ХАЛЫҚАРАЛЫҚ АҚПАРАТТЫҚ ТЕХНОЛОГИЯЛАР УНИВЕРСИТЕТІ / МЕЖДУНАРОДНЫЙ УНИВЕРСИТЕТ / INTERNATIONAL UNIVERSITY

Faculty of Computer Technologies and Cybersecurity
Department of "Mathematical and Computer Modeling"

APPROVED
Vice-rector for academic and educational affairs of
JSC "International University of Information Technologies"
________________ Umarov T.F.
(Signature) (FULL NAME.)
"30" 03 2021

6B06113
(Code of the Educational program)

Engineering Mathematics
(Name of the Educational Program)

# CATALOG OF ELECTIVE DISCIPLINES

**2021 year of receipt**

2021 y.

The catalog of elective disciplines for EP 6V06113 Engineering Mathematics was developed on the basis of the EP working curriculum.

The catalog of elective disciplines was discussed at a meeting of the Department of Mathematical and Computer Modeling

Minutes No. 8 dated March 05, 2021

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| Head of the Department | ____________ signature | Ydyrys A.Zh. Name, title, degree |
| Compiled by CED | ____________ signature | Satybaldina A.N. Name, title, degree |

The catalog of elective disciplines was approved at a meeting of the Educational and Methodological Council of JSC "International University of Information Technologies"

Minutes No. 4 dated March 30, 2021.

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| Director of DAA | ____________ signature | Mustafina A.K. Name, title, degree |

## 1 TERMS AND ABBREVIATIONS

1. 1 An educational program is a single complex of the main characteristics of education, including goals, results and content of education, organization of the educational process, methods and methods of their implementation, criteria for assessing learning outcomes.

The content of the educational program of higher education consists of disciplines of three cycles - general education disciplines (hereinafter referred to as OOD), basic disciplines (hereinafter referred to as DB) and major disciplines (hereinafter referred to as PD).

The OOD cycle includes the disciplines of a compulsory component (hereinafter referred to as OK), a university component (hereinafter referred to as VC) and (or) an optional component (hereinafter referred to as CV). DB and PD include the disciplines of VK and KV.

1. 2 The catalog of elective disciplines (CED) is a systematized annotated list of all disciplines of the elective component for the entire period of study, containing a brief description of them indicating the purpose of the study, a summary (main sections) and expected learning outcomes. The CED reflects the prerequisites and postrequisites of each academic discipline. CED should provide educators with the opportunity to choose an alternative choice of elective academic disciplines for the formation of an individual educational trajectory.

Based on the educational program and CED, students, with the help of advisors, develop individual curricula.

1. 3 Individual curriculum (IEP) - a curriculum formed for each academic year by students independently with the help of an adviser based on the educational program and the catalog of elective disciplines and (or) modules;

IEP determines the individual educational trajectory of each student separately. The IEP includes disciplines and types of educational activities (practices, research / experimental research work, forms of final certification) of a mandatory component (OK), a university component (VC) and an optional component (CV).

1. 4 An adviser is a teacher who performs the functions of an academic mentor studying according to an appropriate educational program, assisting in the choice of a learning path (formation of an individual curriculum) and mastering the educational program during the training period.

1. 5 The university component is a list of compulsory academic disciplines determined by the university independently for mastering the educational program.

1. 6 Optional component - a list of academic disciplines and the corresponding minimum amount of academic credits offered by the university, independently selected by students in any academic period, taking into account their prerequisites and post-requisites.

1. 7 Elective disciplines are academic disciplines included in the university component and an optional component within the framework of established academic credits and introduced by educational organizations, reflecting the individual training of the student, taking into account the specifics of socio-economic development and the needs of a particular region, established scientific schools.

1. 8 Postrequisite (postrequisite) - disciplines and (or) modules and other types of educational work, the study of which requires knowledge, abilities, skills and competencies acquired upon completion of the study of this discipline and (or) modules;

1. 9 Prerequisite (prerequisite) - disciplines and (or) modules and other types of educational work containing knowledge, abilities, skills and competencies necessary for mastering the studied discipline and (or) modules;

1. 10 Competencies - the ability to practically use the knowledge, skills and abilities acquired in the learning process in professional activities.

