<table>
<tr><td rowspan="7">Identification</td><td>Subject (code, title, credits)</td><td colspan="2">CHE 240 Physical Chemistry 4 ECTS</td></tr>
<tr><td>Department</td><td colspan="2">Chemistry and Chemical Engineering</td></tr>
<tr><td>Program (undergraduate, graduate)</td><td colspan="2">Undergraduate</td></tr>
<tr><td>Term</td><td colspan="2">Spring 2024</td></tr>
<tr><td>Instructor</td><td colspan="2">Ayaz Mammadov</td></tr>
<tr><td>E-mail:</td><td colspan="2">ayazmammadov@nkpi.az</td></tr>
<tr><td>Phone:</td><td colspan="2">+994772288877</td></tr>
<tr><td>Prerequisites</td><td colspan="3">Chemistry II</td></tr>
<tr><td>Language</td><td colspan="3">English</td></tr>
<tr><td>Compulsory/Elective</td><td colspan="3">Compulsory</td></tr>
<tr><td>Required textbooks and course materials</td><td colspan="3">Core textbooks
1. Arun Bahl, B. S. Bahl, G. D. Tuli, “Essentials of physical chemistry”. 2010
2. Raymond Chang, John W. Thoman, Jr. "Physical chemistry for the chemical sciences". 2014
Additional References
1. Peter Atkins, Julio de Paula, "Atkins’ physical chemistry". Eighth Edition, 2006
For class presentations and discussions, the student should utilize journal and internet materials. Moreover, the course does not limit the use of learning materials available at Khazar University library.</td></tr>
<tr><td>Course website</td><td colspan="3">This course is based on traditional face-to-face classes</td></tr>
<tr><td rowspan="4">Teaching methods</td><td colspan="2">Lecture</td><td>x</td></tr>
<tr><td colspan="2">Group discussion</td><td>x</td></tr>
<tr><td colspan="2">Research from internet</td><td>x</td></tr>
<tr><td colspan="2">Others</td><td>x</td></tr>
<tr><td rowspan="7">Evaluation</td><td>Methods</td><td>Date/deadlines</td><td>Percentage (%)</td></tr>
<tr><td>Midterm Exam</td><td>Week 7</td><td>30</td></tr>
<tr><td>Quizzes</td><td>Week 5</td><td>10</td></tr>
<tr><td>Presentation/Group work</td><td>Week 4-15</td><td>15</td></tr>
<tr><td>Participation</td><td>Every week</td><td>5</td></tr>
<tr><td>Final Exam</td><td></td><td>40</td></tr>
<tr><td>Total</td><td></td><td>100</td></tr>
<tr><td>Course outline</td><td colspan="3">The objective of this course is to provide the students with an understanding the primitive principals and terminology relevant to physical chemistry and it's application to engineering systems. This course introduces students to the core area of physical chemistry, based around the themes of systems, states and processes.</td></tr>
<tr><td>Course objectives</td><td colspan="3">Throughout this course, we will focus on the following learning objectives:
Calculate changes in thermodynamic properties associated with both phase transitions and chemical reactions. Calculate changes in thermodynamic properties as a result of changes in the environment (e.g. temperature and pressure). Mathematically derive thermodynamic equations. Qualitatively explain the quantitative relationships (equations) between thermodynamic properties. Evaluate different mechanisms proposed for quantum mechanical phenomena. Refine definitions of energy, entropy, heat, and work. Learning Nonelectrolyte and Electrolyte Solutions and their properties.</td></tr>
<tr><td>Learning outcomes</td><td colspan="3">By the end of the course the students should be able
-To apply the basis methods of physical Chemistry
-To apply the laws of thermodynamics and how they can be used for chemical systems.
- To perform problem solving strategies
-Apply the laws of thermodynamics to compute changes in observable physical propertiesfor specific processes.</td></tr>
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Policy		▪ **Participation** Actively participating in class discussions, asking questions, and contributing to group activities can enhance your understanding of complex concepts. It allows you to clarify doubts, exchange ideas, and learn from your peers and the instructor. Students lose 0.3 marks for each lesson they miss. ▪ **Quiz** Quizzes are a form of assessment that helps instructors gauge students' understanding of key concepts and topics. They provide a quick snapshot of whether students have grasped the material presented in lectures or readings. Students will have two quizzes (tests) during the course. They will get maximum 10 marks for quizzes. ▪ **Presentation/Group work** The field of analytical chemistry often involves collaborative projects and presentations in a professional setting. Engaging in group work and presentations during the class helps students develop skills that are directly transferable to their future careers. Students will present their work in the form of a presentation. ▪ **Withdrawal (pass/fail)** The School of Science and Engineering grading guidelines are carefully adhered to throughout this course. In order to pass, a student must typically receive a mark of at least 60%. If the student fails, the course must be retaken. ▪ **Cheating/plagiarism** Any form of plagiarism or cheating on a test, quiz, or project will result in the cancellation of the assignment. In this scenario, the student will receive a score of zero (zero) without any further consideration. ▪ **Professional behavior guidelines** During class hours, students are expected to conduct themselves in a way that fosters a positive academic and professional atmosphere. Discussions without permission and unethical conduct are absolutely forbidden. ▪ **Ethics** In class, students shouldn't be late. During class, all electronic devices must be put away and turned off.	
Week	**Topic**	**Topics**	**Textbook/Assignments**
1	1	**Structure of Atom–Classical Mechanics** Discovery of Electron, Measurement of e/m for Electrons, Determination of the Charge on an Electron, Positive Rays, Protons, Neutrons, Subatomic Particles, Alpha Particles, Rutherford’s Atomic Model, Mosley’s Determination of Atomic Number, Mass Number, Quantum Theory and Bohr Atom	[1] (1-35)
2,3	2	**Structure of Atom–Wave Mechanical Approach** Wave Mechanical Concept of Atom, de Broglie’s Equation, Heisenberg’s Uncertainty Principle, Schrödinger’s Wave Equation, Charge Cloud Concept and Orbitals, Quantum Numbers, Pauli’s Exclusion Principle, Energy Distribution and Orbitals, Distribution of Electrons in Orbitals, Representation of Electron, Configuration, Ground-state Electron Configuration of Elements, Ionisation Energy, Measurement of Ionisation Energies, Electron Affinity, Electronegativity. Isotopes, Isobars and Isotones	[1] (43-97)
4	3	**Chemical Bonding–Lewis Theory** Electronic Theory of Valence, Ionic Bond, Characteristics of Ionic Compounds, Covalent Bond, Conditions for Formation of Covalent Bonds, Characteristics of Covalent Compounds, Co-ordinate Covalent Bond, Differences Between Ionic and Covalent Bonds, Polar Covalent Bonds, Hydrogen Bonding (H-bonding), Examples of Hydrogen-bonded Compounds, Characteristics of Hydrogen-bond Compounds, Exceptions to the Octet Rule, Variable Valence, Metallic Bonding	[1] (151-178)

