**SYLLABUS**

**Fall semester 2023-2024 academic year**

**Educational program ""**

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| **ID**  **and name**  **of course** | **Independent work**  **of the student**  **(IWS)** | | **Number of credits** | | | **General**  **number**  **of credits** | **Independent work**  **of the student**  **under the guidance**  **of a teacher (IWST)** |
| **Lectures (L)** | **Practical classes (PC)** | **Lab. classes (LC)** |
| Partial differential equations |  | | 2 | 2 |  | 4 |  |
| **ACADEMIC INFORMATION ABOUT THE COURSE** | | | | | | | |
| **Learning Format** | **Cycle,**  **component** | **Lecture**  **types** | | **Types**  **of practical classes** | | **Form and platform final control** | |
| Offline |  |  | |  | | standard oral exam | |
| **Lecturer - (s)** | S. Ya. Serovajsky, doctor of science, professor | | | | |
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| **Assistant - (s)** |  | | | | |
| **e-mail :** |  | | | | |
| **Phone :** |  | | | | |
| **ACADEMIC COURSE PRESENTATION** | | | | | | | |
| **Purpose**  **of the course** | **Expected Learning Outcomes (LO) \*** | | | | | **Indicators of LO achievement (ID)** | |
| The main aim of the course is to familiarize students with the fundamental concepts of partial differential equation | LO1 Introduction | | | | | ID1.1 Ordinary differential equations | |
| ID1.2 First order partial differential equations | |
| ID1.3 Reduction of partial differential equations to the canonical form | |
| LO2 Hyperbolic equations | | | | | ID2.1 Cauchy problem for the vibrating string equation | |
| ID2.2 Vibrating of string with fixed ends | |
| ID2.3 Vibrating string equation with free ends | |
| ID2.4 Forced vibrations of the string | |
| LO3 Parabolic equations | | | | | ID3.1 Heat equation with known temperature at the boundary | |
| ID3.2 Heat equation with known heat flux through the boundary | |
| ID3.3 Heat equation in the presence of heat sources | |
| LO4 Elliptic equations | | | | | ID4.1 Variational method in mathematical physics problems | |
| ID4.2 Laplace equation in a circle | |
| ID4.3 Green function method | |
| LO5 Approximate solving and inverse problems | | | | | ID5.1 Finite difference method | |
| ID5.2 Inverse problems of mathematical physics. | |
| **Prerequisites** | Mathematical analysis, differential equations, numerical methods | | | | | | |
| **Postrequisites** | Special courses | | | | | | |
| **Learning Resources** | 1. [Polyanin, A.D.](https://en.wikipedia.org/wiki/Andrei_Polyanin) Handbook of Linear Partial Differential Equations for Engineers and Scientists, Boca Raton: Chapman & Hall/CRC Press, 2002. 2. Tikhonov, A.N.; Samarskii, A.A. Equations of Mathematical Physics. – New York, Dover Publ., 1990. 3. Stakgold I. Boundary value problems of mathematical physics. – Philadelphia: SIAM, 2000. 4. Boas M. [Mathematical Methods in the Physical Sciences](https://en.wikipedia.org/wiki/Mathematical_Methods_in_the_Physical_Sciences), Hoboken: John Wiley & Sons, 2006. 5. Roubíček, T., [Nonlinear Partial Differential Equations with Applications](https://cds.cern.ch/record/880983/files/9783764372934_TOC.pdf). International Series of Numerical Mathematics, vol. 153 (2nd ed.), Basel, Boston, Berlin: Birkhäuser, 2013. 6. Kusse B. Mathematical Physics: Applied Mathematics for Scientists and Engineers. – Germany: Wiley-VCH, 2006. 7. Courant R., Hilbert D. [Methods of Mathematical Physics](https://en.wikipedia.org/wiki/Methods_of_Mathematical_Physics), New York: Interscience Publishers, 1989. 8. [Evans, L.C.](https://en.wikipedia.org/wiki/Lawrence_C._Evans) Partial Differential Equations, Providence: American Mathematical Society, 1998. 9. Drábek, P.; Holubová, G. Elements of partial differential equations. Berlin: de Gruyter, 2007. 10. Wazwaz, A. Partial Differential Equations Methods and Applications. A.A. Balkema,  2002. | | | | | | |