## 2 ELECTIVE DISCIPLINES

| No. | Cycle of discipline | Discipline Code | Name of the discipline | Semester | Number of credits | Prerequisites |
|---|---|---|---|---|---|---|
| | | | ***3 course*** | | | |
| one | PD KV | CED6501 | Elective №1 from CED | 5 | 6 | |
| | | SFT6531 | Java programming | | | |
| | | SFT6541 | C # programming | | | |
| 2 | PD KV | CED6503 | Elective №3 from CED | 6 | 6 | |
| | | MAT6533 | Pipeline fluid transportation problems | | | Numerical Methods, Algorithms and Data Structures, Introduction to Programming |
| | | MAT6523 | Operation research | | | Algebra and Geometry, Mathematical Analysis, Algorithms and Data Structures |
| 3 | PD KV | CED6504 | Elective №4 from CED | 6 | four | |
| | | EGR6514 | Mathematical models of heat transfer in a multilayer region | | | Numerical Methods, Introduction to Programming |
| | | EGR6524 | Modeling Moisture Transport in a Porous Medium | | | Numerical Methods, Introduction to Programming |
| | | | ***4 course*** | | | |
| four | PD KV | CED6505 | Elective №5 from CED | 7 | 6 | |
| | | EGR6515 | Mathematical Models of Energy Saving Problems in an Underground Pipeline | | | Numerical Methods, Algorithms and Data Structures, Introduction to Programming |
| | | EGR6525 | Laplace transform in engineering problems | | | Complex analysis, Mathematical analysis |
| five | PD KV | CED6507 | Elective №7 from CED | 7 | 6 | Elective №3 from CED |
| | | MAT6557 | Nonlinear extremal problems | | | Extreme Problem Solving Techniques, Operation Research, Introduction to Programming |
| | | MAT6537 | Dynamic programming | | | Extreme Problem Solving Techniques, Operation Research, Introduction to Programming |
| 6 | PD KV | CED6506 | Elective №6 from CED | 7 | 6 | |
| | | EGR6516 | Modeling ill-posed problems | | | Numerical Methods, Algorithms and |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | Data Structures, Introduction to Programming |
| | | EGR6526 | Ill-Posed Problems of Non-Stationary Processes | | | Numerical Methods, Algorithms and Data Structures, Introduction to Programming |

## 3 DESCRIPTION OF ELECTIVE DISCIPLINES

| Discipline description | |
|---|---|
| Discipline Code | SFT6531 |
| Name of the discipline | Java programming |
| Number of credits (ESTS) | 6 |
| Course, semester | 3, 5 |
| Department name | MKM |
| Course author (s) | Olzhaev O.M. |
| Prerequisites | Introduction to programming |
| Post-requisites | - |
| The purpose of studying the discipline | The course will introduce students to object-oriented programming using Java. Students are expected to know the basics of scalar types (integers, strings, booleans) and fundamental control structures in procedural programming (loops, assignment statements, conditional expressions). Finally, it will include a short introduction to the Java Framework and Java JDBC. |
| Brief description of the course (main sections) | This course was designed to introduce the student to the Java language. Java GUI, Java Database will be studied in this course. Java's unique architecture allows programmers to develop a single application that can run smoothly and reliably across multiple platforms. In this hands-on course, students gain extensive experience with Java and its object-oriented features. Students learn to create robust console and graphical applications, and store and retrieve data from relational databases. |
| Expected results of the study (acquired by students knowledge, skills and competence) | □ Build robust console and graphical applications<br>□ Understand the concept of OOP, as well as the purpose and principles of use inheritance, polymorphism, encapsulation and method overloading.<br>□ Determine the classes, objects, members of the class and the relationships between them necessary for a specific problem.<br>□ Build Java applications using robust OOP techniques (such as interfaces and APIs) and properly structuring the program (such as using access control identifiers, automatic documentation via comments, handling error exceptions). |

