Course Syllabus

1	**Course title**	Physical chemistry 2
2	**Course number**	0303341
3	**Credit hours**	3 Hours
	Contact hours (theory, practical)	(3,0)
4	**Prerequisites / corequisites**	0303241
5	**Program title**	Bachelor degree in chemistry
6	**Program code**	0303
7	**Awarding institution**	The University of Jordan
8	**School**	Science
9	**Department**	Chemistry
10	**Course level**	3ed year
11	**Year of study and semester (s)**	Fall, Spring and Summer
12	**Other department(s) involved in teaching the course**	N/A
13	**Main teaching language**	English
14	**Delivery method**	☒ Face to face learning ☐ Blended ☐ Fully online
15	**Online platforms(s)**	☐ Moodle ☒ Microsoft Teams ☐ Skype ☐Zoom ☐Others……
16	**Issuing/Revision Date**	February 28-2023

17 Course Coordinator:

Name: Mohammed A Gharaibeh	Contact hours: 8:30-9:30 S,T,T
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18 Other instructors:

N/A

19 Course Description:

Physical chemistry 2 is the second out of three physical chemistry sequence offered by the department of chemistry. This class is intended for undergraduates majoring in chemistry. The subjects covered in this course are electrochemistry, chemical kinetics, and surface chemistry. The first part of the course will deal with solutions of electrolytes and electrochemical cells. This part is a continuation of chemical thermodynamics covered in physical chemistry I course. The second part is concerned with chemical kinetics. In this part we will investigate in some detail rate and rate law of chemical reactions, analysis of kinetic data, Arrhenius law and transition state theory, reactions in solution, composite reactions and reaction mechanisms, some examples and applications of composite reactions, and homogeneous catalysis. In the third part surface chemistry will be introduced. Here we will explore adsorption, some important isotherms, heterogeneous catalysis, surface tension, and colloids.

20 Course aims and outcomes:

A- Aims:

1. Develop a firm and solid understanding of the fundamental principles of physical chemistry.
2. Explain the fundamental concepts and phenomena of physical chemistry, in particular, in electrochemistry and electrochemical equilibrium, chemical kinetics and reaction dynamics, reaction mechanisms, catalysis, and surface chemistry.
3. Acquire a quantitative understanding of physical chemistry, by both expressing ideas and concepts into mathematical relations, and by understanding physical concepts behind mathematical formulas. Furthermore, students will be able to derive important mathematical relations.
4. Promote problem-solving skills by applying different mathematical methods and techniques to the solution of relevant problems, and by encouraging students to work systematically through complex problems.
5. Appreciate the continuous interplay between experiment and theory in physical chemistry.
6. Allow students to develop an awareness of the connections between topics in physical chemistry, in order to explore physical chemistry as a "unified" field of study and research.
7. Integrate the fundamental subjects learned with practical and industrial applications.
8. Stimulate student's interest to the state of art techniques and developments in the field of physical chemistry, through chemical primary sources and literature.

B- Course Learning Outcomes (CLOs): Upon successful completion of this course students will be able to:

CLO-1. Acknowledge the basic concepts in electrochemistry, chemical kinetics and surface chemistry.
CLO-2. Derive Debye Huckel Limiting Law and apply this law for some electrochemical systems.
CLO-3. Understand electrochemical cells and learn the factors that affect their electromotive force.
CLO-4. Derive the integrated rate laws and apply these laws for elementary chemical reactions.
CLO-5. Apply the steady-state approximation to obtain a rate law for a composite reaction.
CLO-6. Outline types of adsorption on surfaces and reorganize some transport properties of substances.