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| **Academic**  **course policy** | | The academic policy of the course is determined by [the Academic Policy](https://univer.kaznu.kz/Content/instructions/%D0%90%D0%BA%D0%B0%D0%B4%D0%B5%D0%BC%D0%B8%D1%87%D0%B5%D1%81%D0%BA%D0%B0%D1%8F%20%D0%BF%D0%BE%D0%BB%D0%B8%D1%82%D0%B8%D0%BA%D0%B0.pdf) and [the Policy of Academic Integrity of Al-Farabi Kazakh National University .](https://univer.kaznu.kz/Content/instructions/%D0%9F%D0%BE%D0%BB%D0%B8%D1%82%D0%B8%D0%BA%D0%B0%20%D0%B0%D0%BA%D0%B0%D0%B4%D0%B5%D0%BC%D0%B8%D1%87%D0%B5%D1%81%D0%BA%D0%BE%D0%B9%20%D1%87%D0%B5%D1%81%D1%82%D0%BD%D0%BE%D1%81%D1%82%D0%B8.pdf)  Documents are available on the main page of IS Univer .  **Integration of science and education.** The research work of students, undergraduates and doctoral students is a deepening of the educational process. It is organized directly at the departments, laboratories, scientific and design departments of the university, in student scientific and technical associations. Independent work of students at all levels of education is aimed at developing research skills and competencies based on obtaining new knowledge using modern research and information technologies. A research university teacher integrates the results of scientific activities into the topics of lectures and seminars (practical) classes, laboratory classes and into the tasks of the IWST, IWS, which are reflected in the syllabus and are responsible for the relevance of the topics of training sessions andassignments.  **Attendance.** The deadline for each task is indicated in the calendar (schedule) for the implementation of the content of the course. Failure to meet deadlines results in loss of points.  **Аcademic honesty.** Practical/laboratory classes, IWS develop the student's independence, critical thinking, and creativity. Plagiarism, forgery, the use of cheat sheets, cheating at all stages of completing tasks are unacceptable.  Compliance with academic honesty during the period of theoretical training and at exams, in addition to the main policies, is regulated by [the "Rules for the final control"](https://univer.kaznu.kz/Content/instructions/%D0%9F%D1%80%D0%B0%D0%B2%D0%B8%D0%BB%D0%B0%20%D0%BF%D1%80%D0%BE%D0%B2%D0%B5%D0%B4%D0%B5%D0%BD%D0%B8%D1%8F%20%D0%B8%D1%82%D0%BE%D0%B3%D0%BE%D0%B2%D0%BE%D0%B3%D0%BE%20%D0%BA%D0%BE%D0%BD%D1%82%D1%80%D0%BE%D0%BB%D1%8F%20%D0%9B%D0%AD%D0%A1%202022-2023%20%D1%83%D1%87%D0%B3%D0%BE%D0%B4%20%D1%80%D1%83%D1%81%D1%8F%D0%B7%D1%8B%D0%BA%D0%B5.pdf) , ["Instructions for the final control of the autumn / spring semester of the current academic year"](https://univer.kaznu.kz/Content/instructions/%D0%98%D0%BD%D1%81%D1%82%D1%80%D1%83%D0%BA%D1%86%D0%B8%D1%8F%20%D0%B4%D0%BB%D1%8F%20%D0%B8%D1%82%D0%BE%D0%B3%D0%BE%D0%B2%D0%BE%D0%B3%D0%BE%20%D0%BA%D0%BE%D0%BD%D1%82%D1%80%D0%BE%D0%BB%D1%8F%20%D0%B2%D0%B5%D1%81%D0%B5%D0%BD%D0%BD%D0%B5%D0%B3%D0%BE%20%D1%81%D0%B5%D0%BC%D0%B5%D1%81%D1%82%D1%80%D0%B0%202022-2023.pdf) , "Regulations on checking students' text documents for borrowings".  Documents are available on the main page of IS Univer .  **Basic principles of inclusive education.