RUSSIAN MINISTRY OF SCIENCE AND EDUCATION

FEDERAL STATE BUDGETARY EDUCATIONAL INSTITUTION
OF HIGHER EDUCATION
«BASHKIR STATE UNIVERSITY»

FACULTY OF MATHEMATICS AND INFORMATION TECHNOLOGIES

Approved: at the department meeting
Protocol # 6 from January 26, 2021
Head of the department
_____ Ishkin H.K.

Coordinated with:
EMC chairman of the faculty/institute
_____ Efimov A.M.

WORKING PROGRAM OF DISCIPLINE (MODULE)

Discipline **Discreet mathematics**
(name of the discipline)

Obligatory part
(name of the part enclosing the discipline (obligatory, formed by participants of the educational activity, facultative))

bachelor (undergraduate) program

Course of training (speciality)
01.03.02 Applied mathematics and informatics
(code and name of the course of training (speciality))

Subdivision of the course of training (profile)
Applied programming and data analysis
(name of the profile of training)

Qualification (level of training)
bachelor
(name of the level of training)

Designer (compiler): associate professor of the MA department, PhD	_____ Abuzyarova N.F..

For enrollment of: 2021

Ufa 2021

Designer: _ associate professor, PhD Abuzyarova Natalia Fairbakhovna.

The working program of the discipline is approved at the meeting of the department of Higher algebra and geometry,
protocol # __6__ from __January__ , « 26 » 2021.

Head of the department _____ Ishkin H.K.

The addenda and updates introduced into the working program of the discipline are approved at the meeting of the department of Higher algebra and geometry,
protocol # __11__ from __June__ , « 15 » 2021.

Head of the department _____ Ishkin H. K.

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List of documents and materials

1. List of expected results of education in the discipline correlated with the indicators of reaching the competencies.

As a result of acquiring the educational program the learner should reach the following results in the discipline.

Competency being formed (with code)	Code and name of the indicator of reaching the competency	Learning results in the discipline
GPC-1 – Is able to apply fundamental knowledge acquired in the field of mathematics and/or natural sciences and to use them in professional activities.	*GPC-1.1 Knowing concepts.*	**Semester 1** Must know: the Basics of the set theory concept of a set, operations on sets, duality principle, Cartesian product, basic combinatorics notions, rules and formulas, set mappings, cardinality, **Semester 2** Must know: Cartesian product of sets which have cardinalities of the continuum. Comparing of cardinalities. Cantor-Bernstein theorem. Cardinality of the set of all subsets of given set. Cardinality of the set of all subsets of naturals. Partial ordering relation. Choice axiom and Ceremelo theorem. Basics of mathematical logic. Formal logic. Propositional calculus.
	GPC-1.2. Ability to operate with concepts..	Semester 1 Must be able: to operate with sets, calculate the number of permutations, combinations, cardinalities of sets, images and preimages,apply MP and AP of combinatorics. Semester 2 Must be able: to compare cardinalities of sets, operate with propositions, formal logic of propositional forms, calculate binary relations
	GP-1.3. Ability to solve problems.	**Semesters 1 and 2** Must have: the ability to combine theoretical knowledge with practical skills in solving educational training problems.

2. Goal and role of the discipline in the structure of educational program.

Code and name of the indicator of reaching the competency	**Learning results in the discipline**	Grading criteria for learning results			
		«Unsatisfactory»	«Satisfactory»	«Good»	«Excellent»
GPC-1.1 Knowing concepts.	**Semester 1** Must know: the Basics of the set theory concept of a set, operations on sets, duality principle, Cartesian product, basic combinatorics notions, rules and formulas, set mappings, cardinality. **Semester 2** Must know: Cartesian product of sets which have cardinalities of the continuum. Comparing of cardinalities. Cantor-Bernstein theorem. Cardinality of the set of all subsets of given set. Cardinality of the set of all subsets of naturals. Partial ordering relation. Choice axiom and Ceremelo theorem. Basics of mathematical logic. Formal logic. Propositional calculus	Practically does not know	Has substantial gaps in the knowledge	Knows almost all	Knows all
GPC-1.2. Ability to operate with concepts.	**Semester 1** Must be able: to operate with sets, calculate the number of permutations, combinations, cardinalities of sets, images and preimages,apply MP and AP of combinatorics. **Semester 2** Must be able: to compare cardinalities of sets, operate with propositions, formal logic of propositional forms, calculate binary relations	Practically is unable	Is unable in most	Is able to do almost all	Is able to do all

GPC-1.3. Ability to solve problems.	**Semesters 1 and 2** Must have: the ability to combine theoretical knowledge with practical skills in solving educational training problems.	Practically does not have	Does not have in most	Has in essential	Has

The discipline «Discreet Mathematics» belongs to the obligatory part.
The discipline is studied in the first year, semesters 1 and 2.
The goal of learning the discipline: to acquire the mathematical apparatus used in specialization disciplines.
For learning the discipline the background of competencies formed in the previous level of education and verified during the enrollment at the university is required.

