**SYLLABUS**

**Fall semester 2020-2021 academic years**

**on the educational program “Selected problems in the physics of non-ideal plasma”**

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| **Discipline’s code** | **Discipline’s title** | **Independent work of students (IWS)** | **No. of hours per week** | | | | | **Number of credits** | | **Independent work of student with teacher (IWST)** |
| **Lectures (L)** | **Practical training (PT)** | | **Laboratory (Lab)** | |
| **IVFNP 7702** | Selected problems of non-ideal plasma physics | 98 | 15 | 30 | | - | | 5 | | 7 |
| **Academic course information** | | | | | | | | | | |
| **Form of education** | **Type of course** | **Types of lectures** | | | **Types of practical training** | | **Number of IWS** | | | **Form of final control** |
| Offline | Theoretical | Problematic,  analytical | | | Problem solving,  situational tasks | | 6 | | | Writing exam |
| Lecturer | Prof. Dr. Tlekkabul Ramazanov | | | | | | **Of./p.** | | By schedule | |
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| Telephone number | 377-31-89 | | | | | |

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| **Academic presentation of the course** |

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| **Aim of course** | **Expected Learning Outcomes (LO)**  As a result of studying the discipline the PhD student will be able to: | **Indicators of LO achievement (IA)**  (for each LO at least 2 indicators) |
| Know and understand properties of complex plasma | Explain the essence of the current state of development of the physics of dusty plasma | Understand basic concepts about nonideal plasma |
| Classify different effects in plasma |
| Solve various problems with the properties of a complex plasma based on modern theories | Apply dynamic methods of nonideal plasma |
| Calculate a radial distribution function on the basis of expansion by small parameter. |
| Calculate the properties of complex plasma | Use ionization equilibrium and composition of nonideal plasma |
| Apply Ornstein-Zernike equationfor a radial distribution function |
| Evaluate the model of interaction between particles | Derive equation for effective charge-charge potential, which takesinto account the screening and quantum mechanical effects |
| Find the degeneration parameter for semiclassical plasma |
| Describe the basic theoretical methods at investigation of ionization equilibrium | Determine parameters and structures characterizes a dusty plazma |
| UseSaha equation for composition of semiclassical nonideal plasma |
| **Prerequisites** | “Probability theory”, "Electricity and magnetism", “Thermodynamics and statistical physics”, and "Introduction to plasma physics" and "Physics of nonideal plasma". | |
| **Post requisites** | Scientific-research work of doctorate | |
| **Information resources** | 1. T.S. Ramazanov, K.N. Dzhumagulova, [Phys. Plas. 9, 3758](http://dx.doi.org/10.1063/1.1499497) (2002). 2. T.S. Ramazanov, K.N. Dzhumagulova, M.T. Gabdullin, Phys. Plasm. 17, 042703 (2010). 3. T.S.Ramazanov, K.N. Dzhumagulova, Yu.A. Omarbakiyeva, [Phys. Plasm. 12, 092702](http://dx.doi.org/10.1063/1.2008213) (2005). 4. Baimbetov F.B., Ramazanov T.S. Mathematical simulation in nonideal plasma physics. Almaty. Scinse. 1994.-212 P. (Monograph). 5. Hansen J.-P. Statistical mechanics of dense plasmas. (Review). Amsterdam. 1982. 6. Ichimaru S., Iyetomi H., Tanaka S. Statistical physics of dense plasmas. Physics Reports. 1987. V.149. No.2-3. W. Ebeling, W.-D. Kraeft, D. Kremp, Theory of bound states and ionization equilibrium in plasmas and solids (Akademie-Verlag, Berlin, 1976). 7. W. Ebeling, W.-D. Kraeft, D. Kremp, Theory of bound states and ionization equilibrium in plasmas and solids (Akademie-Verlag, Berlin, 1976).R. Redmer, Phys. Rep. 282, 35 (1997). 8. R. Redmer, G. Röpke, Contrib. Plasma Phys. 29, 343 (1989). 9. R.Redmer, Phys. Rev. E 59 1073-1081 (1999). 10. S. Kuhlbrodt, R. Redmer, Phys. Rev. E. 62, 7191 (2000). 11. B.M. Smirnov, Physics of atom and ion (Moscow, Nauka 1986). 12. G.I. Kerley, J. Chem. Phys. 85, № 9 5228-5231 (1986). | |