** The educational environment of the university is conceived as a safe place where there is always support and equal attitude from the teacher to all students and students to each other, regardless of gender, race / ethnicity, religious beliefs, socio-economic status, physical health of the student, etc. All people need the support and friendship of peers and fellow students. For all students, progress is more about what they can do than what they can't. Diversity enhances all aspects of life.  All students, especially those with disabilities, can receive counseling assistance by phone / e- mail enter *teacher's contacts* or via video link in MS Teams *enter a permanent link to the meeting.*  **Integration MOOC (massive open online course).** In the case of integrating MOOC into the course, all students need to register for MOOC. The deadlines for passing MOOC modules must be strictly observed in accordance with the course study schedule.  **ATTENTION!** The deadline for each task is indicated in the calendar (schedule) for the implementation of the content of the course, as well as in the MOOC. Failure to meet deadlines results in loss of points. | | | | |
| **INFORMATION ABOUT TEACHING, LEARNING AND ASSESSMENT** | | | | | | |
| **Score-rating letter system of assessment of accounting for educational achievements** | | | | | **Assessment Methods** | |
| **Grade** | **Digital**  **equivalent**  **points** | | **points,**  **% content** | **Assessment according to the traditional system** | **Criteria-based assessment** is the process of correlating actual learning outcomes with expected learning outcomes based on clearly defined criteria. Based on formative and summative assessment.  **Formative assessment is** a type of assessment that is carried out in the course of daily learning activities. It is the current measure of progress. Provides an operational relationship between the student and the teacher. It allows you to determine the capabilities of the student, identify difficulties, help achieve the best results, timely correct the educational process for the teacher. The performance of tasks, the activity of work in the classroom during lectures, seminars, practical exercises (discussions, quizzes, debates, round tables, laboratory work, etc.) are evaluated. Acquired knowledge and competencies are assessed.  **Summative assessment** -type of assessment, which is carried out upon completion of the study of the section in accordance with the program of the course.Conducted 3-4 times per semester when performing IWS. This is the assessment of mastering the expected learning outcomes in relation to the descriptors. Allows you to determine and fix the level of mastering the course for a certain period. Learning outcomes are evaluated. | |
| A | 4.0 \_ | | 95-100 | Great |
| A- | 3.67 | | 90-94 |
| B+ | 3.33 | | 85-89 | Fine |
| B | 3.0 | | 80-84 | **Formative and summative assessment**  The teacher introduces his own types of assessment or uses the proposed option | **Points % content**  The teacher enters his score into points in accordance with the calendar (schedule).  The exam does not change  and the final score in the course. |
| B- | 2.67 | | 75-79 | Activity at lectures | 5 |
| C+ | 2.33 | | 70-74 | Work in practical classes | 20 |
| C | 2.0 | | 65-69 | Satisfactorily | Independent work | 25 |
| C- | 1.67 | | 60-64 | Design and creative activity | 10 |
| D+ | 1.33 | | 55-59 | Unsatisfactory | Final control (exam) | 40 |
| D | 1.0 | | 50-54 | TOTAL | 100 |
| **Calendar (schedule) for the implementation of the content of the course. Methods of teaching and learning.** | | | | | | |

