I. I. Mechnikov Odesa National University
Faculty of Mathematics, Physics and Information Technologies
Department of Physics and Astronomy

Course Syllabus

Soft Matter Physics

Volume	4 credits, 120 hours.
Semester, year of study	1 semester, 1st year of study
Days, time, place	Friday at 13.00, room 16, Pastera st, 42
Teacher(s)	Prof. Malomuzh M.P.
Контактний телефон	0675206667
E-mail	mnp@onu.edu.ua
Workplace	room 16, Pastera 42 st
Consultations	Face-to-face consultations: Friday at 15.00, room 16, Pastera 42

COMMUNICATION

Communication with students: E-mail mnp@onu.edu.ua; Viber; Telegram, face-to-face meetings.

COURSE SUMMARY

The purpose of teaching the academic discipline is:

to familiarize students with the main results of modern research on the physics of water, as well as with the role that water plays in the emergence and maintenance of warm-blooded life.

The main objectives of studying the discipline are:

to form in students stable knowledge of the physics of water, as well as the ability to apply them to solving various applied problems.

To be able to use conceptual and specialized knowledge and understanding of current problems and achievements of selected areas of modern theoretical and experimental physics and/or astronomy to solve complex tasks and practical problems.

To choose and use appropriate methods of processing and analyzing data from physical and/or astronomical research and assessing their reliability.

To carry out a phenomenological and theoretical description of the studied physical and/or astronomical phenomena, objects and processes.

Analyze and summarize scientific results in the chosen field of physics and/or astronomy, track the latest achievements in this field, communicating with colleagues in a mutually beneficial manner.

Find information and data necessary to solve complex problems in physics and/or astronomy, using various sources, in particular, scientific publications, scientific databases, etc., evaluate and critically analyze the information and data obtained.

COURSE DESCRIPTION

Forms and methods of study

The course will be taught in the form of lectures (40 hours) and the organization of independent work of students (80 hours).

The following forms of work are used during teaching the discipline - lecture and independent work. During lectures and practical classes, the following teaching methods are used: explanatory-illustrative method; information-receptive; reproductive method (reproduction-reproduction); problem-based presentation method; partial-search method.

During independent work, the research method is used (the student masters the literature on the specified topic), on the topic of the INDS makes a presentation and report).

Content of the academic discipline

1. Thermodynamic and kinetic properties of water and aqueous solutions

Topic I. Thermodynamic properties of water

1. Phase diagram of water;
2. Normal, superheated and supercooled water;
3. Anomalous behavior of density, compressibility and heat capacity of water;
4. Features of intermolecular interaction;
5. Equation of state of water;
6. Comparison of the properties of water and argon;
7. Water-salt solutions;
8. Water-alcohol solutions;
9. Behavior of contraction of solutions.

Topic II. Dielectric properties of water

1. The magnitude and temperature dependence of the dielectric permittivity of water;

2. Frequency dependence of the dielectric constant of water;
3. Features of dipole relaxation in water;
4. Refractive index of water and aqueous solutions.

Topic III. Kinetic properties of water

1. Temperature dependence of self-diffusion coefficients and viscosity;
2. Thermal conductivity of water;
3. Conductivity of water and salt solutions;
4. Scattering of light and neutrons in water;
5. Features of thermal motion of molecules in water and argon.

2. Clustering of water as a necessary condition for the existence of living

I. Clustering of molecules of liquid water and steam

1. Dimers, trimers and multimers of water;
2. Dimerization of water vapor;
3. Thermal excitations of dimers and clusters of higher order;
4. Dielectric permittivity and heat capacity of water vapor as a set of clusters;
5. General approach to the description of the dielectric properties of water;
6. Effective polarizability of liquid water molecules;
7. Dielectric permittivity of liquid water;
8. The time of the settled life of liquid water molecules;
9. The structure of liquid water from the point of view of the clustering pattern and the nature of the thermal motion of molecules in it.

II. Modern view of the problems of transport in liquid water

1. Collective transport of molecules and ions in water;
2. Transport of molecules and features of their rotational motion in supercooled water;
3. Shear viscosity of normal and supercooled water;
4. The role of hydration effects in transport processes;
5. Methods of water purification.