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| **Academic policy of the course in the context of university moral and ethical values** | **Academic Behavior Rules:**  All students have to register at the MOOC. The deadlines for completing the modules of the online course must be strictly observed in accordance with the discipline study schedule.  ATTENTION! Non-compliance with deadlines leads to loss of points! The deadline of each task is indicated in the calendar (schedule) of implementation of the content of the curriculum, as well as in the MOOC.  **Academic values:**  - Practical trainings/laboratories, IWS should be independent, creative.  - Plagiarism, forgery, cheating at all stages of control are unacceptable.  - Students with disabilities can receive counseling at e-mail \*\*\*\*\*\*\*@gmail.com. |
| **Evaluation and attestation policy** | **Criteria-basedevaluation:**  assessment of learning outcomes in relation to descriptors (verification of the formation of competencies in midterm control and exams).  **Summativeevaluation:** assessment of work activity in an audience (at a webinar); assessment of the completed task. |

**CALENDAR (SCHEDULE) THE IMPLEMENTATION OF THE COURSE CONTENT:**

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| --- | --- | --- | --- | --- | --- | --- | --- |
| weeks | Topic name | LO | ID | Amountof hours | Maximum score | Form of Knowledge Assessment | The  Form of the lesson  / platform |

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| Module **1**The effective potentials of nonideal plasma. | | | | | | | |
| 1 | **L.1** Basic Сoncepts about Nonideal Plasma. Different Effects in a Plasma. | LО 1 | ID 1.1. | 2 |  |  | offline |
| 1 | **PT 1**To dimension the Relations between Plasma Parameters, such as Debye Radius, Average Distance between Particles and de Broglie Wave-Length. | LО 1 | ID 1.2. | 1 | 8 | Analysis | offline |
| 2 | **L.2** Basic Сoncepts about Nonideal Plasma. “Charge-Charge” Interactions in Nonideal Plasma. | LО 1 | ID 1.1-1.2. | 2 |  |  | offline |
| 2 | **PT 2** To dimension the effective potentials of “Charge-Charge” interactions | LО 1 | ID 1.1. | 1 | 8 | Analysis | offline |
| 3 | **L.3** Basic Сoncepts about Nonideal Plasma. “Charge-Atom”Interactions in Nonideal Plasma. | LО 1 | ID 1.2. |  |  |  | offline |
| 3 | **PT 3** To dimension the effective potentials of “Charge-Atom” interactions. | LО 1 | ID1.1. |  | 8 |  | offline |
| 3 | **IWSP 1 Consultation on the implementation of IWS1** | LО 1 | ID1.2. |  | 5 |  | offline |
| 3 | **IWS 1.** To derive equation for effective charge-charge potential, which take into account the screening and quantum mechanical effects | LО 2 | ID 1.1-1.2. |  | 20 | Logictask | offline |
| **Module П** | | | | | | | |
| 4 | **L.4** Electrical Methods of Nonideal Plasma Generation | LО 3 | ID 1.1-1.2. | 1 |  |  | offline |
| 4 | **PT 4** Composition of ideal plasma on the basis of the Saha equation | LО 1 | ID 1.1-1.2. |  | 8 |  | offline |
| 5 | **L.5** Lecture 5. Dynamic Methods of Nonideal Plasma Generation, Shock waves expieriments. | LО 4 | ID 1.1-1.2. |  |  |  | offline |
| 5 | **PT 5** The Lowering of Ionization Potential. | LО 1 | ID2.1. |  | 8 |  | offline |
| 5 | **IWSP 2 Consultation on the implementation of IWS2** | LО 1 | ID2.1. |  | 5 |  | offline |
| 5 | **IWS2** Degeneration parameter for semiclassical plasma. | LО 4 | ID2.1. |  | 20 | Logictask | offline |
| 5 | **Make a structural and logical diagram of the readmaterial** | LО 1 | ID2.2. |  | 10 |  | offline |
| 5 | **MT 1** | LО 1 | ID3.1. |  | 100 |  |  |
| 6 | **L.6** Ionization equilibrium and Composition of Nonideal Plasma. | LО 1 | ID2.2. | 2 |  |  | offline |
| 6 | **PT 6** Composition of Classical Nonideal Plasma on the Basis of the Saha Equation with Taking into Account the Lowering of Ionization Potential. | LО 1 | ID2.1-2.2. | 1 | 8 | Analysis | offline |
| 7 | **L.7** Thermodynamic Properties of a Nonideal Plasma. | LО 1 | ID3.2. |  |  |  | offline |
| 7 | **PT 7** Composition of Semiclassical Nonideal Plasma on the Basis of the Saha Equation with Taking into Account the Lowering of Ionization Potential. | LО 5 | ID3.1-3.2. | 1 | 8 | Analysis | offline |