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| --- | --- | --- | --- |
| **A week** | **Topic name** | **Number of hours** | **Max.**  **ball** |
| **MODULE 1 Introduction** | | | |
| **1** | **L 1 Ordinary and partial differential equations**. General definitions. First order partial differential equations | 2 | 2 |
| **Seminar 1.** First order partial differential equations | 2 | 2 |
| **PC 1.** Ordinary differential equations |  | 8 |
| **2** | **L 2. Partial differential equations as mathematical models.** Heat equation. Wave equation. Poisson equation. | 2 | 2 |
| **PC 2.** First order partial differential equations. | 2 | 2 |
| **LC 2.** First order partial differential equations. |  | 8 |
| **IWS P 1.** Consultations on the implementation of **IWST 1** |  |  |
| **3** | **L 3. Classification of partial differential equations to the canonical form.** Reduction of partial differential equations to the canonical form | 2 | 2 |
| **PC 3.** Reduction of partial differential equations to the canonical form | 2 | 2 |
| **LC 3.** Reduction of partial differential equations to the canonical form |  | 8 |
| **IWST 1. Reduction of partial differential equations to the canonical form** |  | 8 |
| **MODULE 2 Hyperbolic equations** | | | |
| **4** | **L 4 Cauchy problem for the vibrating string equation.** Movement of unlimited string. Cauchy problem for the vibrating string equation. D'Alembert method. Running waves | 2 | 2 |
| **PC 4.** Cauchy problem for the vibrating string equation | 2 | 2 |
| **LC 4.** Cauchy problem for the vibrating string equation |  | 8 |
| **5** | **L 5. Vibrating string equation with fixed ends.** First boundary value problem for the vibrating string equation. Method of variable separation. Sturm – Liouville problem. Solution of the first boundary value problem for the vibrating string equation. | 2 | 2 |
| **PC 5.** Vibrating of string with fixed ends | 2 | 2 |
| **LC 5.** Vibrating of string with fixed ends |  | 8 |
| **6** | **L 6. Vibrating string equation with free ends** Problem statement. Second boundary value problem for the vibrating string equation. Method of variable separation. Sturm – Liouville problem. Solution of the second boundary value problem for the vibrating string equation. | 2 | 2 |
| **PC 6.** Vibrating string equation with free ends | 2 | 2 |
| **LC 6.** Vibrating string equation with free ends |  | 8 |
| **IWST 2.** Consultations on the implementation of **IWS 2** |  |  |
| **7** | **L 7. Forced vibrating of the string.**Inhomogeneous vibrating string equation.Fourier method. Solution of boundary value problems for the inhomogeneous vibrating string equation. | 2 | 2 |
| **PC 7.** Forced vibrations of the string | 2 | 2 |
| **LC 7.** Forced vibrations of the string |  | 8 |
| **IWS 2. Fourier method for hyperbolic equations** |  | **8** |
| **Midterm control** | | | **100** |
|  | | |  |
| **MODULE 3 Parabolic equations** | | | |
| **8** | **L 8. Heat equation with known temperature at the boundary***.* First boundary problem for the heat equation. Method of variable separation. Sturm – Liouville problem. Solution of the first boundary value problem for the heat equation. | 2 | 1 |
| **PC 8.** Heat equation with known temperature at the boundary | 2 | 2 |
