**AL-FARABI KAZAKH NATIONAL UNIVERSITY**

**Faculty of Mechanics and Mathematics**

**Department of Mechanics**

**Final Control Program**

**Course: "Methods of Study of Compressible Fluids"**

**Educational Program:** **"7M05405 – Mechanics and Energy"**

**Course: 1st year Master student**

**Semester: 1**

**Credits: 5**

**Location: Almaty, 2024**

Final control program developed by PhD, Associate Professor, Acting Professor of the Department of Mechanics, Yerzhan Belyayev.

The exam program was reviewed and approved at the Department of Mechanics meeting on September 13, 2024, Protocol No. 2.

Approved by

Head of the Department of Mechanics \_\_\_\_\_\_\_\_\_\_\_\_\_ Dinara Turalina.

**Purpose of the Exam in the form of a "PROJECT"**

One of the main goals of higher education systems is to develop students' competencies. Project-based learning is an effective method to achieve this.

The Project is independent scientific-practical research by the student aimed at consolidating and systematizing knowledge gained during the course as a whole and on a specific topic. It develops skills and teaches students to apply their knowledge in practice to solve specific scientific and practical problems in mechanics and formulate and argue their position on these issues.

The final project will serve as the basis for writing a scientific article for submission to a domestic journal included in the list of the Committee for Control in the Sphere of Education and Science of the Republic of Kazakhstan (CCSES).

The Project is carried out over the academic semester. It assesses students' abilities to independently apply their knowledge in solving practical tasks, navigate the informational space, and evaluate their level of analytical, research skills, and creative thinking.

**Project Stages**

|  |  |  |
| --- | --- | --- |
| 1 | Conduct a literature review on the research topic to understand the problem. | Weeks 1-2 |
| 2 | Justify the relevance of the problem. | Week 3 |
| 3 | Define the purpose and objectives of the research problem. | Week 4-5 |
| 4 | Formulate the physical problem statement. | Week 6 |
| 5 | Formulate the mathematical problem statement (mathematical model: main equations, initial and boundary conditions). | Week 7 |
| 6 | Choose a research method (laboratory experiment or numerical experiment) and justify the choice. | Week 8 |
| 7 | Explain the research methodology. | Week 9 |
| 8 | Conduct the research and analyze the results (tables, graphs, analysis). | Weeks 10-13 |
| 9 | Make justified conclusions. | Week 14 |
| 10 | Prepare and format the project report. This report will serve as the basis for a scientific article in the CCSES journal. | Week 15 |

**Project Report Content**

|  |  |  |  |
| --- | --- | --- | --- |
| No. |  | Content | pages |
| 1 | **Introduction** | |  |
|  | 1.1 | Literature Review |  |
|  | 1.2 | Problem Relevance |  |
| 2 | **Problem Statement** | |  |
|  | 2.1 | Physical Problem Statement |  |
|  | 2.2 | Mathematical Problem Statement (main equations, initial and boundary conditions) |  |
| 3 | **Research Methodology** | |  |
|  | 3.1 | Research method (laboratory or numerical experiment) |  |
|  | 3.2 | Justification of the research method |  |
|  | 3.3 | Research Methodology |  |
|  | 3.4 | Research results |  |
| 4 | **Conclusion** | |  |
| 5 | **References** | |  |

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| **Project Topics** |
| 1. Thermodynamic Modeling of a Cascade Vapor Compression Refrigeration Cycle. 2. Thermodynamic Modeling of a Refrigeration Cycle with Two-Stage Compression and Flash Intercooling. 3. Thermodynamic Modeling of a Single-Stage Vapor Compression Refrigeration Cycle. |

**Final Control Program for the course**

**“Methods of Study of Compressible Fluids”**

**Academic Year: 2024-2025**

Faculty of Mechanics and Mathematics

Department of Mechanics

Course: Methods of Study of Compressible Fluids

Specialty: "7M05405 – Mechanics and Energy"

Year: 1st year Master student

Number of students: 3

Instructor: Yerzhan Belyayev

Exam platform: Moodle Distance Learning System

Exam format: COMBINED #1: written project followed by an oral defense.

EXAM PROCEDURE

The exam consists of two parts: a written component (project implementation, implementation report) and an oral component (project defense).

The written part of the project is to be completed within the timeframe specified by the instructor in the Moodle LMS. The deadline is 24 hours before the start of the oral exam.