| Discipline description | |
|---|---|
| Discipline Code | SFT6541 |
| Name of the discipline | C # programming |
| Number of credits (ESTS) | 6 |
| Course, semester | 3, 5 |
| Department name | MKM |
| Course author (s) | Zhanabekov Zh. |
| Prerequisites | Introduction to programming |
| Post-requisites | - |
| The purpose of studying the discipline | Create a knowledge system about the .NET Framework class library and the object-oriented C # .NET language. Generate knowledge and skills for developing applications using C # .NET. Develop an understanding and use of the benefits of the .NET platform. |
| Brief description of the course (main sections) | The course is designed to develop students' knowledge of some of the tools available in the .NET Framework Class Library. The course will also improve students' knowledge of the C # programming language and teach how to apply object-oriented architecture and design principles to .NET applications written in C # .NET. |
| Expected results of the study (acquired by students knowledge, skills and competence) | □ Creation of console / window applications in Visual Studio .NET;<br>□ Create and use classes and objects in a C # application;<br>□ Use the concepts of encapsulation, inheritance and polymorphism in console / window applications;<br>□ Handling process error;<br>□ Creature charts and so.<br>□ Explain drawn up software documentation. |

| Discipline description | |
|---|---|
| Discipline Code | MAT6533 |
| Name of the discipline | Pipeline fluid transportation problems |
| Number of credits (ESTS) | 6 |
| Course, semester | 3, 6 |
| Department name | MKM |
| Course author (s) | Rysbayuly B. |
| Prerequisites | Numerical Methods, Algorithms and Data Structures, Introduction to Programming |
| Post-requisites | - |
| The purpose of studying the discipline | Teach students to model the problem of fluid transportation by pipeline. |
| Brief description of the course (main sections) | This course is intended for 3rd year students of the EP Engineering Mathematics. In this discipline, students study mathematical models of liquid transportation through a pipeline, methods for solving a difference scheme. In addition, they will be able to write algorithms and run programs, as well as perform numerical analysis. |
| Expected results of the study (acquired by students knowledge, skills and competence) | Students will master the methods of composing difference schemes for partial differential equations. They will learn how to compose algorithms for solving grid equations, carry out numerical calculations and analyze the results obtained. |

| Discipline description | |
|---|---|
| Discipline Code | MAT6523 |
| Name of the discipline | Operation research |
| Number of credits (ESTS) | 6 |
| Course, semester | 3, 6 |
| Department name | MKM |
| Course author (s) | Satybaldina A.N. |
| Prerequisites | Algebra and Geometry, Mathematical Analysis, Algorithms and Data Structures |
| Post-requisites | Nonlinear Extreme Problems, Dynamic Programming |
| The purpose of studying the discipline | - provide students with concepts and tools to help them understand operations research and mathematical modeling techniques. These methods will help students find answers to economic questions that will help them make appropriate decisions. |
| Brief description of the course (main sections) | The course is intended for third-year students in mathematics and computer modeling. Linear programming (LP; also called linear optimization) is a technique for achieving the best result (such as maximum profit or minimum cost) in a mathematical model whose requirements are represented by linear relationships. This course aims to familiarize students with linear optimization theory and its applications. The area of linear programming is the appropriate methods for efficiently calculating optimal solutions to a problem that is modeled by a linear objective function and a set of linear constraints. Linear programming is a special case of mathematical programming (mathematical optimization). Many practical problems in operations research can be expressed as linear programming problems. Some special cases of linear programming, such as network flow problems and multi-product flow problems, are considered important enough to warrant much research into specialized algorithms to solve them. A number of algorithms work to solve other types of optimization problems, while solving LP problems as subproblems. |
| Expected results of the study (acquired by students knowledge, skills and competence) | At the end of this course, students will be ready to model the problem as a linear programming problem and apply the appropriate method to find the optimal solution. |

| Discipline description | |
|---|---|
| Discipline Code | EGR6514 |
| Name of the discipline | Mathematical models of heat transfer in a multilayer region |
| Number of credits (ESTS) | four |
| Course, semester | 3, 6 |
| Department name | MKM |
| Course author (s) | Rysbayuly B. |
| Prerequisites | Numerical Methods, Introduction to Programming |
| Post-requisites | - |
| The purpose of studying the discipline | Teach students to solve the equation of heat conduction in an inhomogeneous medium. |
| Brief description of the course (main sections) | Methods for solving grid equations are studied in the course. Will study the approximation of various initial, boundary and interior boundary conditions. |
| Expected results of the study (acquired by students knowledge, skills and competence) | Students will master the methods of compiling difference schemes for partial differential equations in a heterogeneous medium. They will learn how to compose algorithms for solving grid equations, carry out numerical calculations and analyze the results obtained. |

