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CHEM 236-002: Physical Chemistry for Chemical Engineers

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Avzianova, Elena, "CHEM 236-002: Physical Chemistry for Chemical Engineers" (2022). *Chemistry, Environmental and Forensic Science Syllabi*. 412.
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NJIT New Jersey Institute of Technology

THE COLLEGE OF SCIENCE AND LIBERAL ARTS

THE DEPARTMENT OF CHEMISTRY AND ENVIRONMENTAL SCIENCE

Spring 2022 Course Syllabus

CHEM 236-001 (4 credits, 5 contact hours)

IMPORTANT: The shift to remote and converged learning due to the COVID-19 pandemic has required that both instructors and students make changes to their normal working protocols for courses. Students are asked to practice extra care and attention in regard to academic honesty, with the understanding that all cases of plagiarism, cheating, multiple submission, and unauthorized collaboration are subject to penalty. Students must properly cite and attribute all sources used for papers and assignments. Students may not collaborate on exams or assignments, directly or through virtual consultation, unless the instructor gives specific permission to do so. Posting an exam, assignment, or answers to them on an online forum (before, during, or after the due date), in addition to consulting posted materials, constitutes a violation of NJIT's Code on Academic Integrity. Likewise, unauthorized use of live assistance websites, including seeking "expert" help for specific questions during an exam, can be construed as a violation of the policy.

CHEM 236 Prerequisites: (CHEM 122 or CHEM 126) and (CHEM 124 or CHEM 125A) and ChE 230 with a grade C or better.

CHEM 236 Course Description: This course will introduce the chemical engineering students to the concepts of order, disorder, chemical equilibrium and phase equilibrium. Credit for this course will not be given if credit for CHEM 235 has been given.

Office hours: **TBA**

Instructor: **Dr. Avzianova**
Contact information: ***Canvas is the best way to contact the instructor.***

Required Textbook:

Title	**Physical Chemistry**
Author	Peter **Atkins**, Julio de Paula, and James Keeler
Edition	**11th**
Publisher	Oxford University Press
ISBN #	**ISBN-10**: 0198769865, **ISBN-13**: 9780198769866

Required Materials:
For **Converged Learning mode:** all students **must** have access to a computer with awebcam with which they can access Canvas and the lockdown browser. In addition, a second devicemay be required for live proctoring by the instructor or TA in order for students to be allowed to use their own formula sheet. A scientific calculator is recommended and allowed for all activities and assignments.

University-wide Withdrawal Date: The last day to withdraw is Monday, April 4,2022. It will be strictly enforced.

Learning Outcomes: *By the end of this course, you should be able to do the following:*

1. Calculate thermodynamic functions of chemical reactions (enthalpy, entropy, Gibbs energy, heatcapacity) based on the tabulated data at the reference and other temperatures.
2. Sketch, interpret, and use phase diagrams for one-component systems.
3. Derive the basic thermodynamic relations and state the approximations and the applicability.
4. Calculate the thermodynamic functions of pure compounds and of components in mixtures.
5. Sketch the phase diagrams for liquid-gas, liquid-liquid, and liquid-solid equilibria for mixtures and beable to interpret them.
6. Calculate activities and activity coefficients of ions in solutions.
7. Determine equilibrium constants and reaction quotients based on reaction and/or thermodynamicdata.
8. Calculate the transfer parameters (diffusion coefficient, viscosity, thermal and electricalconductivity).
9. Determine the Arrhenius parameters of a chemical reaction from the rate constant vs. temperaturedata.
10. Analyze data for reactions of simple orders.
11. Build up mechanisms of complex chemical reactions, construct corresponding systems of ordinarydifferent equations, and use the steady-state or pre-equilibrium approximations.
12. Estimate rate constants of elementary chemical reactions using the Simple Collision Theory and theTransition State Theory.

Grading Policy: The overall grade for this course consists of the following:

Homework and quizzes	30%
Midterm Exam I	20%
Midterm Exam II	20%
Final Exam	30%

Your final letter grade in this course will be based on the following tentative curve:

A	90% and higher	**C**	70% to 74%
B+	85% to 89%	**D**	60% to 69%
B	80% to 84%	**F**	59% and lower
C+	75% to 79%		

Attendance Policy: Attendance is mandatory whether in-person or online. Graded assignments missed due to absence will receive a grade of zero unless the excuse is approved by the Dean of Students office.

Lectures: Students are expected to read the specified textbook material and review the slides posted **before** coming to class. The lectures will consist of in-depth discussion of the material, active solving of exercises, and group assignments.

Homework: Homework is an expectation of the course and is **mandatory**. All homework assignments are online and have specific due dates. If for any reason due date is extended, it will be extended for the whole class. Homework assignments will have multiple attempts available and will not be timed or proctored. Late homework assignments will not be accepted without a Dean of Students approved excuse as noted elsewhere.

Quizzes: All quizzes are POP UP (i.e., are NOT announced in advance). No requests whether a quiz would appear on a specific date must be made. NO make-up quizzes will be offered.

Lecture: computer and calculator are required for all lectures. Students are expected to come to lecture after having reviewed **lecture** notes available in Canvas. **A laptop** is required for all classes. We will be doing a lot of problem -solving, so **a paper notebook** where you can do problems is highly recommended.

