4-Conduct metric titration.** **a) Strong acid x Strong base.** **b) Weak acid x Strong base.** **c) Mixture of acids X Strong base.** **d) Weak acid x Weak base** **e) Precipitation titration.** **F) Displacement titration.** **Experiment -5-Determination of solubility product of sparingly soluble salt by conduct metric method.** **Experiment -6-Determination the degree of hydrolysis and hydrolysis constant of salt by conduct metric method.** **Experiment -7-Effect of viscosity on conductance of solutions.** **Experiment -8-Thermodynamic constants for chemical cell.** **Experiment -9-a-Application of Nernest equation to Cu/Cu+2 electrodes.**	**1st Week** **2nd Week** **3rd Week:** **4th Week** **5th Week** **6th Week** **7th Week** **8th Week** **9th Week** **10th Week** **11th Week** **12th Week** **13th Week** **14th Week** **15th Week** **16th Week** **17th Week** **18th Week** **19th Week**

Experiment -9-b-Application of Nernest equation to Zn/Zn+2 electrodes.	**20th Week**
Experiment -10-Determination of electrode Potential.	**21th Week**
Experiment -11-Potentiometric determination of the dissociation constant of weak acid.	**22th Week**
Experiment -12-Determination of decomposition Potential:	**23th Week**
Experiment -13-Determination of Avogadro numbers and Faradayconstant from electrolysis of dilute sulphuric acid.	**24th Week**
Experiment -1-Determination the order of the reaction for sodium sulphite with potassium iodate in acidic medium using differential method.	**25th Week**
Experiment -2-Determination the order of the reaction for sodium sulphite with potassium iodate in acidic medium usinghalf time method.	**26th Week**
Experiment -3-Determination the reaction order of potassiumper sulphate with potassium iodate.	**27th Week**
Experiment -4-Kinetics study for the reaction between acetone and iodine.	**28th Week**
Experiment -5-Reaction for Ethyl acetate with hydroxyl ion using titration method.	**29th Week**
Experiment -6-Determination of rate constant for Inversion of Sucrose catalyzed by hydrogen ion using polarimeter.	**30th Week**
Experiment -7- Kinetic study for decomposition of hydrogen peroxide catalyzed by MnO_2.	**31th Week**
Experiment -8-Determination of rate constant by gas evolution method for hydrolysis of Benzene diazonium chloride.	**32th Week**
Experiment -9-Determination of activation energy for the reaction Bromide/ Bromate ions without measuring rate constant.	

Experiment -10-Kinetic study for hydrolysis of methyl acetate with hydrochloric acid; **Experiment -11-Simulation of chemical reactions** **Experiment -12-Effect of Ionic strength on chemical reaction rate.** **Experiment -13-Determination of activation energy for the sodium sulphite with potassium iodate in acidic medium.**	

19. Examinations:

a- In a particular cell a 0.01 demal solution of KCl gave a resistance of 150 ohm at 25oC, while a 0.01N solution of hydrochloric acid gave a resistance of 51.4 ohm at the same temperature. The specific conductance of demal solution is 0.0014 ohm-1cm-1. Calculate the equivalent conductance of this electrolyte.

b- Calculate the equivalent conductance at infinite dilution of acetic acid if it's of HCl, CH3COONa and NaCl are 426.16, 91 and126.45 equiv-1mho cm2 respectively at 25oC.

c- The equivalent conductance for acetic acid is 48.15 equiv-1mho.cm2in a solution Concentration is 0.001N.Calculate Λo for acetic acid if λo H+ and λo CH3COO- is (349.8 and 40.9) equiv-1mho.cm2 respectively at 25oC.Calculate the degree of dissociation for acetic acid and dissociation constant.

d- A measurement with a conductivity- measuring cell at 25oC shows a resistance of 747.5 ohm for a 0.01M solution of KCl and a value of 876 ohm when the electrolyte is a 0.005M solution Calcium chloride. Calculate the conductivity and the molar conductivity of the solution of CaCl2, if (Λo .is149Ω-1cm2 mol-1).

e- Prove that L = Kcell C-

Q2/Define the following terms: (10marks)

1-Ohm's law, 2-volt, 3-Electrolytes, 4-Walden,s rule ,5-types of protons in solution .

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Q2-B/ Explain the following (40marks)

1– The Type of conductance cells.

2- Comment on the most modification in the Wheatstone bridge.

3- Explain the Kohlrausch's law.

4- Comment on the rounding in the titration curve for weak acid vise the strong abase.

20. Extra notes:

I will try to do my best to cover the course very well.

21. Peer review

I will try to contact with my practical team.