# KAZAK NATIONAL UNIVERSITY

## after aI Farabi

Mechanics and Mathematics Faculty Department of mathematics

## It is confirmed

at session of the faculty's Scientfic Council Protocol № from « » 2024

Faculty's Dean

**Course Syllabus**

**Course Title: Modern Problems of Theory of Equations of Mathematical Physics**

**Semestr: 2023-2024 Spring**

**Credits/ECTS: 3 / 5**

**Degree Cycle (Level): Doctorate**

**Course Type: Compulsory**

**Language of Instruction: Kazakh, English**

**Requisites**

*The table below is automatically filled in if it is included in the Education Program*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Type | Program Code | Educational program | Course Title | Consent status |
| * AR | 10101 |  |  |  |
| * CR (Co-requisite) |  |  |  |  |
| * PR (Prerequisite) | **MAT205** | **Mathematical and Computer Modeling** | **Ordinary Differential Equations** |  |

**Course Description**

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\_Course 'Equations of Mathematical Physics' includes basic facts about practical applications, construction and classifications of second order partial differential equations of parabolic, elliptic and hyperbolic types ; typical integration techniques for classical types of boundary conditions ; formulation of the Cauchy problem; ideas of problems correct statement - existence and uniqueness theorems; basic concepts and theorems of the general theory of differential equations and its applications for description and modeling different physical phenomena and

engineering processes - heat- and mass-transfer, ground water flow, string vibration etc.; basic principles and methods for solving linear differential equations - fundamental solutions and variable separating methods

**Instructor (s)**

|  |  |  |
| --- | --- | --- |
| Name Surname | Degree | Contact information |
| 1. Kaisar Maratovich Tulenbayev | Candidate of Sci. in Math and Phys | tulen75@hotmail.com |

**Skills and competences**

|  |  |
| --- | --- |
| Academic Skills | Subject-Specific Skills |
| Knowledge in the field of modern concepts of partial differential equations, skills in classifications of linear PDE, descriptions of its canonical types. | Ability to apply Methods of solving PDE boundary problems – using fundamental solutions for infinite domains for homogeneous |
| Understanding of correct task statements  and typical methods of its investigations. for  boundary problems | Method of using Fourier's series for solving typical boundary problems for homogeneous and inhomogeneous PDE in finite domains |
| Necessary skills for analytical solving of classical boundary problems of Math Physic | Practical using of Equations of Math Phys for modelling some engineering processes - heat- and masstransfert, ground water and other fluids flow, etc |

**Weekly course plan**

|  |  |  |
| --- | --- | --- |
| № | Topics | Activity |
| 1 | . Lect.1.Introduction to Partial Differential Equations of Mathmatical Phusucs. Definitions. Terminology. | Lecture, practical works, home work |
| 2 | Simple Examples of PDE Heat equation. Classification and Canonical forms | Lecture, practical works, home work |
| 3 | Reduction of an equation of general form to canonical type | Lecture, practical works, home work |
| 4 | Lect.2. Hydraulic equations (Ground water with open surface. Oil  strata).Example of solving steady state boundary problem. | Lecture, practical works, home work, Quiz #1. |
| 5 | Correctness of task statements for PDE, initial and boundary  conditions. Separating variables method for parabolic PDE. | Lecture, practical works, home work |
| 6 | Lect 3. Separating variables method for general boundary problems  for homogeneous heat rquations.  Eigen values and eigen functions of boundary problems. | Lecture, practical works, home work |
| 7 | Separating variables method for boundary problems  for inhomogeneous heat equation. | Lecture, practical works, home work  Mid term quiz.#2 |
| 8 | Details of separating variables technique. 2D boundary problems.  Maximal principle for heat equation. Uniqueness theorem. | Lecture, practical works, home work |
| 9 | Lect 4. Elliptical equations. Laplace and Poisson’s equations. Properties of Harmonic functions. | Lecture, practical works, home work |
| 10 | Principle of maximum. Uniqueness of solution of boundary problems for elliptical PDE. | Lecture, practical works, home work  Quiz #3 |
| 11 | Separating variables method for elliptical PDE. | Lecture, practical works, home work |
| 12 | Lect 5.Hyperbolic PDE. D’Alambert solution. Separation of  variables for Hyperbolic PDE . . Eigen  function and eigen-values. | Lecture, practical works, home work |
| 13 | Homogeneous and non-homogeneous boundaries problems | Lecture, practical works, home work. Quiz #4 |
| 14 | Energetic principle of uniqueness for hyperbolic PDE, finite domain. | Lecture, practical works, home work |
| 15 | Lect 6. Convergence of the series. Examples  Review of anothet methods of solution of PDE.  Preparing to Final exam. Fina Exam | Lecture, practical works |