| Discipline description | |
|---|---|
| Discipline Code | EGR6524 |
| Name of the discipline | Modeling Moisture Transport in a Porous Medium |
| Number of credits (ESTS) | four |
| Course, semester | 3, 6 |
| Department name | MKM |
| Course author (s) | Nurtas M. |
| Prerequisites | Numerical Methods, Programming Languages |
| Post-requisites | - |
| The purpose of studying the discipline | Teach students to model the problem of moisture transfer in a porous medium. |
| Brief description of the course (main sections) | Methods for solving grid equations are studied in the course. Will study the approximation of various initial, boundary and interior boundary conditions. |
| Expected results of the study (acquired by students knowledge, skills and competence) | Students will master the methods of compiling difference schemes for partial differential equations in a porous medium. They will learn how to compose algorithms for solving grid equations, carry out numerical calculations and analyze the results obtained. |

| Discipline description | |
|---|---|
| Discipline Code | EGR6515 |
| Name of the discipline | Mathematical Models of Energy Saving Problems in an Underground Pipeline |
| Number of credits (ESTS) | 6 |
| Course, semester | 4, 7 |
| Department name | MKM |
| Course author (s) | Rysbayuly B. |
| Prerequisites | Numerical Methods, Algorithms and Data Structures, Introduction to Programming |
| Post-requisites | - |
| The purpose of studying the discipline | To acquaint students with the problem of energy conservation in an underground pipeline and learn how to analyze the solution to the problem. |
| Brief description of the course (main sections) | In practice, energy saving problems are modeled mainly by differential equations of elliptical or parabolic types of three-dimensional modeling. Taking into account the peculiarities of the process, some boundary conditions are established. Methods for solving the constructed models have been developed and software products have been created. The computational experiment is based on real data on pipes and fluids. |
| Expected results of the study (acquired by students knowledge, skills and competence) | Students will acquire knowledge on solving problems with bringing solutions to a practically acceptable result; will acquire the skills of mathematical analysis of applied management and the ability to independently understand the analytical solution. |

| Discipline description | |
|---|---|
| Discipline Code | EGR6525 |
| Name of the discipline | Laplace transform in engineering problems |
| Number of credits (ESTS) | 6 |
| Course, semester | 4, 7 |
| Department name | MKM |
| Course author (s) | Rysbayuly B. |
| Prerequisites | Complex analysis, Mathematical analysis |
| Post-requisites | - |
| The purpose of studying the discipline | Examine the Laplace transform to understand the behavior of a wide range of mechanical and electrical systems, from helicopters to skyscrapers, from light bulbs to mobile phones. |
| Brief description of the course (main sections) | This tool captures the behavior of the system and displays it in a graphical form that is used by engineers on a daily basis to design complex systems. This course focuses on the concept of the system transfer function. Also called a system function, a transfer function fully describes the response of a system to any input signal in a very conceptual manner. This visualization does not take place in the time domain, where we usually observe the behavior of systems, but rather in the "frequency domain". We need a device to transition from the time domain to the frequency domain; this is the Laplace transform. |
| Expected results of the study (acquired by students knowledge, skills and competence) | Students will learn how to work with the Laplace transform in engineering problems. |