The oral part of the exam will be conducted at the time indicated in the exam schedule.

Number of files to be attached: 1

Exam duration: 2 hours.

Grading criteria: **70%** of the grade is allocated to the written part (assessment of the report) and **30%** to the oral defense.

The maximum overall score for the submission is 100 points.

Following the exam, the student must submit a completed project in the form of a report in (\*.docx) format via Moodle LMS.

An originality check will be conducted on the submitted exam work.

The uploaded file size should not exceed 30 MB.

The final grade will be assigned by the committee based on the assessment results.

The time allowed for entering the exam grade into the assessment register for a project-based exam is 24 hours.

**Recommended Literature**

**Basic:**

1. Robert D. Zucker, Oskar Biblarz Fundamentals of Gas Dynamics // Second Edition, John Wiley & Sons, Inc. 2002, ISBN 0-471-05967-6, P. 493.
2. Г. Г. Черный Газовая динамика // Москва «НАУКА» 1988, 424 с.
3. В. П. Стулов Лекции по газовой динамике // Москва ФИЗМАТЛИТ 2004, 191 с.
4. А. Н. Крайко, А. Б. Ватажин, А. Н. Секундов Газовая динамика // Москва ФИЗМАТЛИТ 2001, 761 с.
5. Genick Bar-Meir Fundamentals of Compressible Fluid Mechanics // 7449 North Washtenaw Ave Chicago, IL 60645, P. 399.
6. Г.В.Липман, А.Рошко, *Элементы газовой динамики*, М., ИИЛ, 1960.
7. Л.Г.Лойцянский, *Механика жидкости и газа*, М., ГИТТЛ, 1957.
8. Ю. В. Лапин, М. Х. Стрелец Внутренние течения газовых смесей // Москва «Наука» 1989, 366 с.

**Additional:**

1. Г.Н.Абрамович, *Прикладная газовая динамика*, М., Наука, 1969.
2. Л.И.Седов, *Методы подобия и размерности в механике*, М.,Наука, 1987.
3. Я.Б.Зельдович, Ю.П.Райзер, *Физика ударных волн и высокотемпературных явлений в газах*, М., Наука, 1966.
4. М.А.Лаврентьев, Б.В.Шабат, *Проблемы гидродинамики и их математические модели*, М.,Наука, 1977.
5. Б.Л.Рождественский, Н.Н.Яненко, *Системы квазилинейных уравнений и их приложения к газовой динамике*, М., Наука, 1968.
6. Л.Д.Ландау, Е.М.Лифшиц, *Гидродинамика*, М., Наука, 1986.
7. Н. Ф. Краснов, В. Н. Кошевой, В. Т. Калугин Аэродинамика отрывных течений //Москва «Высшая школа» 1988, 347 с.
8. П. Чжен Отрывные течения // Издательство «Мир», Москва, 1972.

**ASSESSMENT CRITERIA**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Grade | GPA Equivalent | Percentage | Traditional Grade | Criteria |
| А | 4,0 | 95-100 | Excellent | Complete understanding and justification of the problem's relevance. Full command and comprehension of the physical and mathematical problem statements, research methodology, accuracy of research, comprehensive analysis of results, justified conclusions, and report formatting meeting all requirements. |
| А- | 3,67 | 90-94 |
| В+ | 3,33 | 85-89 | Good | Significant understanding and justification of the problem's relevance. Strong command of the physical and mathematical problem statements, methodology, and research, with a limited analysis of results and conclusions. Report formatting meets requirements. |
| В | 3,0 | 80-84 |
| В- | 2,67 | 75-79 |
| С+ | 2,33 | 70-74 | Satisfactory | Limited understanding and justification of the problem's relevance. Weak comprehension of the physical and mathematical problem statements, incorrect research methodology, incomplete analysis, unsubstantiated conclusions, and lack of logical flow. Report formatting does not meet requirements. |
| С | 2,0 | 65-69 |
| С- | 1,67 | 60-64 |
| D+ | 1,33 | 55-59 |
| D- | 1,0 | 50-54 |
| FX | 0,5 | 25-49 | Unsatisfactory | Complete lack of problem understanding and research accuracy. Report formatting does not meet requirements. |
| F | 0 | 0-24 | Unsatisfactory | Violation of final control regulations. |
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**Lecturer Yerzhan Belyayev**