3. Content of the working program (duration of the discipline, sorts and forms of classes, educational and methodical support for the individual work of learners).

Content of the working program is given in Appendix 1.

4. Fund of grading materials in the discipline.

4.1. List of competencies and indicators of reaching competencies with expected learning results in the discipline correlated with them. Description of criteria and scales for grading the learning results in the discipline.

GPC-1 – Is able to apply fundamental knowledge acquired in the field of mathematics and/or natural sciences and to use them in professional activities.

GPC-1 – Is able to apply fundamental knowledge acquired in the field of mathematics and/or natural sciences and to use them in professional activities.

The form of the final grading in the discipline in both semesters 1 and 2 is an exam.

Criteria for grading are scores which are set by the instructor for various activities (grading tasks) in and upon learning modules listed in the Rating plan of the discipline.

from 45 up to 59 scores – «satisfactory»;
from 60 up to 79 scores – «good»;
from 80 scores up – «excellent».

4.2. Typical grading tasks or other materials required for grading the learning results in discipline correlated with the indicators of reaching the competencies which are set in the educational program. Methodical materials determining the grading procedures for learning results in the discipline.

Code and name of the indicator of reaching the competency	**Learning results**	**Grading tasks**
GPC-1.1 Knowing concepts.	**Semester 1** Must know: the Basics of the set theory concept of a set, operations on sets, duality principle, Cartesian product, basic combinatorics notions, rules and formulas, set mappings, cardinality. **Semester 2** Must know: Cartesian product of sets which have cardinalities of the continuum. Comparing of cardinalities. Cantor-Bernstein theorem. Cardinality of the set of all subsets of given set. Cardinality of the set of all subsets of naturals. Partial ordering relation. Choice axiom and Ceremelo theorem. Basics of mathematical logic. Formal logic. Propositional calculus.	Problems for the midterm grading, exam topics and exam tickets, work at the board and in class room.

GPC-1.2. Ability to operate with concepts.	**Semester 1** Must be able: to operate with sets, calculate the number of permutations, combinations, cardinalities of sets, images and preimages,apply MP and AP of combinatorics. **Semester 2** Must be able: to compare cardinalities of sets, operate with propositions, formal logic of propositional forms, calculate binary relations	Problems for the midterm grading, exam topics and exam tickets, work at the board and in class room.
GP-1.3. Ability to solve problems.	**Semesters 1 and 2** Must have: the ability to combine theoretical knowledge with practical skills in solving educational training problems.	Problems for the midterm grading, exam topics and exam tickets, work at the board and in class room.

Topics for the exam in Semester 1.

1. Operations on sets and their properties. Duality principle. Cartesian product.
2. Combinatorics.Multiplicative principle (product rule). Additive principle (sum rule).
3. (k,n) – permutations, (k,n) – permutations with repetitions.
4. (k,n) – combinations, (k,n) – combinations with repetitions
5. Binary relations and their properties. Equivalence relation.
6. Mappings of sets. Image and pre-image of elements and sets, their properties.
7. Surjections, injectioins, bijections. Examples.
8. Inverse map. Composite map. Properties.
9. Equivalence of sets. Finite sets.
10. Denumerable sets. Examples. Criterion.
11. Countable sets and their subsets. Countable union of countable sets. The set of rational is denumerable.
12. Cartesian product of countable sets. Polynomials with rational coefficitents.
13. Sets having infinite cardinality, their properties. Continuum. The set (0;1).
14. Cardinality of set of all sequences which members are 0 and 1.
15. Cardinality of set of all subsequences of naturals.
16. .How to compare of cardinalities?
17. .Cardinality of power set of given set.

Topics for the exam in Semester 2.

1. Propositions and operations on them. Propositional forms.
2. Tautologies and contradictions.
3. Properties of tautologies.
4. Existence of propositional form containing only two connectives that is equivalent ot given form.
5. Schaeffer and Webb connectives and their properties.

6. Conjunctive and disjunctive normal forms. (CNF and DNF)
7. Existence of CNF and DNF.
8. Perfect CNF and perfect DNF.
9. Existence and uniqueness of perfect DNF equivalent to given one.
10. Existence and uniqueness of perfect CNF equivalent to given one.
11. Boolean functions and propositional forms.
12. Composite Booleans. Complete Boolean systems.
13. Zhehgalkin polynomials.
14. Basics of formal theory.
15. Deduction principle.