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		Student Outcomes (SO)						
		SO-1	SO-2	SO-3	SO-4	SO-5	SO-6	SO-7
Course Learning Outcomes (CLO)	CLO-1	✓						
	CLO-2	✓	✓	✓				
	CLO-3	✓		✓				
	CLO-4	✓	✓	✓				
	CLO-5	✓						
	CLO-6	✓		✓				

21. Topics Outline and Schedule:

Week	Lecture	Topic	Teaching Methods*/platform	Evaluation Methods**	References
1	1.1	Introducing the course	In the class	Quiz 1 + Mid exam	Keith Laidler *et al*, Physical Chemistry, 4th ed. **Ch 7**
	1.2	Electrostatics and electrical conductivity	In the class	Quiz 1 + Mid exam	*ibid*
	1.3	7.1: Faraday's laws of electrolysis	In the class	Quiz 1 + Mid exam	*ibid*
2	2.1	7.2: Molar conductivity (I)	In the class	Quiz 1 + Mid exam	*ibid*
	2.2	7.2: Molar conductivity (II)	In the class	Quiz 1 + Mid exam	*ibid*
	2.3	7.3: Weak	In the class	Quiz 1 + Mid exam	*ibid*

		electrolytes, Ostwald's dilution law			
3	3.1	7.4: Strong electrolytes	In the class	Quiz 1 + Mid exam	*ibid*
	3.2	7.4: Strong electrolytes: Debye- Huckel theory (I)	In the class	Quiz 1 + Mid exam	*ibid*
	3.3	7.4: Strong electrolytes: Debye- Huckel theory (II)	In the class	Quiz 1 + Mid exam	*ibid*
4	4.1	7.4: Strong electrolytes: Kohlrausch equation	In the class	Quiz 1 + Mid exam	*ibid*
	4.2	7.5, 7.6: Independent migration of ions; transport numbers	In the class	Quiz 1 + Mid exam	*ibid*
	4.3	7.8: Ion conductivities; thermodynamics of ions	In the class	Quiz 1 + Mid exam	*ibid*
5	5.1	7.10: Activity coefficients	In the class	Quiz 1 + Mid exam	*ibid*
	5.2	7.10: Debye-Huckel Limiting Law	In the class	Quiz 1 + Mid exam	*ibid*
	5.3	7.11, 7.12: Ionic equilibria, ionization of water	In the class	Quiz 1 + Mid exam	*ibid*
6	6.1	8.2: The Daniel cell; the standard hydrogen electrode	In the class	Quiz 2 + Mid exam	Keith Laidler *et al*, Physical Chemistry, 4th ed. **Ch 8**
	6.2	8.3: Thermodynamics of electrochemical cells (I)	In the class	Quiz 2 + Mid exam	*ibid*
	6.3	8.3: Thermodynamics of electrochemical cells (II)	In the class	Quiz 2 + Mid exam	*ibid*
7	7.1	9.1, 9.2, 9.3: Rates and empirical rate equations	In the class	Quiz 3 + Mid exam	Keith Laidler *et al*, Physical Chemistry, 4th ed. **Ch 9**
	7.2	9.4: Analysis of kinetic results (I)	In the class	Quiz 3 + Mid exam	*ibid*
	7.3	9.4: Analysis of kinetic results (II)	In the class	Quiz 3 + Mid exam	*ibid*
8	8.1	9.4: Analysis of kinetic results (III)	In the class	Quiz 3 + Mid exam	*ibid*
	8.2	9.5: Techniques for fast reactions	In the class	Quiz 3 + Mid exam	*ibid*
	8.3	9.6, 9.7: Molecularity; The Arrhenius equation (I)	In the class	Quiz 3 + Mid exam	*ibid*
9	9.1	9.7: The Arrhenius equation (II)	In the class	Quiz 3 + Mid exam	*ibid*
	9.2	9.9: The preexponential factor: collision theory	In the class	Quiz 3 + Mid exam	*ibid*
	9.3	9.9: The preexponential factor: transition state theory (I)	In the class	Quiz 3 + Mid exam	*ibid*
10	10.1	9.9: The preexponential factor: transition state theory (II)	In the class	Quiz 3 + Mid exam	*ibid*
	10.2	9.10: Reactions in solutions (I)	In the class	Quiz 3 + Mid exam	*ibid*
	10.3	9.10: Reactions in solutions (II)	In the class	Quiz 3 + Mid exam	*ibid*
11	11.1	10.1, 10.2: Introduction; types of composite reactions	In the class	Quiz 4 + Mid exam	Keith Laidler *et al*, Physical Chemistry, 4th ed. **Ch 10**
	11.2	10.3: Rate equations for composite mechanisms (I)	In the class	Quiz 4 + Mid exam	*ibid*
	11.3	10.3: Rate equations for composite mechanisms (II)	In the class	Quiz 4 + Mid exam	*ibid*
12	12.1	10.4: Rate constants and equilibrium constants	In the class	Quiz 4 + Mid exam	*ibid*
	12.2	10.5: Free-radical	In the class	Quiz 4 + Mid exam	*ibid*
		reactions		Quiz 4 + Mid exam	*ibid*
	12.3	10.9: Catalysis	In the class	Quiz 4 + Mid exam	*ibid*