| Discipline description | |
|---|---|
| Discipline Code | MAT6557 |
| Name of the discipline | Nonlinear extremal problems |
| Number of credits (ESTS) | 6 |
| Course, semester | 4, 7 |
| Department name | MKM |
| Course author (s) | Satybaldina A.N. |
| Prerequisites | Extreme Problem Solving Techniques, Operation Research, Introduction to Programming |
| Post-requisites | - |
| The purpose of studying the discipline | To acquaint students with the theory of nonlinear optimization and its applications. |
| Brief description of the course (main sections) | The area of nonlinear programming provides appropriate methods for efficiently computing optimal solutions to a problem that is modeled by a nonlinear objective function and a set of linear or nonlinear constraints.<br>Also in this course, students are introduced to dynamic programming. It is a mathematical optimization method and a computer programming method. This method was developed by Richard Bellman in the 1950s and has found applications in many fields, from aerospace engineering to economics. In both contexts, this refers to simplifying a complex problem by breaking it down recursively into simpler subproblems. While some problems with a solution cannot be split up in this way, solutions that span multiple points in time often break apart recursively. Similarly, in computer science, if a problem can be optimally solved by breaking it down into subproblems and then recursively finding optimal solutions to the subproblems, then it is said to have<br>optimal substructure. |
| Expected results of the study (acquired by students knowledge, skills and competence) | At the end of this course, students will be ready to model the problem as a nonlinear programming problem and apply the appropriate method to find the optimal solution. |

| Discipline description | |
|---|---|
| Discipline Code | MAT6537 |
| Name of the discipline | Dynamic programming |
| Number of credits (ESTS) | 6 |
| Course, semester | 4, 7 |
| Department name | MKM |
| Course author (s) | Satybaldina A.N. |
| Prerequisites | Extreme Problem Solving Techniques, Operation Research, Introduction to Programming |
| Post-requisites | - |
| The purpose of studying the discipline | To acquaint students with dynamic (quadratic and convex) programming. |
| Brief description of the course (main sections) | Quadratic programming (QP) is the process of solving a special type of mathematical optimization problem, in particular, a quadratic optimization problem (with a linear constraint), that is, the problem of optimizing (minimizing or maximizing) a quadratic function of several variables subject to a linear constraint on these variables. Quadratic programming is a special type of nonlinear programming. If subproblems can be recursively nested within larger problems so that dynamic programming techniques are applicable, then there is a relationship between the value of the larger problem and the values of the subproblems. |
| Expected results of the study (acquired by students knowledge, skills and competence) | At the end of this course, students will be ready to apply dynamic programming technologies to solve various optimization problems. |

| Discipline description | |
|---|---|
| Discipline Code | EGR6516 |
| Name of the discipline | Modeling ill-posed problems |
| Number of credits (ESTS) | 6 |
| Course, semester | 4, 7 |
| Department name | MKM |
| Course author (s) | Rysbayuly B. |
| Prerequisites | Numerical Methods, Algorithms and Data Structures, Introduction to Programming |
| Post-requisites | - |
| The purpose of studying the discipline | To acquaint students with the main methods of solving incorrectly posed practical tasks. |
| Brief description of the course (main sections) | Models of heat propagation in a multilayer region are considered. Approximate methods for solving ill-posed problems of artificial structures are being developed, algorithms for solving various types of inverse problems are being developed. Computational experiments are carried out, output data are analyzed. |
| Expected results of the study (acquired by students knowledge, skills and competence) | At the end of this course, students will be ready to apply methods for solving incorrectly posed practice problems. |

| Discipline description | |
|---|---|
| Discipline Code | EGR6526 |
| Name of the discipline | Ill-Posed Problems of Non-Stationary Processes |
| Number of credits (ESTS) | 6 |
| Course, semester | 4, 7 |
| Department name | MKM |
| Course author (s) | Rysbayuly B. |
| Prerequisites | Numerical Methods, Algorithms and Data Structures, Introduction to Programming |
| Post-requisites | - |
| The purpose of studying the discipline | To acquaint students with incorrectly posed tasks of non-stationary processes. |
| Brief description of the course (main sections) | Many mathematical problems consist in the fact that the solution z is sought from the initial data u. It is assumed that u and z are related by the functional dependence z = R (u). A problem is called a well-posed problem (or well-posed) if the following conditions (correctness conditions) are met: 1) the problem has a solution for any admissible input data (the existence of a solution); 2) only one solution corresponds to each initial data u (unambiguousness of the problem); 3) the solution is stable. Problems that do not satisfy at least one correctness condition are called ill-posed problems (or incorrectly posed). In this course I will consider just such ill-posed problems of non-stationary processes. |
| Expected results of the study (acquired by students knowledge, skills and competence) | At the end of this course, students will be ready to apply methods for solving incorrectly posed practice problems. |