**Course Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| Active verb | What will be done/produced | How this learning outcome will be achieved |
| **Classification** | **Ability to classify main types of Equations of Math Physics** | **Lecture, practical works, home works** |
| **Solving boundary problems** | **Knowledge of Method separate variables for solving boundary problems for heat, eliptical and hyperbolic PDE** | **Lecture, practical works, home work, quizzes** |
| **Solving the Cauchy problem** | **Knowledge of Potentials method to solve the Cauchy problem in infinite domain** | **Lecture, practical works, home work, quizzes** |
| **Investigation** | **Investigation of well-posed boundary problems for PDE** | **Lecture, practical works, home work, quizzes** |
| **Modeling** | **Practical applications of Equations of Math Phys for modelling engineering and physical processes** | **Lecture, discussions, practical works, home work, quizzes.** |

**Planned Learning Activities and Teaching Method**

* Lecture (online)
* Questions & Answer (during Lessons time)
* Problem Solving (online)
* Quizzes (4 quizzes online)
* Home works

**Reading List**

If the number of Required / Recommended / Other reading list is more than one, you can add a line below

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Type | Author | Title | Publishing year | ISBN | Publisher/Web site |
| * Required | W.A. Strauss | Math Physics  Partial  Differential  Equations  (PDF) | 2012 | ISBN-13 978-0470-05456-7 | Brown  University,  USA |
| * Recommended | Internet sources | Equations of math physics | - | - | - |
| * Other | Instructor of the  course | SlidIes of lectures  (PPT) | 2021-22 | N/A | Moodle, SDU |

**Assessment Methods and Criteria**

*The University’s normative rules regarding assessment apply. See the Code of Practice on Assessments.*

*These norms set the boundary conditions for all instructors of University.*

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*If the pre-final grade is more than one, you can insert a row below in the table.*

|  |  |  |  |
| --- | --- | --- | --- |
| Assessment | Description | Quantity | % |
| * Pre-final | Assignment | 10 | 10 |
| * Pre-final | Quiz | 4 | 50 |
| * Final | Project | 1 | 40 |
| Total |  |  | 100 |

**Student Workload**

\* Student workload filling [example](https://drive.google.com/file/d/1ds2UC_rKgR5p2eeChthv0OiRocIwpIh2/view?usp=sharing)

[Resource](https://drive.google.com/file/d/1RWpEdLL7RzZpb431i_iTbmNpR-AkuJ_t/view?usp=sharing)

|  |  |  |  |
| --- | --- | --- | --- |
| Activity | Quantity | Duration | Total Hours |
| Lecture | 7 themes | 2-6 h | 28-30 h |
| Practical lessons | 10-11 h | 1 h | 10-11 h |
| Quizzes | 4 | 1 h | 4 h |
| Home works | 8 | 1-1.5 h | 12 h |
| Total Workload |  |  | 54-57 h |

**Academic Integrity**

Students must ensure that all work completed for this course is their own work. Any evidence of plagiarism, data falsification, fabrication, collusion, self-plagiarism and/or other forms of academic misconduct will be penalised. Further, information can be found in the Code of Practice on Academic Integrity.

**Late/Non Submission and Attendance Policy**

Academic excellence and high achievement are only possible in an environment where the highest standards of academic honesty and integrity are maintained: students at SDU must ensure they adhere to this requirement. Active participation is an integral part of teaching and learning at SDU. Therefore, regular class attendance is required of all students and records of any absences are kept for each class: a student whose attendance falls below 70% will fail the course. Students are also expected to be in class on time: poor punctuality is seen as being discourteous to the teacher and other students, therefore repeat incidences of late arrivals are subject to a penalty. The use of electronic devices (e.g.: computers, tablets, phones) is only permitted upon tutor instruction. Any other activities (e.g.: texting, surfing, gaming, social emails, online shopping...etc.) are strictly forbidden during class time. Students found to be engaged in any non-class activity may lose marks for overall participation.

**Course Specific Policy**

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1. The syllabus is given as a guideline and the rate as well as order of priorities of coverage may be varied as instructor may feel necessary. However, it is expected that the material required for the common exams will have been covered by the date of exam.

2. For students who have completed all the lab. works and have received an average percentage of at least 85%, it is possible to transfer the summative grade (PF) to the final exam grade.

3. Copying other people's lab. work leads to a score of 0 - 20 (out of 100) points \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Approved by Head of Department**

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