III. Manifestation of water properties in living matter

1. The upper limit of the existence of living things as the limit of the existence of crystalline water;

2. Features of water clustering within the temperature interval of the existence of living things;

3. pH of water, its temperature dependence and effect on oxygen transport by erythrocytes;

4. Erythrocyte as an internal combustion engine;

5. Oscillatory motion of DNA helices in the cellular aqueous environment;

6. The lower limit of the existence of living matter as a result of the formation of nanoscopic clusters in cellular water;

7. Why is the temperature of the human liver equal to 42 C?

Recommended reading

1. Bulavin L.A., Lokotosh T.V., Malomuzh N.P. Role of collective self-diffusion in water and other liquids, J.Mol.Liq. – 2008 – 137. – P. 1–24.
2. L.A.Bulavin, N.P.Malomuzh. Upper temperature limit for the existence of the alive matter // JML (Letter to the Editor) – 124 (2006) 136.
3. Махлайчук П.В. Роль водневих зв'язків у формуванні властивостей води/ дисертація на здобуття ступеню кандидата фізико-математичних наук, Одеса – 2013.
4. A.I.Fisenko and N.P.Malomuzh. To what extent is water responsible for the maintenance of the life for warm-blooded organisms // Int.J.Mol.Sc. – 10 (2009) 2383-2411
5. A.I.Fisenko and N.P.Malomuzh. Role of the H-bond network in the creation of life-giving properties of water// Chem.Phys. - 345 (2008) 164-172.

ASSESSMENT

The academic discipline "Physics of Water and Hydrogen Bonded Systems" is assessed on a 100-point scale.

Methods of current control: Current control is carried out based on the results of the current survey on control questions.

Periodic control is carried out in the form of two control papers on course topics. The student's activity in the course is also assessed: oral questioning at lectures, solving practical problems, performing control papers.

The final semester grade is determined based on the results of current and periodic controls.

Final semester control - credit. The final semester control is carried out orally on questions submitted to prepare for the current and final controls.

Final control assessment criteria

Theoretical question assessment criteria:

– full detailed answer – 12 points;

– full, but not detailed answer – 10 points;

– a complete but not expanded answer that contains a minor error or contradiction – 9 points, 1 point is deducted for each subsequent minor error or contradiction;

– an incomplete answer that does not contain critical errors or contradictions – 5 points,

1 point is deducted for each subsequent minor error or contradiction;

– an answer that contains a critical error or inaccuracy, or the absence of an answer is evaluated at 0 points.

The number of points that the applicant received in the exam is the sum of the points that were received for each task on the exam ticket.

The final grade is given by the sum of the points of the current and final control according to the scale given below.

Distribution of points received by applicants

<table>
<tr><td colspan="2">Current control</td><td rowspan="2">Final control</td><td rowspan="2">Total points</td></tr>
<tr><td colspan="2">Content module 1</td></tr>
<tr><td>Lectures</td><td>Test work</td><td rowspan="2">24</td><td rowspan="2">100</td></tr>
<tr><td>16</td><td>60</td></tr>
</table>

Independent work of students. Forms of independent work of students are: preparation of theoretical material based on lecture materials, basic and additional recommended literature. The purpose of independent work of the student is to provide solid knowledge of theoretical material, acquire practical skills in solving problems and conduct experimental research in atomic physics.

The evaluation criteria are: completeness of the presented material, quality of the report and presentation, answers to questions of the teacher and fellow students.

The results of independent work on the preparation of theoretical material are assessed by the quality of the performance of current tests.

The deadlines for submission/performance of independent work tasks are determined by the teacher.

COURSE POLICY

Determined by regulatory documents/Regulations that are in force at I.I. Mechnikov ONU (https://onu.edu.ua/uk/geninfo/official-documents).

The deadline for completing course tasks is determined by the teacher. In case of good reasons, the teacher allows the postponement of the deadline for completing tasks. Recalculation of debts - with the permission of the dean's office.

Each student must remember about academic integrity, which is ensured by independent performance of educational tasks, tasks of current and final control, proper reference to sources of information in the case of performing creative works, compliance with the norms of the legislation on copyright and related rights, provision of reliable information about the results of their own scientific activities.

For violation of academic integrity, students may be held academically liable in accordance with the Regulation on Academic Integrity at I.I. Mechnikov ONU. (https://onu.edu.ua/pub/bank/userfiles/files/documents/acad-dobrochesnost.pdf).