Exam tickets

Each exam ticket consists of 2 topics, the first topic is taken randomly from the theory, the second topic is the problem to solve. The exhaustive talk on each topic is graded by 15 scores.

Grading criteria (in scores):

- **25-30 scores** if student demonstrates the knowledge of 80% or more of the required educational material in the discipline.
- ***17-24 scores*** if student demonstrates the knowledge from 60% to 79% of the required educational material in the discipline.
- **10-16 scores** if student demonstrates the knowledge from 45% to 59% of the required educational material in the discipline.
- **1-10 scores** if student demonstrates the knowledge less than 45% of the required educational material in the discipline.

An example of examination tickets is given in Appendix 4.

Problems for the midterm grading.

The discipline is subdivided into two modules in each of the two semesters. Each module is ended by graded Special Work (1-4).

The midterm grading can yield 30 scores, 15 per each of two modules. Examples of problems for the midterm grading are given in Appendix 3.

Work at the board and in class room.

The work at the board consists in selective solving some problems similar to those students get online through the universitary WebWork server. Solution of these problems is accompanied with the discussion of the theory. For each module student gets at the board at least once. His knowledge of the theory is graded by 5 scores, solution of problems is graded by 10 scores, addenda from the class room is graded by 5 scores. Totally 20 scores per each of the two modules.

Laboratory.

Laboratory work is organized as solving selected problems of the Special Works 1-4 with a written report on each of them. It is graded separately and is not included to the grading of the discipline for semester.

Calculation and graphing.

Calculation and graphing work is organized as solving selected problems from the first and second WebWork tasks with a written report on each of them. It is graded separately and is not included to the grading of the discipline for semester.

4.3. Rating-plan of the discipline.

Rating-plan of the discipline is given in Appendix 2.

5. Educational, methodic and informational support of the discipline.

5.1. List of references to primary and complementary educational literature necessary for acquiring the discipline.

Primary literature:

1. Levin O. Discreet Mathematics. // University of Northern Colorado. USA. 2021. http://discrete.openmathbooks.org/pdfs/dmoi-tablet.pdf.
2. John E. Hutchinson. Introduction to MATH. ANALYSIS.// Department of MathematicsSchool of Mathematical Sciences. 1995 https://maths-people.anu.edu.au/~john/Assets/Lecture%20Notes/B21H_97.pdf https://www.booksfree.org/introduction-to-mathematical-analysis-by-john-e-hutchinson-1994-pdf-free-download/ANU
3. Исаев, К.П. Дискретная математика [Электронный ресурс]. Ч.1: учеб. пособие / К.П. Исаев,О.А. Кривошеева, Р.С. Юлмухаметов; Башкирский государственный университет. — Уфа: РИЦ БашГУ, 2014. — Электрон. версия печ. публикации. — Доступ возможен через Электронную библиотеку БашГУ. <URL:https://elib.bashedu.ru/dl/read/Isaev,Krivosheeva,Yulmuhametov_Diskretnaya matem_Uch.pos_ch1_2014.pdf>.
4. Исаев, К.П. Дискретная математика [Электронный ресурс]. Ч.2: учеб. пособие / К.П. Исаев,О.А. Кривошеева, Р.С. Юлмухаметов; Башкирский государственный университет. — Уфа: РИЦ БашГУ, 2014. — Электрон. версия печ. публикации. — Доступ возможен через Электронную библиотеку БашГУ. — <URL:https://elib.bashedu.ru/dl/read/Isaev,Krivoshenka,Uylmuhametov_Diskretnaya matem_Uch.pos_ch2_2014.pdf>.

Auxiliary literature:

1.Юлмухаметов, Р.С. Дискретная математика: Курс лекций / Р. С. Юлмухаметов, В. И. Луценко, Н. Ф. Абузярова ; Министерство образования РФ; Башкирский государственныйуниверситет .— Уфа : РИО БГУ, 2002 .— 262 с. – 92 экз.

2.Юлмухаметов, Р.С. Дискретная математика: учеб. пособие / Р. С. Юлмухаметов, К. П.Исаев, К. В. Трунов ; БашГУ .— Уфа : РИО БашГУ, 2005 .— 172 с. - 86 экз.

3.Практикум по дискретной математике [Электронный ресурс] / Башкирский государственный университет; сост. К.П. Исаев; О. А. Кривошеева; Р.С. Юлмухаметов .—Уфа : РИЦ БашГУ, 2014 .— Электрон. версия печ. публикации .— Доступ возможен через Электронную библиотеку БашГУ .—

<URL:https://elib.bashedu.ru/dl/local/Isaev_Krivosheeva_Yulmuhametov_sost_Practikum podiscretnoy matematik e_2014.pdf>.