| **LC 8.** Heat equation with known temperature at the boundary |  | 7 |
| **9** | **L 9. Heat equation with known heat flux through the boundary.**Second boundary problem for the heat equation. Method of variable separation. Sturm – Liouville problem. Solution of the second boundary value problem for the heat equation | 2 | 1 |
| **PC 9.** Heat equation with known heat flux through the boundary. | 2 | 2 |
| **LC 9.** Heat equation with known heat flux through the boundary. |  | 7 |
| **IWST.** Consultation on the implementation **of IWS 3.** |  |  |
| **10** | **L 10.** Inhomogeneous heat equation. Fourier method. Solution of boundary value problems for the inhomogeneous heat equation | 2 | 1 |
| **PC 10.** Heat equation in the presence of heat sources | 2 | 2 |
| **LC 10.** Heat equation in the presence of heat sources |  | 7 |
| **IWS 3.** Fourier method for parabolic equations |  | 7 |
| **MODULE 4 Elliptic equations** | | | |
| **11** | **L 11. Laplace equation and its connection with theory of functions of a complex variable and variational calculus***.*Analytical and harmonic functions. Minimization of functions and stationary condition. Dirichlet integral and variational method. | 2 | 1 |
| **PC 11.** Variational method in mathematical physics problems | 2 | 2 |
| **LC 11.** Variational method in mathematical physics problems |  | 7 |
| **12** | **L 12. Electrostatic field equation in a circle***.*Potential of the electrostatic field of a point charge and an infinite wire. Laplace equation in a circle. Method of variable separation. Solution of the inner and outer boundary value problem for the Laplace equation in a circle. | 2 | 1 |
| **PC 12.** Laplace equation in a circle | 2 | 2 |
| **LC 12.** Laplace equation in a circle |  | 7 |
| **IWST 4.** Consultations on the implementation of **IWS 4** |  |  |
| **13** | **L 13. Green functions method for the Laplace and Poisson equations***.* Integration by parts and Green formulas. Integral representation of the harmonic function. Green function method for mathematical physics problems | 2 | 1 |
| **PC 13.** Green function method | 2 | 2 |
| **LC 13.** Green function method |  | 7 |
| **IWS 4. Methods of solving elliptic equations** |  | 7 |
| **MODULE 5** | | | |
| **14** | **L 14. Finite difference method for mathematical physics problems***.* Approximation of derivatives. Euler method for ordinary differential equations. Finite difference method for the heat equation. Explicit difference scheme for the heat equation | 2 | 1 |
| **PC 14.** Finite difference method | 2 | 2 |
| **LC 14.** Finite difference method |  | 7 |
| **IWST 5.** Consultations on the implementation of **IWS 5** |  |  |
| **15** | **L 15. Inverse problems of mathematical physics.** Identification of the mathematical models. Direct and inverse problems of mathematical physics. Inverse problems of mathematical physics and the theory of extremum. | 2 | 1 |
| **PC 15.** Inverse problems of mathematical physics | 2 | 2 |
| **LC 15.** Inverse problems of mathematical physics |  | 7 |
| **IWS 5.** Finite difference method |  | 6 |
| **Midterm control 2** | | | **100** |
| **Final control (exam)** | | | **100** |
| **TOTAL for course** | | | **100** |