13	13.1	18.1, 18.2: Adsorption, adsorption isotherms (I)	In the class	Quiz 5 + Mid exam	*ibid*
	13.2	18.2: Adsorption isotherms (II)	In the class	Quiz 5+ Mid exam	*ibid*
	13.3	18.4, 18.5: Reactions on surfaces, surface heterogeneity	In the class	Quiz 5 + Mid exam	Keith Laidler *et al*, Physical Chemistry, 4th ed. **Ch 18**
14	14.1	18.7: Surface tension and capillarity	In the class	Quiz 5 + Mid exam	*ibid*
	14.2	18.8: Liquid films on surfaces	In the class	Quiz 5 + Mid exam	*ibid*
	14.3	18.9: Colloidal systems	In the class	Quiz 5 + Mid exam	*ibid*
15	15.1	Review for the final exam			

22 Evaluation Methods:

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

Evaluation Activity	Mark	Topic(s)	CLO	Period (Week)	Platform
Quiz 1*	10	Chapter 7	1	Week 4	Written exam
Quiz 2*	10	Chapter 9	2	Week 8	Written exam
Mid exam	30	Chapters 7+8	1-2	Week 10	Written exam
Quiz 3*	10	Chapter 9	3	Week 12	Written exam
Homework*	10	Chapter 10	4	Week 14	Written HW
Final exam	50	All Chapters	1-6	Final exams week	Written exam

* From the three quizzes and the homework, a semester word will be taken with grade of 20/100

23 Course Requirements

N/A

24 Course Policies:

A- Attendance policies:
Students should attend at least 85% of the total number of the lectures.

B- Absences from exams and submitting assignments on time:
Students who miss an exam must submit and acceptable excuse and then a makeup exam will be appointed.

C- Health and safety procedures:
Followed according to university regulations.

D- Honesty policy regarding cheating, plagiarism, misbehavior:
Followed according to university regulations.

E- Grading policy:
1. Mid exam 30%
2. Semester work 20%
3. Final exam: 50%
The letter grade scale is adopted.

F- Available university services that support achievement in the course:
Central library, personal computer labs at different locations in the university, e-learning site, faculty member's website.

25 References:

A- Required book(s), assigned readings and audio-visuals:
K. J. Laidler, J. H. Meiser, and B. C. Sanctuary, Physical Chemistry, 4th ed., Houghton Mifflin company, 2003.

B- Recommended books, other materials, and media:
Lecture notes and other documents and information relevant to the course are available at my e- leering site of The University of Jordan (https://elearning.ju.edu.jo//).

Furthermore, students are strongly recommended to frequently consult one or more of the following books (all available at the university library):

1. P. W. Atkins, and J. de Paula, Atkins' Physical Chemistry, 10th ed., OUP, 2014.
2. G. Barrow, Physical Chemistry, 6th ed., McGraw-Hill College, 1996.
3. T. Engel, and P. Reid, Physical Chemistry, 3rd ed., Pearson Education, Inc., 2013.
4. I. N Levine, Physical Chemistry, 6th ed., the McGraw-Hill Companies, 2009.
5. R. Silbey, R. Alberty, and M. Bawendi, Physical Chemistry, 4th ed., John Wiley, 2004.

26 Additional information:

N/A

Name of Course Coordinator:	*Dr. Mohammed A Gharaibeh*	Signature:	M. Gharaibeh
Head of Curriculum Committee/Department:	*Prof. Deeb Taher*	Signature:	
Head of Department:	*Dr. Ahmad Makahleh*	Signature:	
Head of Curriculum Committee/Faculty:		Signature:	
Dean:	*Prof. Mahmoud Al-Jaghoub*	Signature:	