**SYLLABUS**

**Fall semester 2022-2023 academic years**

**on the educational program “……………… ”**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Discipline’s code** | **Discipline’s title** | **Independent work of students (IWS)** | **Number of credits** | **Number of credits** | **Independent work of student with teacher (IWST)** |
| **Lectures (L)** | **Practical training (PT)** | **Laboratory (Lab)** |
|  | **Additional directions of functional analysis and their applications** |  | 1 | 1 | - | 2 |  |
| **Academic course information** |
| **Form of education** | **Type of course**  | **Types of lectures** | **Types of practical training**  | **Form of final control** |
| Full-time |  |  |  |
| Lecturer  | Serovajsky Simon |  |
| e-mail | serovajskys@mail.ru |
| Telephone number | +7 701 8315197 |

|  |  |  |
| --- | --- | --- |
| **Aim of course**  | **Expected Learning Outcomes (LO)\***As a result of studying the discipline the undergraduate will be able to: | **Indicators of LO achievement (ID)**(for each LO at least 2 indicators) |
| Analysis of the sequential method and its applications | 1. To know the general idea of sequential method | 1.1. Convergence of the sequences1.2. Cauchy criterion of mathematical analysis |
| 2. To know the general forms of solutions of partial differential equations | 2.1. Classic solution2.2. Generalized solution |
| 3. To know the basis of distribution theory  | 3.1. Standard definition of distribution3.2. Sequential definition of distribution |
| 4. To know the completion method | 4.1. Cantor definition of real numbers 4.2. Completion theorem4.3. Completion method |
| 5. To know application of completion method | 5.1. Existence theorems5.2. Convergence of sequences of approximate solutions5.3. Substantiation of partial differential equations  |
| **Prerequisites** | functional analysis, mathematical physics equations, differential equations, mathematical modelling, numerical methods, variational calculus and optimization methods, differential equations  |
| **Post requisites** | Special courses |
| **Information resources \*\*** | **Literature:\*\***1. Serovajsky S. Sequential models of mathematical physics. – London, CRS Press, 2019.
2. Серовайский С.Я. Секвенциальные модели математической физики. – Алматы, Print-S, 2004.
3. Reed M., Simon B. Functional Analysis, N.Y., Academic Press 1980.
4. Vladimirov V.S. Methods of the theory of generalized functions. Taylor & Francis, 2002.
5. Тихонов А.Н., Самарский А.А. Уравнения математической физики. – М., Наука, 2008
6. Антосик П., Микусинский Я., Сикорский P. Обобщенные функции. Секвенциальный подход. – М., Мир, 1976.
7. Самарский А. А. Теория разностных схем. – М., Наука, 1977.

**Internet resources:**1. [Bressan, Alberto](https://en.wikipedia.org/wiki/Alberto_Bressan) (December 8, 2010). ["Noncooperative Sequential models: A Tutorial"](https://www.math.psu.edu/bressan/PSPDF/game-lnew.pdf)  Department of Mathematics, Penn State University.
2. <http://window.edu.ru/resource/918/77918/files/mathphis.pdf>
3. И.М.Гельфанд, Г.Е.Шилов. [Обобщенные функции и действия над ними](http://www.mccme.ru/free-books/distr1/index.html)
 |

|  |  |
| --- | --- |
| **Academic policy of the course in the context of university moral and ethical values** | **Academic Behavior Rules:** All students are required to register for the MOOC. The deadlines for completing the modules of the online course must be strictly observed in accordance with the schedule for studying the discipline. Leave in case of current MOOC or SPOC courses.**ATTENTION!** Failure to meet deadlines results in loss of points! The deadline for each task is indicated in the calendar (schedule) for the implementation of the content of the training course, as well as in the MOOC. Leave in case of current MOOC or SPOC courses.**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-based evaluation:** assessment of learning outcomes in relation to descriptors (verification of the formation of competencies in midterm control and exams).**Summative evaluation:** assessment of work activity in an audience (at a webinar); assessment of the completed task. |