5.2. List of the Internet resources and software necessary for acquiring the discipline, including professional data bases and reference systems.

1. Universitary WebWork server: http://webwork-okko.bashedu.ru/webwork2/.
2. Sharipov R. A. Electronic course «Linapril FMiIT» in the system of distant learning of BSU: <URL: https://sdo.bashedu.ru/course/view.php?id=1553 >.

6. Hardware equipment, materials and rooms necessary for implementing the educational process in the discipline.

Names of specialized rooms, rooms and laboratories	***Activity form***	***Name of the equipment/software***
1	***2***	***3***
Rooms 502, 501, 517 or any other room according to the current time table	*Lectures*	The board for writing
Rooms 502,501, 517 or any other room according to the current time table	*Seminars*	The board for writing
Library, reading halls	*Individual work*	Internet. The universitary WebWork server

Appendix 1

FEDERAL STATE BUDGETARY EDUCATIONAL INSTITUTION
OF HIGHER EDUCATION
«BASHKIR STATE UNIVERSITY»

CONTENT OF THE WORKING PROGRAM

of the discipline Linear algebra and applications for semesters 1 and 2

full-time
learning form

Activity	Duration
Total duration of the discipline (CUD / hours)	8/288
Academic hours for the work with instructor	140.4
lectures	68
seminars	68
laboratory	
other (consultation in group or individually and other forms of learning activities assuming collaboration of learners with instructor)	4,4
Academic hours for individual work of learners	51
Academic hours for preparing to exam/credit test/differentiated credit test (Grading)	96,6

Final grading:
exam in semester 1
exam in semester 2

Item no.	Topic and its content	Learning forms: lectures, seminars, laboratory, and individual work with duration (in academic hours)				Primary and auxiliary literature (numbers in the reference list)	Task for individual work of learners	• Forms of current grading (clolloquia, quizes, computer tests etc)
		LEC	SEM					
1	2	3	4	5	6	7	8	9
Semester 1, Module 1								
1.	Operations on sets and their properties. Duality principle. Cartesian product Power set. Cardinality of a set. .	6	6			1-3	10, first lonline WebWork task, problems 1-8 from the first midterm grading task	Scores for the work at the board and in class room
2.	Binary relations and their properties. Equivalence relation. Properties. Comparing of cardinalities.	6	6			1-3	Special Work-1	Scores for the work at the board and in class room
3.	Mappings of sets. Image and pre-image of elements and sets, their properties Surjections, injectioins, bijections. Examples. Inverse map. Composite map. Properties	6	6			1-3	10, first lonline WebWork task, problems 17-24 from the first midterm grading task	Scores for the work at the board and in class room
Semester 1, Module 2								
4	Combinatorics.Multiplicative principle (product rule). Additive principle (sum rule).	6	6			1-3	10, second online WebWork task, problems 1-5 from the first midterm grading	Scores for the work at the board and in class room

	(k,n) – permutations, (k,n) – permutations with repetitions. (k,n) – combinations, (k,n) – combinations with repetitions						task	
5	Equivalence of sets. Finite sets. Denumerable sets. Examples. Criterion. Countable sets and their subsets. Countable union of countable sets. Cardinality of set of all sequences which members are 0 and 1. Cardinality of set of all subsequences of naturals. .	6	6			1-3	10, second online WebWork task, problems 6-10 from the first midterm grading task	Scores for the work at the board and in class room
6	The set of rational is denumerable. Cartesian product of countable sets. Polynomials with rational coefficitents. Sets having infinite cardinality, their properties. Continuum. The set (0;1). How to compare of cardinalities? Cardinality of power set of given set.	6	6			1-3	Special Work-2	Scores for the work at the board and in class room
	Total hours for Semester 1:	36	36					

Item no.	Topic and its content	Learning forms: lectures, seminars, laboratory, and individual wrk with duration (in academic hours)				Primary and auxiliary litrature (numbers in the reference list)	Task for individual work of learners	Forms of current grading (clolloquia, quizes, computer tests etc)
		LEC	SEM	LAB	IND			
1	2	3	4	5	6	7	8	9
Semester 2 Module 1								
1.	Propositions and operations on them. Propositional forms. Tautologies and contradictions.Properties of tautologies. Existence of propositional form containing only two connectives that is equivalent ot given form.	8	8			1-4	10, first online WebWork task, problems 17-24 from the first midterm grading task	Scores for the work at the board and in class room
2	Schaeffer and Webb connectives and their properties. Conjunctive and disjunctive normal forms. (CNF and DNF) Existence of CNF and DNF. Perfect CNF and perfect DNF. Existence and uniqueness of perfect DNF equivalent to given one. Existence and uniqueness of perfect CNF equivalent to given one.	8	8			1-4	Special Work-3	he work at the board and in class room