**Dean \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Head of Department \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Lecturer \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**RUBRICATOR OF THE SUMMATIVE ASSESSMENT**

**CRITERIA EVALUATION OF LEARNING OUTCOMES**

Issued at the request of the teacher for each planned summative assessment (IWST)

**TEMPLATE**

**Task name** (points, % content from 100% MC, copy from the calendar (graphics) implementation of the content of the training course, methods of teaching and learning

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| --- | --- | --- | --- | --- |
| **Criterion** | **"Excellent"**  **Max. weight in %** | **"Good"**  **Max. weight in %** | **"Satisfactory"**  **Max. weight in %** | **"Unsatisfactory"**  **Max. weight in %** |
|  |  |  |  |  |

**Example 1. Written assignment "My professional history" (25% of 100% MC)**

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| --- | --- | --- | --- | --- |
| **Criterion** | **"Excellent"**  20-25% | **"Good"**  15-20% | **"Satisfactory"**  10-15% | **"Unsatisfactory"**  0-10% |
| **Understanding Theories**  **and concepts of professional identity and professionalism of a teacher** | Deep understanding of theories, concepts of professional identity and teacher professionalism. Relevant and relevant links (citations) to key sources are provided. | Understanding theories, concepts of professional identity and teacher professionalism. Links (citations) to key sources are provided. | Limited understanding of theories, concepts of professional identity and teacher professionalism. Limited references (citations) to key sources are provided. | Superficial understanding / lack of understanding of theories, concepts of professional identity and professionalism of the teacher.  Relevant references (citations) to key sources are not provided. |
| **Awareness of key issues of professional identity and professionalism of teachers in Kazakhstan** | Links well the key concepts of professional identity and teacher professionalism with the context of Kazakhstan. Excellent substantiation of arguments with evidence from empirical research (for example, based on interviews or statistical analysis). | Links the concepts of professional identity and teacher professionalism with the context of Kazakhstan. Supports arguments with evidence from empirical research. | Limited connection of the concepts of professional identity and professionalism of teachers with the context of Kazakhstan. Limited use of evidence from empirical research. | There is little or no connection between the concepts of a teacher's professional identity and the context of Kazakhstan. Little or no use of empirical research. |
| **Policy proposal or practical recommendations/suggestions** | Offers sound policy and/or practical recommendations, proposals for improving the professional identity and professionalism of teachers in Kazakhstan. | Offers some policy and/or practical recommendations, proposals for enhancing the professional identity and professionalism of teachers in Kazakhstan | Limited policy and practical recommendations. Recommendations are non-essential, not based on rigorous analysis, and are shallow. | Little or no policy and practice advice, or advice of very low quality. |
| **Letter,**  **APA style** | The writing demonstrates clarity, conciseness and correctness. Strictly follows the APA style. | The letter demonstrates clarity, conciseness and correctness. Basically follows the APA style. | The letter has some key errors and clarity needs to be improved. There are mistakes in following the APA style. | The writing is unclear, it is difficult to follow the content. Lots of mistakes in following the APA style. |

**Example 2. Group presentation "Teaching profession in Kazakhstan" (30% of 100% RK)**

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| --- | --- | --- | --- | --- |
| **Criterion** | **"Excellent"**  25-30% | **"Good"**  20-20% | **"Satisfactory"**  15-20% | **"Unsatisfactory"**  0 – 15% |
| **Understanding theories and concepts of the professional identity of the teacher and the teaching profession** | Deep understanding of theories, concepts of the professional identity of the teacher and the teaching profession. | Understanding theories, concepts of the professional identity of the teacher and the teaching profession. | Limited understanding of theories, concepts of the professional identity of the teacher and the teaching profession. | Superficial understanding / lack of understanding of theories, concepts of the professional identity of the teacher and the teaching profession. |
| **Awareness of key issues of the professional identity of the teacher and the teaching profession in Kazakhstan** | Competent correlation of the key concepts of the professional identity of the teacher and the teaching profession with the context of Kazakhstan. Excellent substantiation of arguments with evidence from empirical research (for example, based on interviews or statistical analysis). | There is a connection between the concepts of professional identity of a teacher and the teaching profession with the context of Kazakhstan. The arguments are backed by evidence from empirical research. | Limited correlation of the professional identity of the teacher and the concepts of the teaching profession with the context of Kazakhstan. Limited use of evidence from empirical research | Insignificant connection / lack of connection between the concepts of the teacher's professional identity and the context of Kazakhstan. Little or no empirical research is used. |
| **Pilot Study** | Excellent use of the results of pilot studies (interviews or surveys) in the presentation | Good use of the results of pilot studies (interviews or surveys) in the presentation. | Satisfactory use of the results of pilot studies (interviews or surveys) in the presentation. | Poor use of the results of pilot studies (interviews or surveys) in the presentation. |
| **Suggestion of policy or practical recommendations/suggestions** | Offers very good policy and/or practical advice or suggestions for improving the professional identity and teaching profession in Kazakhstan. | Offers some policy and/or practical recommendations or suggestions for improving the professional identity and teaching profession in Kazakhstan. | Limited policy and practical recommendations. Recommendations are non-essential, not based on rigorous analysis, and are shallow. | Little or no policy and practice advice, or advice of very low quality. |
| **Presentation,**  **teamwork** | Excellent, attractive presentation, excellent quality of visuals, slides, materials, excellent teamwork. | Good engagement, good quality visuals, slides or other materials, good teamwork. | Satisfactory level of involvement, satisfactory quality of materials, satisfactory level of teamwork. | Low engagement, low quality content, poor teamwork. |