Syllabus
Inorganic and Physical Chemistry

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Course Description

This course of Inorganic and Physical Chemistry is studied by undergraduate medical students (General Medicine and Dentistry) during the first semester. Course has theoretical part of 9 lectures and lab practicum of 32 hours. As the course is introductory to the international students, it also shows the general university rules, facilitating the adaptation. The course has an optional e-supplementary which helps students to find the texts and to solve the tests.

Course Objectives

Students finished this course must be able to analyze, interpret and generalize the results of experimental and computational works of a chemical nature.

'Excellent' mark requirements:

Knows the theoretical foundations of the fundamental sections of inorganic, physical and colloid chemistry and the current state of chemistry, methods for interpreting the results of chemical experiments, observations and measurements, and summarizes the results obtained.

'Good' mark requirements:

Knows the theoretical foundations of the fundamental sections of inorganic, physical and colloid chemistry and the current state of chemistry, methods of interpreting the results of chemical experiments, observations and measurements.

'Satisfactory' mark requirements:

Knows the theoretical foundations of the fundamental sections of inorganic, physical and colloid chemistry, methods of interpreting the results of chemical experiments, observations and measurements.

Reading and Texts

1. Maliki Muniratu, *Introductory Chemistry*
2. Janice Gorzynski Smith, *Principles of General, Organic and Biological Chemistry*
3. Satyajit D. Sarker, *Chemistry for Pharmacy Students*
4. Peter Atkins, *Physical Chemistry*
5. Anatol Malijevsky, *Physical Chemistry in Brief*
6. Fred Basolo, *Coordination Compounds*
7. Dennis Prieve, *Physical Chemistry of Colloids and Surfaces*

Written work, Attendance, and Gradings

No mandatory tests are taken during the lectures, but the attendance can be checked by the Dean's office. Also, a good attendance is required for successful completion of the lab practicum.

There is no 'zachet' in this discipline, exam only. 50 points can be earned in during the lab practicum. The final exam gives another 50 points max. Thus, 100 points is the summary maximum. The final marks are distributed by criteria:

86-100 excellent
71-85 good
56-70 satisfactory
0-55 not passed.

Plagiarism

All works must be done individually except lab experiments which are designed for 2-3 students. But even these experiments require individual reports. Any contacts and cooperation during the final exam will result in immediate disqualification (0 points).

Themes

Lecture 1. **Basic concepts and laws of chemistry.**

The subject of chemistry. Chemistry and medicine. Modern content of concepts: atom, molecule, element, simple and complex matter. Allotropy. Mole. The law of conservation of mass of substances. The law of constancy of the composition, the conditions for its observance. Daltonides and berthollides. Avogadro's law. Mole volume. The Clapeyron-Mendeleev equation.

The most important classes of inorganic compounds: oxides (peroxides), acids, salts (normal, acidic, basic, double, mixed, complex). Oxidation-reduction reactions. Selection of coefficients by the electronic balance method.

Lecture 2. **The structure of the atom. Periodicity of properties of elements**

The structure of the Bohr-Sommerfeld atom. Quantum numbers. The principle of least energy. The Pauli principle. The Hund rule. Wave properties of an electron, the ratio of Louis de Broglie. Wave function. Electronic orbitals.

Periodic law and periodic system. Features of the filling of atomic orbitals. s-, p-, d-, f-elements. Periodicity of the properties of atoms. Radii of atoms and ions. Ionization potentials and the electron affinity energy, change by period and group. Electronegativity of elements and its variation by periods and groups. Secondary periodicity. The structure of the nucleus. Radioactivity.

Lecture 3. **Chemical bond and valence**

Development of the theory of chemical bond and valence. The theory of Kossel and Lewis. Quantum-chemical theories: the theory of valence bonds, the basic concepts of the theory of molecular orbitals (using the example of a hydrogen molecule).

Covalent bond and its properties: energy, length, coupling angle, saturation, directionality, polarizability. σ and π-bonds. Hybridization of orbitals. Dative bond. Metal, ionic, hydrogen bonds.

Lecture 4. **Intermolecular interaction (IMB)**

The forces of Van der Waals. Orientational, induction and dispersion interactions. The energy and nature of the IMB in comparison with the energy and nature of the chemical bond. Intermolecular hydrogen bond. Dependence of the physical properties of substances with the molecular structure on the nature of IMB. The influence of hydrogen bond on the physical properties of substances. Features of physical properties of water. Hydrophilic and lipophilic compounds.

Lecture 5. **Thermodynamics and Kinetics**

Chemical thermodynamics and chemical kinetics. Thermodynamic parameters and functions of the state of systems. The first law of thermodynamics. The standard enthalpy of the formation of substances. The concepts of entropy, Gibbs energy and its application to establish the direction of chemical reaction.

The rate of chemical processes. Law of mass action. Factors determining the rate of chemical reactions. Rate constant. Molecularity and order of reaction. Effect of temperature on the rate of chemical reaction. Activation energy. The Arrhenius equation. Catalysis and inhibition. The constant of chemical equilibrium. The Le Chatelier-Brown principle.

***Lecture 6.* Solutions and reactions in aqueous solutions**
Dispersed systems. Colloidal and true solutions. Dissolution as a physicochemical process. Water as a solvent. Solvation and hydration. Solvates and hydrates. Solubility of substances. Influence of temperature, pressure, nature of solutes and solvent on solubility. Henry's Law. Ways to express the composition of the solution: molarity, molality, mass and mole fractions and percentages. The phase diagram of water. Colligative properties of solutions.
Electrolytes and non-electrolytes. Electrolytic dissociation, mechanism of dissociation. Hydration of ions in solution. Strong and weak electrolytes. Molar conductivity, Grotthuss mechanism. Conductometric titration. The degree of dissociation of electrolytes, the influence of various factors on it. Dissociation constant. The Ostwald's dilution law. Theories of acids and bases by Arrhenius, Bronsted and Lewis.
The dissociation of water, the dissociation constant and the ion product. Hydrogen index (pH). The concept of buffer solutions.
Poorly soluble electrolytes. Solubility product. Effect of temperature, like ions and pH on the solubility of substances. Criteria for the formation of precipitation.
Hydrolysis of salts. Hydrolysis of salts by cation and anion. The mechanism of hydrolysis.

***Lecture 7.* Oxidation-reduction processes**
Oxidation-reduction (redox) reactions, their classification (intramolecular, intermolecular, self-oxidation-self-reduction). Redox potential, the causes of its occurrence (for example, a metal electrode in a solution of its salt). The Nernst equation. Standard and real potentials. The hydrogen electrode as a reference electrode. Galvanic cells. Electrochemical series of metal activity. Types of galvanic cells (metal, redox, concentration). Accumulators. Redox potential and the direction of redox reactions. Electrochemical corrosion of metals, ways of protection from it. Electrolysis of melts and solutions.

***Lecture 8.* Coordination (complex) compounds**
Werner's coordination theory: the central atom, ligands, coordination number, charge of the complex ion, outer and inner spheres. Typical complexing agents and ligands. Factors determining the ability of atoms and ions to act as a central atom and ligands. Denticity of ligands. Nomenclature of coordination compounds, isomerism. Stepwise and cumulative stability constants. Geometry of complexes. High- and low-spin complexes.

***Lecture 9.* Colloid chemistry**
Colloidal solutions. Surfactants (nonionic, anionic, cationic). Solutions of the surfactants, surface tension. Formation of micelles, influence of temperature, concentration, solvent polarity, additives. Coagulation and flocculation. Sorption.