5	4	**Chemical Bonding–Orbital Concept** Valence Bond Theory, Nature of Covalent Bond, Sigma (σ) Bond, Pi (π) Bond, Orbital Representation of Molecules, Concept of Hybridization, Types of Hybridization, Hybridization involving *d* orbitals, Hybridization and Shapes of Molecules, sp^3 hybridization of Carbon, sp^2 hybridization of Carbon, sp hybridization of Carbon	[1] (193-211)
6	Review topics: 1-4		
7	**Midterm exam**		
8	5	**Gas Laws** Nature of Physical Chemistry, Some Basic Definitions An Operational Definition of Temperature Units: Force, Pressure, Energy Atomic Mass, Molecular Mass, and the Chemical Mole The Ideal Gas Law The Kelvin Temperature Scale, The Gas Constant *R* Dalton's Law of Partial Pressures Real Gases The van der Waals Equation, The Redlich–Kwong Equation The Virial Equation of State, Condensation of Gases and the Critical State	[2] (1-22)
9	6	**The First Law of Thermodynamics** Work and Heat The First Law of Thermodynamics Enthalpy, A Comparison of ΔU and ΔH, A Closer Look at Heat Capacities Gas Expansion, Isothermal Expansion, Adiabatic Expansion, The Joule–Thomson Effect Thermochemistry, Standard Enthalpy of Formation, Dependence of Enthalpy of Reaction on Temperature Bond Energies and Bond Enthalpies, Bond Enthalpy and Bond Dissociation Enthalpy	[2] (73-116)
10	7	**The Second Law of Thermodynamics** Spontaneous Processes Entropy, Statistical Definition of Entropy, Thermodynamic Definition of Entropy The Carnot Heat Engine, Thermodynamic Efficiency, The Entropy Function, Refrigerators, Air Conditioners, and Heat Pumps The Second Law of Thermodynamics Entropy Changes, Entropy Change due to Mixing of Ideal Gases, Entropy Change due to Phase Transitions, Entropy Change due to Heating The Third Law of Thermodynamics, Third-Law or Absolute Entropies Entropy of Chemical, Reactions The Meaning of Entropy, Isothermal Gas Expansion	[2] (129-160)
11	8	**Gibbs and Helmholtz Energies and Their Applications** Gibbs and Helmholtz Energies The Meaning of Helmholtz and Gibbs Energies, Helmholtz Energy, Gibbs Energy Standard Molar Gibbs Energy of Formation Dependence of Gibbs Energy on Temperature and Pressure, Dependence of *G* on Temperature, Dependence of *G* on Pressure Gibbs Energy and Phase Equilibria, The Clapeyron and the Clausius–Clapeyron Equations, Phase Diagrams, The Gibbs Phase Rule	[2] (175-196)
12	**Problem Solving**		

13	9	**Nonelectrolyte Solutions** Concentration Units, Percent by Weight, Mole Fraction, Molarity, Molality Partial Molar Quantities, Partial Molar Volume, Partial Molar Gibbs Energy Thermodynamics of Mixing Binary Mixtures of Volatile Liquids, Raoult's Law, Henry's Law Real Solutions, The Solvent Component, The Solute Component Phase Equilibria of Two-Component Systems, Distillation, Solid–Liquid Equilibria Colligative Properties, Vapor-Pressure Lowering	[2] (213-239)
14	10	**Electrolyte Solutions** Electrical Conduction in Solution, Some Basic Definitions, Degree of Dissociation, Ionic Mobility, Applications of Conductance Measurements A Molecular View of the Solution Process Thermodynamics of Ions in Solution, Enthalpy, Entropy, and Gibbs Energy of Formation of Ions in Solution Ionic Activity Debye–Hückel Theory of Electrolytes, The Salting-In and Salting-Out Effects Colligative Properties of Electrolyte Solutions	[2] (261-290)
15	**Review**		
	Final exam		

This syllabus is a guide for the course and any modifications to it will be announced in advance.