Exams: There will be two midterm exams held in **regular class hours** during the semester and one comprehensive final exam. The following exam periods are tentative and therefore possibly subject to change:

Midterm Exam I	March 24 – April 2 (after the material from lectures 1 - 10 is completely covered)
Midterm Exam II	April 7 – 13 (after the material from lectures 12 - 21 is completely covered)
Final Exam Period	May 6 - 12

Any potential violation of exam rules will be reviewed and reported ifnecessary to the Dean of Students.
The final exam will test your knowledge of all course material covered but may be weighted somewhat towards material not tested on before.

Makeup Exam Policy: There will normally be **NO MAKE-UP QUIZZES OR EXAMS** during the semester. Only excuses approved by the Dean of Students office by presenting written verifiable proof of the reason for missing the quiz or exam, e.g., a doctor's note, police report, court notice, etc. clearly stating the date and time of the mitigating problem. The student must also notify the CES Department Office and instructor that the quiz or exam will be missed.

ADDITIONAL RESOURCES

Chemistry Tutoring Center: It is recommended to find out which tutors can tutor physical chemistry, as some tutors are only proficient in general and/or organic chemistry tutoring.

Hours of operation will be determined but are generally Monday through Friday including some hours later in the day. Please email Dr. Balasubramanian if you have any questions about the tutoring center and availability of physical chemistry tutoring.

Accommodation of Disabilities: **O**ffice of **A**ccessibility **R**esources and **S**ervices offers long-term and temporary accommodations for students at NJIT.

If you are in need of accommodations due to a disability please contact Chantonette Lyles, Associate Director at the OARS at 973-596-5417 or via email at lyles@njit.edu. For further information regarding self-identification, the submission of medical documentation and additional support services provided please visit the Accessibility Resources and Services (OARS) website.

Important Dates (See Fall 2022 Academic Calendar to check for updates in case of snow days or other emergency situations):

Month	Date	Event
January	18	First Day of Classes
January	24	Last Day to Add/Drop a Class
March	14	Spring break begins
March	19	Spring break ends
April	15	Good Friday – no classes
May	3	Last Day of Classes
May	4	Reading Day 1
May	5	Reading Day 2
May	6	Final Exams Begin
May	12	Final Exams End
May	14	Final Grades Due

Course Outline

Class	Week	Topic	Assignment[c)]
1, 2	1	**2A, 2B, 2C** Internal energy. The theorem of equipartition of energy. The first law of thermodynamics. Heat and Work. Enthalpy. Standard State. Temperature Dependence of Reaction Enthalpies. Kirchhoff's Law.	All HW's assignments see on Canvas
3, 4	2	**2D, 2E** Exact and inexact differential. Changes in Internal Energy and Enthalpy. Joule Experiment. Joule-Thomson Experiment. Adiabatic changes. Adiabatic reversible expansion.	
5, 6	3	**3A, 3B** Entropy and the second law of thermodynamics. Heat Engines. Carnot Cycle. Entropy changes for specific processes. Third Law of Thermodynamics. Third Law Entropies of Chemical Substances. Standard Molar Entropy.	
7, 8	4	**3C, 3D** Gibbs Free Energy. Maximum work. Fundamental Equation. Maxwell Relations. Properties of Gibbs Energy. Gibbs – Helmholtz Equation.	
9, 10	5	**4A, 4B** Material equilibrium. Phase Diagrams. Chemical Potential. Chemical Potential of Real Gases. Fugacity. Clapeyron equation. Clausius-Clapeyron Equation.	
11	6	**FIRST MIDTERM EXAM Ch 2-4**	
12	6	**5A** Properties of Simple Mixtures. Partial Molar Quantities. Gibbs - Duhem Equation. Thermodynamics of Mixing.	

13, 14	7	**5B, 5C** Binary Liquid Mixtures. Raoult's Law. Henry's Law. Ideal solutions. Ideal Dilute Solutions. Colligative Properties. Phase diagrams of binary systems, level rule	
15, 16	8	**5D, 5F** Azeotropes, phase separation. Completely miscible liquids. Immiscible Liquids. Partially miscible liquids. Activities and activity coefficient.	
17, 18	9	**6A, 6B** Equilibrium constant, reaction quotient. Response of equilibria to conditions.	
19, 20	10	**1B** Molecules motion in gases. Mean and most probable speeds. Collision frequency. Mean free path. Collisions with walls and surfaces. Effusion.	
21	11	**16A** Transport properties of gas. Diffusion, thermal conductivity and viscosity.	
22	11	**SECOND MIDTERM EXAM – Ch 5-6**	
23	12	**17A** Rate of reaction, integrated rate laws.	
24	12	**Good Friday**	
25, 26	13	**17B, 17C** Arrhenius equation, reactions approaching equilibrium.	
27, 28	14	**17 D, 17E** Elementary reactions, steady-state approximation. Steady-state approximation, pre-equilibria.	

The position in the table is tentative.

Final notes:

Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at: http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf.

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university. If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu

This syllabus may change based on material covered and other factors.