Semester 2, Module 2								
3	Perfect CNF and perfect DNF. Existence and uniqueness of perfect DNF equivalent to given one. Existence and uniqueness of perfect CNF equivalent to given one.	8	8			1-4	10, second online WebWork task, problems 1-12 from the first midterm grading task	Scores for the work at the board and in class room
4	Boolean functions and propositional forms. Composite Booleans. Complete Boolean systems. Zhehgalkin polynomials. Basics of formal theory. Deduction principle.	8	8			1-4	Special Work-4	Scores for the work at the board and in class room
	Total hours for Semester 2:	**32**	32					
	Total hours for the year:	68	68					

Appendix 2

Rating-plan of the disciline Discreet Mathematics
Course of training (speciality) *01.03.02 Applied mathematics and informatics*
Year 1, semester 1 (fall)

Forms of learning activities of students	Scores for each task	Number of tasks in a module	Scores	
			Minimum	Maximum
Module 1				
Current grading				
1. Work at the board and in class room			0	20
Midterm grading				
1. Solution of Special Work-1	15	1	0	15
Module 2				
Current grading				
1. Work at the board and in class room			0	20
Midterm grading				
1. Solution of Special Work-2	15	1	0	15
Rewarding scores				
According to the Regulation on the modular scoring system			0	10
Attending/missing classes (scores for missing classes are subtracted)				
Attending lectures			0	-6
Attending seminars			0	-10
Final grading				
1. Exam	15	2	0	30

Rating-plan of the discipline Discreet Mathematics
Course of training (speciality) *01.03.02 Applied mathematics and informatics*
Year 1, semester 2 (spring)

Forms of learning activities of students	Scores for each task	Number of tasks in a module	Scores	
			Minimum	Maximum
Module 1				
Current grading				
2. Work at the board and in class room			0	20
Midterm grading				
1. Solution of Special Work-3	15	1	0	15
Module 2				
Current grading				
1. Work at the board and in class room			0	20
Midterm grading				
1. Solution of Special Work-4	15	1	0	15
Rewarding scores				
According to the Regulation on the modular scoring system			0	10
Attending/missing classes (scores for missing classes are subtracted)				
Attending lectures			0	-6
Attending seminars			0	-10
Final grading				
1. Exam	15	2	0	30

Examples of problems from Special Works.

Special Work-1.

Task №1. Draw the set

$$(A\Delta B) \cap \bar{C}.$$

Task №2. For the map f: $\mathbb{R} \rightarrow \mathbb{R}$ given by the formula $f(x)=x^2+4x+5$. Find $f([1,4])$.

Special Work-2.

Task №1.

Your Blu-ray collection consists of 9 comedies and 7 horror movies. Give an example of a question for which the answer is:

(a) 16.

(b) 63.

Task №2

In a recent survey, 30 students reported whether they liked their potatoes Mashed, French-fried, or Twice-baked. 15 liked them mashed, 20 liked French fries, and 9 liked twice baked potatoes. Additionally, 12 students liked both mashed and fried potatoes, 5 liked French fries and twice baked potatoes, 6 liked mashed and baked, and 3 liked all three styles. How many students *hate* potatoes? Explain why your answer is correct.

Task №3

The number 735000 factors as $2^3 \cdot 3 \cdot 5^4 \cdot 7^2$. How many divisors does it have? Explain your answer using the multiplicative principle.

Special Work-3.

Task №1.

Consider the statement about a party, "If it's your birthday or there will be cake, then there will be cake."

(a) Translate the above statement into symbols. Clearly state which statement is P and which is Q.

(b) Make a truth table for the statement.

(c) Assuming the statement is true, what (if anything) can you conclude if there will be cake?

Task №2

Make a truth table for the statement $\neg P \wedge (Q \rightarrow P)$. What can you conclude about P and Q if you know the statement is true?

Appendix 4

An example of examination tickets

FSBEI of HE "BashkirState University"
Department of Mathematics and IT

01.03.02 Applied mathematics and informatics
Applied programming and data analysis

Discipline: «Discreet Mathwmatics»

Examination ticket №1

1. Operations on sets and their properties. Duality Principle.

2. Problem in the topic «Combinatorics».

Head of Dept /_____/ Fazullin Z.Yu.