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

|  |  |  |  |
| --- | --- | --- | --- |
| week | Topic name | Number of hours | Max.score\*\*\* |
| **Module 1 Classic solution of mathematical physics equations** |
| 1 | **Lec 1.** Determination of the heat equation and its classical solution. | 1 | 5 |
| 1 | **Sem 1.** Determination of the heat equation and its classical solution | 1 | 5 |
| 2 | **Lec 2.** Approximation and convergence of the numerical method for the heat equation. | 1 | 5 |
| 2 | **Sem 2.** Approximation and convergence of the numerical method for the heat equation. | 1 | 5 |
| **Module 2 Generalized solution of mathematical physics equations** |
| 3 | **Lec 3.** Generalized functions. Generalized derivatives. Sobolev spaces | 1 | 5 |
| 3 | **Sem 3.** Generalized functions. Generalized derivatives. Sobolev spaces | 1 | 5 |
| 3 | **IWST 1.** Consultation on the implementation of IWS1  |  |  |
| 3 | **SIW 1.** Classic solutions |  | 60 |
| 4 | **Lec 4.** Generalized solution of the mathematical physics problems**.** Relations between classical and generalized solution. | 1 | 5 |
| 4 | **Sem 4.** Relations between classical and generalized solution. | 1 | 5 |
|  | **IWST 2.** Consultation |  |  |
| 5 | **Lec 5.** Physical sense of the generalized solution of the stationary heat equation. Generalized model | 1 | 5 |
| 5 | **Sem 5.** Generalized solutions of the mathematical physics problems | 1 | 5 |
| 6 | **Lec 6.** Approximation of the generalized model for the stationary heat | 1 | 5 |
| 6 | **Sem 6.** Approximation of the generalized model for the stationary heat | 1 | 5 |
| 7 | **IWST 3.** Consultation |  |  |
|  |  **LEVEL CONTROL 1** |  | **100** |
| **Module 3 Basis of sequential theory** |
| 7 | **Lec 7.** Convergence of the sequences and Cauchy principle | 1 | 5 |
| 7 | **Sem 7.** Convergence of the sequences and Cauchy principle | 1 | 5 |
| 8 | **Lec 8.** Picard method and contracting mapping theorem | 1 | 5 |
| 8 | **Sem 8.** Picard method and contracting mapping theorem | 1 | 5 |
| 8 | **IWS 2.** Generalized solutions of mathematical physics problems |  | 30 |
| 9 | **Lec 9.** Completeness of the spaces. Examples of incomplete spaces | 1 | 5 |
| 9 | **Sem 9.** Completeness of the spaces. Examples of incomplete spaces | 1 | 5 |
| 10 | **Lec 10** Cantor’s definition of the set of real numbers. | 1 | 5 |
| 10 | **Sem 10.** Applications of Cantor’s definition of the set of real numbers. | 1 | 5 |
| 10 | **IWST 3.** Consultation |  |  |
| 11 | **Lec 11** Applications of the completion theorem | 1 | 5 |
| 11 | **Sem 11.** Applications of the completion theorem | 1 | 5 |
| 12 | **Lec 12** Sequential generalized functions theory | 1 | 5 |
| 12 | **Sem 12.** Sequential generalized functions theory | 1 | 5 |
| 12 | **IWST 5.** Consultation |  |  |
| 13 | **Lec 13** Sequentialextension of extremum problems | 1 | 5 |
| 13 | **Sem 13** Sequentialextension of extremum problems | 1 | 5 |
| 13 | **IWST 6.** Consultation |  |  |
| 13 | **IWS 3.** Optimization problems with isoperimetric conditions |  | 30 |
| **Module 4. Sequential solution of mathematical physics equations** |
| 14 | **Lec 14** Sequential model of stationary heat transfer phenomenon. | 1 | 5 |
| 14 | **Sem 14.** Sequential model of stationary heat transfer phenomenon. | 1 | 5 |
| 15 | **Lec 15** Sequential models of mathematical physics problems | 1 | 5 |
| 15 | **Sem 15.** Sequential models of mathematical physics problems | 1 | 5 |
| 15 | **IWST 7**. Consultation on examination issues |  |  |
|  |  **LEVEL CONTROL 2** |  | **100** |

Dean \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

Lecturer \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**NOTE:**

 The total volume of the syllabus is no more than 5 pages, font 10, Times New Roman

\* LO is based on cognitive (1-2), functional (2-3), systemic (1-2) competencies, total 4-7.

The types and number of competencies (out of 5) are compiled according to the level of education.

\*\* Give no more than 5-7 sources of literature (full bibliographic description), in depth for the last 10 years. (in exceptional cases, 20-30% of irreplaceable classical textbooks), for natural directions - 10 years. Humanitarian direction -5 years

Literature and resources:

1. Basic literature

2. Additional reading

3. Software

4. Internet resources

5. Professional databases

\*\*\*Spreading the assessment of students' knowledge is at the discretion of the compilers of the syllabus.

.