| 8 | **L.8** Structural Properties of a Nonideal Plasma. Radial distribution function. | LО 1 | ID3.1-3.2. | 2 |  |  | offline |
| 8 | **PT 8** To Calculate a Radial Distribution Function on the Basis of Expansion by small parameter. | LО 1 | ID3.1-3.2. |  | 8 | Analysis | offline |
| 8 | **IWSP 3 Consultation on the implementation of IWS3** | LО 1 | ID3.1-3.2. |  | 5 |  | offline |
| 8 | **IWS 3** To derive equation for lowering of ionization potential of semiclassical nonideal hydrogen plasma. | LО 1 | ID3.1-3.2. |  | 25 | Logictask | offline |
| 9 | **L.9** Ornstain-Zernike Equations for Nonideal Plasma. | LО 1 | ID3.1-3.2. |  |  |  | offline |
| 9 | **PT 9** To Calculate a Radial Distribution Function on the Basis of Ornstain-Zernike Equations. | LО 1 | ID4.1. | 2 | 8 | Analysis | offline |
| 10 | **L.10** Transport Properties of a Nonideal Plasma by Molecular Dynamics Simulation. | LО 1 | ID4.1. | 2 |  |  | offline |
| 10 | **PT 10** To analyze derived results. | LО 1 | ID4.1. |  | 8 | Analysis | offline |
| 10 | **IWSP 4 Consultation on the implementation of IWS4** | LО 1 | ID4.1. |  | 5 |  | offline |
| 10 | **IWS 4** Ornstain-Zernike Equations for Nonideal Plasma. | LО 1 | ID4.2. |  | 15 | Problem task | offline |
| 10 | **IWSP 5**  **Make a structural and logical diagram of the read material** | LО 1 | ID4.1. |  | 10 |  | offline |
| 10 | **МТ (MidtermExam)** | LО 1 | ID4.2. |  | 100 |  | offline |
| 11 | **L.11** Basic Сoncepts about Dusty Plasma. | LО 1 | ID4.2. |  |  |  | offline |
| 11 | **PT 11** A Determination of Parameters and Structure Characterizes of a Dusty Plasma. | LО 1 | ID4.2. | 1 | 8 | Analysis | offline |
| 12 | **L.12**Processes and Mechanisms Charging of Dusty Particles. | LО 1 | ID4.2. | 1 |  |  | offline |
| 12 | **PT 12** A Determination of Parameters and Structure Characterizes of a Dusty Plasma. | LО 1 | ID4.2. | 1 | 8 | Analysis | offline |
| 12 | **IWSP 6 Consultation on the implementation of IWS5** | LО 1 | ID4.2. |  | 5 |  | offline |
| 12 | **IWS5** A Determination of Parameters and Structure Characterizes of a Dusty Plasma. | LО 1 | ID4.2. |  | 25 | Problem task | offline |
| 13 | **L.13** Experimental methods Generated Dusty plasma. | LО 1 | ID4.2. | 1 |  |  | offline |
| 13 | **PT 13** A Determination of Parameters and Structure Characterizes of a Dusty Plasma. | LО 1 | ID5.1. | 1 | 8 | Analysis | offline |
| 14 | **L.14**A Determination of Parameters and Structure Characterizes of a Dusty Plasma. | LО 1 | ID5.1. | 1 |  |  | offline |
| 14 | **PT 14**A Determination of Parameters and Structure Characterizes of a Dusty Plasma. | LО 1 | ID5.1. | 1 | 8 | Analysis | offline |
| 15 | **L.15**Application of Dusty Plasmas. | LО 1 | ID5.1. | 1 |  |  | offline |
|  | **PT 15**A Determination of Parameters and Structure Characterizes of a Dusty Plasma. | LО 1 | ID5.1. | 1 | 8 | Analysis | offline |
|  | **IWSP 7 Consultation on the implementation of IWS6** | LО 5 | ID 5.2. |  | 5 |  | offline |
|  | **IWS6** Degeneration parameter for semiclassical plasma. | LО 1 | ID5.2. |  | 15 | Analysis | offline |
|  | **Тест** | LО 1 | ID5.2. |  | 10 |  | offline |
|  | **MT 2** | LО 1 | ID5.2. |  | 100 |  |  |

[Abbreviations: QS - questions for self-examination; TK - typical tasks; IT - individual tasks; CW - control work; MT - midterm.

Comments:

- Form of L and PT: webinar in MS Teams / Zoom (presentation of video materials for 10-15 minutes, then its discussion / consolidation in the form of a discussion / problem solving / ...)

- Form of carrying out the CW: webinar (at the end of the course, the students pass screenshots of the work to the monitor, he/she sends them to the teacher) / test in the Moodle DLS.

- All course materials (L, QS, TK, IT, etc.) see here (see Literature and Resources, p. 6).

- Tasks for the next week open after each deadline.

- CW assignments are given by the teacher at the beginning of the webinar.]

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**Chairman of the Faculty Methodical Bureau A. T. Gabdullina**

**Head of the Department S. K. Kodanova**

**Lecturer T. S. Ramazanov**